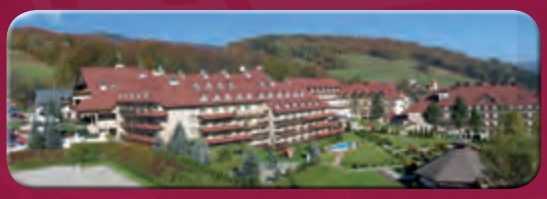
PROGRAMME AND PROCEEDINGS

of the International Scientific Congress

INPO 2017 AMME 25 years 1992-2017

WISŁA 2017

Edited by
Leszek A. Dobrzański & Michał Szota



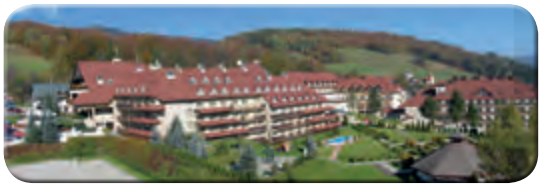
PROGRAMME AND PROCEEDINGS

of the International Scientific Congress

INPO 2017 AMME 25 years 1992-2017

WISŁA 2017

Edited by
Leszek A. Dobrzański & Michał Szota



10th Country-wide Scientific Conference on Surface Engineering INPO 2017

Published by

INTERNATIONAL OCSCO WORLD PRESS

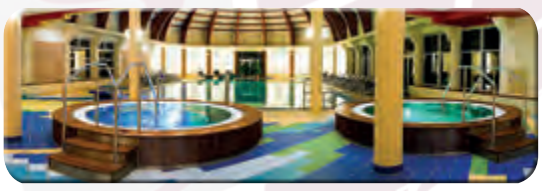


Silver Jubilee International Scientific Conference on Achievements in Mechanical and Materials Engineering AMME'2017

AMME 25 years 1992-2017

Published by

INTERNATIONAL OCSCO WORLD PRESS



INPO-AMME'2017

PROGRAMME AND PROCEEDINGS
of the International Scientific Congress
INPO-AMME'2017

Edited by Prof. L.A. Dobrzański and Prof. M. Szota

Technical edition:
M. Kraszewska, MA (AMME Conference Secretary and Manager)

Computer assistance of the INPO'2017 Conference:
A. Łukaszewicz, MSc

Computer assistance of the AMME'2017 Conference:
M. Kraszewska, MA, P. Zarychta, MSc

Abstracts have been printed from the originals supplied by authors.

INPO'2017 Conference Organisers:

Czestochowa University of Technology, Institute of Materials Engineering,
Association of Polish Inventors and Rationalizers, District Branch in Czestochowa,
Engineering Academy in Poland,
Polish Materials Science Society

AMME'2017 Conference Organisers:

World Academy of Materials and Manufacturing Engineering,
Association of Computational Materials Science and Surface Engineering,
Metallic Materials Section of the Materials Science Committee
of the Polish Academy of Sciences

The publication is financially supported by the Ministry of Science
and Higher Education in Poland allocated to the activities disseminating
science in the framework of the agreement no 875/P-DUN/2017.

Ministry of Science and Higher Education
Republic of Poland

– Task 1 Organisation of XXIV
International Scientific Conference
on Achievements in Mechanical
and Materials Engineering
AMME'2017

INTERNATIONAL OCSCO WORLD PRESS

ISBN 978-83-63553-46-3

CONTENTS

CONGRESS VENUE
The Conference Rooms of Stok Ski & Spa Hotel** in Wisła, Poland**
22nd - 25th October 2017

OFFICIAL LANGUAGE
English and Polish

PROCEEDINGS
Conference Proceedings are handed over to participants at the registration desk.

JOURNALS
Selected papers with the contents relating to the lectures presented during the INPO-AMME'2017 Congress after fulfilling the requirements of AMSE and JAMME journals are published successively in subsequent issues of AMSE and JAMME journals in 2017.

PRESENTATIONS TIME LIMITS
General time limits of presentations are as follows:

opening lecture – 20 minutes,
award holders' lectures – 15 minutes,
plenary lectures – 15 minutes.
invited lectures – 15 minutes

They can be changed by the Organising Committee. Discussions will follow all presentations in a session within its time span.

MULTIMEDIA DESK
Multimedia desk will assist all speakers with multimedia projectors.

POSTER SESSIONS
The poster surface is 1000 mm x 645 mm and a poster can be prepared for the presentation as one piece.

On the poster there should be written a paper title, initials and surnames of authors together with their affiliation and country of origin. The authors are to put their papers personally on the easels on which their paper identification number will be shown 15 minutes before the beginning of a suitable poster session.

REGISTRATION
22nd October 2017 at 16^{00} - 19^{00}
Reception – Stok Ski & Spa Hotel**** in Wisła, Poland

ACCOMMODATION, TRANSPORTATION AND MEALS
22nd- 25th October 2017

Stok Ski & Spa Hotel****
ul. Jawronik 52
Wisła, Poland

Organisers ensure accommodation and meals for the delegates of the INPO-AMME'2017 on 22nd(supper) - 25th (lunch) October 2017 in the Stok Ski & Spa Hotel****. Rooms in Wisła should be left till 12:00. Luggage should be left in the left luggage office of the reception of the Hotel.

ADDRESS OF INPO CONFERENCE

10th Countrywide Scientific Conference on
"Surface Engineering" INPO'2017

ADDRESS OF AMME CONFERENCE

Silver International Scientific Conference on
"Achievements in Mechanical and Materials Engineering" AMME'2017

Until 22nd October 2017

X Konferencja Naukowa Inżynieria
Powierzchni „INPO 2017"
Politechnika Częstochowska
Instytut Inżynierii Materiałowej
Al. Armii Krajowej 19,
42-200 Częstochowa, Poland
Tel/Fax: +48 574 049 897
E-mail: konferencja2017inpo@gmail.com
Home page: http://www.inpo.wip.pcz.pl

AMME'2017 Conference Secretariat
Association of Computational
Materials Science and Surface Engineering
ul. Ziemowita 10/1
44-100 Gliwice, Poland

Tel/Fax: + 48734195050
E-mail: info@amme.pl
Home page: http://www.amme.pl

Since 22nd October 2017

Stok Ski & Spa Hotel****
ul. Jawornik 52A
Wisła, Poland

BANK ACCOUNTS

INPO BANK ACCOUNT

Account name Stowarzyszenie Polskich
Wynalazców i Racjonalizatorów
Oddział Rejonowy w Częstochowie
ul. Wały Dwernickiego 117/121
42-200 Częstochowa, Poland
Bank name BGŻ BNP Paribas S.A. o/ Częstochowa
Account number/ IBAN CODE
PL72 2030 0045 1110 0000 0068 3920
Swift code PPABPLPK
Required remark INPO 2017

Taxpayer identification number (NIP) 9491636656

AMME BANK ACCOUNT

Account name Stowarzyszenie Komputerowej
Nauki o Materialach
i Inzynierii Powierzchni,
ul. Ziemowita 10/1,
44-100 Gliwice, Poland
Bank name ING Bank Slaski
Account number/ IBAN CODE
PL76105012981000002300809767 (PLN)
Swift code INGBPLPW
Required remark AMME'2017, delegate'sfirst and last names, registration no.
Taxpayer identification number (NIP) 631-24-70-12

GENERAL INPO-AMME2017

<table>
<tr><th>SUNDAY
22nd October 2017</th><th colspan="2">MONDAY
23rd October 2017</th></tr>
<tr><td rowspan="9"></td><td colspan="2">07:30 – 09:00
Breakfast</td></tr>
<tr><td colspan="2">10:00 – 10:20
Opening Ceremony and Award Ceremony
Congress Room A+B+C</td></tr>
<tr><td colspan="2">10:20 – 11:00
Opening lectures
Congress Room A+B+C</td></tr>
<tr><td colspan="2">11:00 – 11:35
Concert
Congress Room A+B+C</td></tr>
<tr><td colspan="2">11:35 – 11:50/12:00
Coffee break</td></tr>
<tr><td colspan="2">12:00 – 14:00
BOSS Session
Congress Room A+B+C</td></tr>
<tr><td colspan="2">14:00 – 15:00
Lunch</td></tr>
<tr><td>15:00-16:30
INPO Session 01
Congress Room A</td><td>15:00-16:30
AMME Invited Lectures
Plenary Session I
and Award Ceremony
Congress Room B</td></tr>
<tr><td colspan="2">16:30 – 16:45
Coffee break</td></tr>
<tr><td rowspan="2">16:00 – 19:00
Reception
in Stok Ski &Spa Hotel
in Wisła</td><td colspan="2">16:45 – 18:00
INPO-AMME Poster Session
Congress Room A+B+C</td></tr>
<tr><td colspan="2">18:00-19:00
General Assembly of WAMME
Room D</td></tr>
<tr><td>20:00 - 23:30
Folkloristic Dinner*
Under the Slope Inn
(informal dress)</td><td colspan="2">20:00 - 23:00
Banquet Dinner*
Congress Room A+B+C
(official dress)</td></tr>
</table>

** only for delegates who have received the special invitations*

CONGRESS TIMETABLE

<table>
<tr><th colspan="2">TUESDAY
24th October 2017</th><th>WEDNESDAY
25th October 2017</th></tr>
<tr><td colspan="2">07:30 – 09:00
Breakfast</td><td>07:30 – 09:00
Breakfast</td></tr>
<tr><td>09:00 – 10:45
INPO Session 02
Congress Room A</td><td>09:00 – 10:45
AMME Invited Lectures
Plenary Session II
Congress Room B</td><td rowspan="2">10:00 – 10:20
INPO-AMME Closing Ceremony
Plenary Lecture
Congress Room A+B+C

10:20 – 10:35
Closing Ceremony
Congress Room A+B+C</td></tr>
<tr><td colspan="2">10:45 – 11:15
Coffee break</td><td>10:35 – 11:15
Coffee break</td></tr>
<tr><td>11:15 – 13:00
INPO Session 03
Congress Room A</td><td>11:15 – 13:00
AMME Invited Lectures
Plenary Session III
Congress Room B</td><td rowspan="6">11:30 – 12:30
Lunch</td></tr>
<tr><td colspan="2">13:00 – 15:00
Lunch</td></tr>
<tr><td>15:00 – 16:45
INPO Session 04
Congress Room A</td><td>15:00 – 16:45
AMME Invited Lectures
Plenary Session IV
Congress Room B</td></tr>
<tr><td colspan="2">16:45 – 17:15
Coffee break</td></tr>
<tr><td>17:15-18:00
INPO Session 05
Congress Room A</td><td>17:15-18:0
AMME Invited Lectures
Plenary Session V
Congress Room B</td></tr>
<tr><td colspan="2">18:00 – 19:00
Meeting of Scientific Committee of INPO Conference
Room D</td></tr>
<tr><td colspan="2">20:00 - 22:00
Dinner
(informal dress)</td></tr>
</table>

CONCERT PROGRAMME

Wojciech Waleczek

PIANIST

Wojciech Waleczek is a Polish pianist known for his uncompromising approach to performative art. Born in 1980, over the last twenty years has performed numerous piano recitals as well as symphony and chamber concerts in 21 EU countries, Switzerland, Bosnia and Herzegovina, Moldova, Belarus, Russia, Kazakhstan, Jordan, Palestine, Algeria, Turkey, Iran, Iraq, Tunisia, Canada, Japan, Argentina and the USA.

He has performed as a soloist with the philharmonic orchestras of Kalisz, Koszalin, Lublin, Opole, Pomerania, Rzeszów, Szczecin, Silesia, Swietokrzyska, Wrocław, Zabrze and the Polish Chamber Orchestra of Sopot, Toruń Symphony Orchestra, Capella Bydgostiensis, Beethoven Academy Orchestra in Cracow, the Polish Orchestra "Sinfonia Iuventus", the Elbląg Chamber Orchestra, the Radom Chamber Orchestra, Karlovar Symphony Orchestra, the National Chamber Orchestra of Moldova, the Amman Symphony Orchestra, the Kaposvár Symphony Orchestra, the Symphony Orchestra of the Brest Academic Drama Theater.

In 2014, his chamber album recorded together with violinist Voytek Proniewicz with works by Ferenc Liszt for violin and piano was released by NAXOS, and in 2017 the Vienna record label CAPRICCIO released his latest album containing Ferenc Liszt transcriptions on the Nicolo Paganini caprices.

His numerous achievements include:

- 3rd prize, Arthur Rubinstein Prize founded by Aniela Rubinstein and a special prize of the Kościuszko Foundation in New York at The 2nd International Competition for Young Pianists "Arthur Rubinstein in memoriam" in Bydgoszcz, Poland (1996),
- 1st prize and the prize for the best performance of a concerto at the 4th F. Liszt National Piano Competition in Wrocław, Poland (1997),
- 3rd prize at the 7th International Piano Competition. F. Liszt "Premio Mario Zanfi" in Parma (2000),
- 2nd prize at the Festival of Young Pianists in Gdańsk (2002),
- 3rd prize at the 6th Seiler International Piano Competition in Palermo (2005),
- 3rd prize at the 3rd F. Liszt International Piano Competition in Wroclaw (2005).

Wojciech Waleczek graduated with honours from the Academy of Music in Katowice in the piano class of prof. Zbigniew Raubo in 2003. He continued his studies during a postgraduate course at the Vancouver Academy of Music under the direction of prof. Lee Kum-Sing. In 2014 he was granted a PhD in Arts at the Academy of Music in Bydgoszcz, where he achieved the habilitation in Arts on 27th September 2017.

In addition to concert activity, the artist also deals with academic and didactic activities - he works as an assistant professor at the Institute of Music of the University of Silesia and as an organisational vice president of the SIGNUM Association in Gliwice promoting classical music.

For more information visit www.waleczek.com

PIANO RECITAL – EUROPEAN ROMANTIC MUSIC

Robert Schumann (1810-1856) – Arabesque, op. 18

Fryderyk Chopin (1810-1849) – The Three Waltzes, op. 34

Ferenc Liszt (1811-1886) – 6 chants polonais, S.480:

1. The Wish
2. Spring
3. The Ring
4. Merrymaking
5. My Darling
6. The Bridegroom

Wojciech Waleczek – piano

VOCAL AND PIANO CONCERT – FILM, MUSICAL AND POP MUSIC

Wojciech Kilar – Film Music (Dracula, The Ninth Gate, Pianist, The Land of Promise)

George Gershwin – Summertime from the opera "Porgy and Bess"

„Miasteczko cud" ("Miracle Town") – Jerzy Satanowski (Music) Agnieszka Osiecka (Lyrics)

„To nasze ostatnie bolero" ("This is our last bolero") – Jerzy Satanowski (Music) Agnieszka Osiecka (Lyrics)

"We are the champions" – Freddie Mercury (Music and Lyrics)

Karolina Waleczek – vocal
Wojciech Waleczek – piano

Karolina Waleczek born in 1985 in Poland, a vocalist and a concert leader. She has been singing practically since her childhood – as she says – since she can remember. Her incredible passion for music is visible in her appearances on stage during numerous Festivals, Song Contests and Concerts. Thanks to her verve and familiarity with stage performances, Ms Waleczek does not only sing, but also leads classical and popular music concerts. What characterises Karolina most is her extraordinary voice timbre and her huge vocal scale. She took her private vocal-lessons in Cracow and improved her skills in a Vocal-Ballet College in Gliwice.

As a vocalist she took part in the following festivals:

- 24th Artistic Festival for Youth in Cracow, Poland (2nd prize)
- National Song Competition in Sosnowiec, Poland (2nd prize)
- Jazz Festival in Cracow, Poland

She was awarded the Artistic Prize by the Mayor of Olkusz – her home town.

She leads the concerts fluently in three languages: Polish, English and German. Command of languages also gives her an opportunity to work as a translator and interpreter.

In 2011 she completed her master's degree in Translatology at the Faculty of German Studies at the Jagiellonian University in Cracow. For one year she trained her skills in interpretation and translation at the Translation Training Centre in Sosnowiec – diploma in 2012. She is also a graduate of the Silesian University of Technology – postgraduate studies in transport logistics graduated in 2015.

Since 2008 she has been co-operating with Wojciech Waleczek, leading his concerts and performing together.

Karolina Waleczek

VOCAL

ORGANISERS OF INPO CONFERENCE

Częstochowa University of Technology, Institute of Materials Engineering, Częstochowa

Association of Polish Inventors and Rationalizers, District Branch in Czestochowa

Engineering Academy in Poland, Warsaw

Polish Materials Science Society, Łódź

PATRONAGE OF:

Prof. Norbert Sczygiol

Rector of Częstochowa University of Technology

Prof. Piotr Kula

President of the Polish Materials Science Society

SCIENTIFIC COMMITTEE OF INPO CONFERENCE

Prof. Prof. Tadeusz Frączek (Przewodniczący)
Prof. Prof. Michał Szota (Wiceprzewodniczący)

Prof. Tomasz Babul
Prof. Jolanta Baranowska
Prof. Leopold Berkowski
Prof. Anna Biedunkiewicz
Prof. Marek Blicharski
Prof. Zdzisław Bogdanowicz
Prof. Zbigniew Bojar
Prof. Jan Chłopek
Prof. Andrzej Ciaś
Prof. Jan Cwajna
Prof. Marek Danielewski
Prof. Ryszard J. Dąbrowski
Prof. Anna Dobrzańska–Danikiewicz
Prof. Leszek A. Dobrzański
Prof. Jan Dutkiewicz
Prof. Włodzimierz Dudziński
Prof. Halina Garbacz
Prof. Zbigniew Gawroński
Prof. Grzegorz Golański
Prof. Edward Guzik
Prof. Adam Hernas
Prof. Marek Hetmańczyk
Prof. Mieczysław Jurczyk
Prof. Stanisława Jonas
Prof. Łukasz Kaczmarek
Prof. Ewa Kasprzycka
Prof. Jan Kazior
Prof. Agnieszka Kopia
Prof. Krzysztof Kubiak
Prof. Barbara Kucharska
Prof. Piotr Kula
Prof. Michał Kulka

Prof. Jan Kusiński
Prof. Tadeusz Kulik
Prof. Andrzej Kwatera
Prof. Małgorzata A. Lewandowska
Prof. Piotr Liberski
Prof. Jerzy Lis
Prof. Eugeniusz Łągiewka
Prof. Bogusław Major
Prof. Adam Mazurkiewicz
Prof. Bogusław Mendala
Prof. Stanisław Mitura
Prof. Jarosław Mizera
Prof. Andrzej Michalski
Prof. Jerzy Michalski
Prof. Maciej Motyka
Prof. Anita Olszówka-Myalska
Prof. Marcin Nabiałek
Prof. Piotr Niedzielski
Prof. Grzegorz J. Niewielski
Prof. Jerzy Nowacki
Prof. Katarzyna Ożga
Prof. Jerzy Pacyna
Prof. Marta Paczkowska
Prof. Aleksandra Pertek
Prof. Bogdan Piekarski
Prof. Wojciech Przetakiewicz
Prof. Karol Przybyłowicz
Prof. Jerzy Ratajski
Prof. Ferdynand Romankiewicz
Prof. Jacek Sawicki
Prof. Jan Sieniawski
Prof. Jerzy Smolik
Prof. Jerzy Sobczak
Prof. Jerzy Robert Sobiecki
Prof. Barbara Surowska
Prof. Lucjan Swadźba
Prof. Małgorzata Szadkowska
Prof. Jerzy Szawłowski
Prof. Marian Szczerek
Prof. Wojciech Szkliniarz
Prof. Michał Tacikowski
Prof. Edmund Tasak
Prof. Bogdan Wendler
Prof. Tadeusz Wierzchoń
Prof. Henryk Woźnica
Prof. Mieczysław Wysiecki
Prof. Andrzej Zieliński
Prof. Paweł Zięba
Prof. Zbigniew Żurek

INPO CONFERENCE ORGANISING TEAM

Prof. Michał Szota	INPO *Conference Chairman*
Prof. Tadeus Frączek	*INPO Conference V-ce Chairman*
Prof. Barbara Kucharska	*Secretary*
Ms Justyna Klimas-Organa, MSc	*Member*
Mr Adrian Łukaszewicz, MSc	*Member*
Ms Milena Pilarska, MSc	*Member*
Ms Katarzyna Ryszko, MSc	*Member*
Ms Paulina Kordas, MSc	*Member*

INPO 2017 AMME 25 1988-2017

22nd – 25th October 2017
WISŁA, POLAND

International Scientific Congress INPO-AMME

10th Country-wide Scientific Conference on Surface Engineering INPO 2017

Silver Jubilee International Scientific Conference on Achievements in Mechanical and Materials Engineering AMME 2017

conference2017inpo@gmail.com www.inpo.wip.pcz.pl info@amme.pl www.amme.pl

ORGANISERS OF AMME CONFERENCE

World Academy of Materials and Manufacturing Engineering, Gliwice, Poland

Association of Computational Materials Science and Surface Engineering, Gliwice, Poland

Metallic Materials Section of the Materials Science Committee of the Polish Academy of Sciences, Gliwice, Poland

PATRONAGE OF:

Prof. Bogusław Major
Chairman of the Materials Science Committee of the Polish Academy of Sciences

PROGRAMME COMMITTEE OF AMME CONFERENCE

Prof. Leszek A. Dobrzański *(Chairman)* **Poland**

Prof. Sadek C. Absi-Alfaro	Brazil	Prof. Janusz Dobrzański	Poland
Prof. Marcin Adamiak	Poland	Prof. Georgy Drapak	Ukraine
Prof. Piotr Bała	Poland	Prof. Nikolaos Gouskos	Greece
Prof. Gilmar Batalha	Brazil	Prof. Janez Grum	Slovenia
Prof. Emin Bayraktar	France	Prof. Toshio Haga	Japan
Prof. Silvio Francisco Brunatto	Brazil	Prof. Abdel Magid Hamouda	Qatar
Prof. Tadeusz Bołd	Poland	Prof. Stuart Hampshire	Ireland
Prof. Andrzej Buchacz	Poland	Prof. Fuling Han	China
Prof. Tara Chandra	Australia	Prof. Adam Hernas	Poland
Prof. Grzegorz Chladek	Poland	Prof. Marek Hetmańczyk	Poland
Prof. Jan Cwajna	Poland	Prof. Hong Hocheng	Taiwan
Prof. Tsanka Dikova	Bulgaria	Prof. Kim Ill-Soo	South Korea
Prof. Anna Dobrzańska-Danikiewicz	Poland	Prof. Yong-Teak Im	South Korea

AMME CONFERENCE ORGANISING TEAM

Prof. Leszek A. Dobrzański	*AMME Conference Chairman*
Ms Marzena Kraszewska, MA	*Secretary and Conference Manager*

AUXILIARY TEAM

Prof. Piotr Malara	*Member*
Dr Zbigniew Brytan	*Member*
Dr Dawid Cichocki	*Member*
Dr Marek Sroka	*Member*
Ms Justyna Hajduczek-Jarka, MSc	*Member*
Mr Piotr Zarychta, MSc	*Member*

ACCOMPANYING EVENTS

- Handing the honorary awards of Prof. Fryderyk Staub Golden Owl for achievements in promoting the Polish science and higher education on the international arena and for achievements in collaboration with the Polish scientific community of materials engineering for 2016-2017
- Handing Prof. Leopold Jeziorski Golden Medal as the Honorary Special Award of the World Academy of Materials and Manufacturing Engineering for distinguished scientists for 2016-2017
- Handing Professor Boris Tomov Crystal Owl as the Honorary Award of the World Academy of Materials and Manufacturing Engineering for a promising Polish Young Professor for 2015-2016
- Handing Professor Juriy Shalapko Silver Owl as the Honorary Award of the World Academy of Materials and Manufacturing Engineering for international cooperation - in 2016 Polish-Italian cooperation
- Handing Professor Jan Adamczyk Bronze Owl as the Honorary Award of the World Academy of Materials and Manufacturing Engineering for a young scientist for a distinguished PhD or DSc thesis 2015-2016
- The Bidisciplinary Occasional Scientific Session BOSS'2017 on the occasion of the 70th anniversary of Prof. Leszek A. Dobrzański's birthday
- The General Assembly of the World Academy of Materials and Manufacturing Engineering
- The Meeting of the Association of Computational Materials Science and Surface Engineering
- The Annual Meeting of the Metallic Materials Section of the Materials Science Committee of the Polish Academy of Sciences

PREFACE OF THE AMME'2017 CONFERENCE CHAIRMAN

Distinguished WAMME Fellows and ACMS&SE Members!
Dear Delegates of INPO-AMME Congress !
Dear Guests!
Ladies and Gentlemen!

It is 25 years since October 1992, when as a young 45-year-old Dean of the Faculty of Mechanical Engineering of the Silesian University of Technology in Gliwice, I invited a group of Friends, mainly Deans and other Guests from various foreign Universities, to Gliwice for the common scientific conference, in which the Polish representatives of materials science, mechanics and manufacturing engineering also participated. It is how the 25-year-old history of the International Scientific Conference on Achievements in Mechanical and Materials Engineering AMME has began.
Many thousands of participants from more than 50 countries from the most remote parts of the world and also from Poland have participated in it. It has a long and good tradition. This is one of the reasons that we are currently organizing the current Conferences in October 2017. But this is not the only reason.
Today, after 25 years, the situation is quite different. On the 4th September 2017 I reached the age of 70. On 1st October 2017, after 50 years of employment at the Silesian University of Technology in Gliwice, Poland, I finished my career at this University, retired, and attained Emeritus Professor positions. We took the effort to organize our own research unit under the name Medical and Dental Engineering Centre for Research, Design and Production ASKLEPIOS in Gliwice, Poland and this idea I have decided to sacrifice all my energy in the coming years. I would like to thank all those who came here especially to celebrate all those occasions with me.
On 19th August 2016, which was over a year ago, Prof. Leopold Jeziorski died unexpectedly. He was an unusual, friendly, wise and for many years took care of the integration of the Polish scientific community of materials engineering. He has still many friends who recall him with great respect and esteem here. Many of them made their scientific career as he helped them in their promotion as a member of the Central Commission for Scientific Degrees. He was a graduate, a full-time professor, a Vice Rector, a Dean, a Director of the Institute of the Częstochowa University of Technology, Poland and finally its Doctor Honoris Causa, as well as of the Lodz University of Technology in Lodz, Poland. He was the initiator and long-time organizer of the National Scientific Conference on Surface Engineering INPO, organized every three years, which is held this year for the tenth time, but unfortunately without his personal participation. He was also a Founder Fellow of the World Academy of Materials and Manufacturing Engineering WAMME and a member of the Programme Committees for AMME and CAM3S Conferences, for more than a decade organized under the patronage of the WAMME Academy.
Because Prof. Leopold Jeziorski was so closely connected with the INPO and AMME Conferences, it was decided to join them organizing the INPO-AMME Congress, which is related to the tradition of the COMMENT Congresses, in order to commemorate Prof. Leopold Jeziorski. The memory of Prof. Leopold Jeziorski is commemorated in a special way, because for the first time Prof. Leopold Jeziorski Golden Medal as the Honorary Special Awards of the World Academy of Materials and Manufacturing Engineering for distinguished scientists for outstanding scientific and organizational achievements in three categories are handed:

- Outstanding Polish scholars connected with WAMME,
- Outstanding foreign scholars,
- Young Scientists.

The laurates receive the WAMME membership if they have not been selected to WAMME so far together with this Medal.
I am very pleased to announce that for the first time this year the Chapter has awarded five WAMME Prof. Leopold Jeziorski Golden Medal in 2016 and 2017 and they are received by:

- Professor Jerzy Nowacki - Vice President of WAMME
- Professor Jerzy Pacyna - Member of the WAMME Presidium
- Professor Miklos Tisza from University in Miskolc, Hungary
- Professor Zoia Duriagina from Lviv Polytechnic - State University in Lviv, Ukraine
- Professor Michał Szota - outstanding alumnus of Prof. Leopold Jeziorski
- Professor Tadeusz Frączek - outstanding alumnus Prof. Leopold Jeziorski.

To the traditions of conferences of series on Achievements in Mechanical and Materials Engineering AMME, the yearly handing of honorary awards of the Prof. Fryderyk Staub Golden Owl for achievements in promoting the Polish science and higher education on the international arena and achievements in collaboration with the Polish scientific community of materials and manufacturing engineering to eminent scientists nominates by the Chapter belong. The honorary awards of the Prof. Fryderyk Staub Golden Owl for achievements in promoting the Polish science and higher education on the international arena and achievements in collaboration with the Polish scientific community of materials and manufacturing engineering in 2016 and 2017 are achieved by the outstanding scientist:

- Prof. Sabu Thomas (India) 2016
- Prof. Dhanash Chandra (USA) 2017
- Prof. M. Muruganant (India) 2017

So far the very prestigious awards have been achieved by outstanding scientists from many countries of the world in the following order: Prof. Marcel Hubert Van de Voorde (Belgium) 1997, Prof. Frank William Travis (Scotland) 1998, Prof. Jose Manuel Torralba Castillo (Spain) 1999, Prof. Maria Helena Robert (Brazil) 2000, Prof. Saleem Mahammed Sarwar Jang Hashmi (Ireland) 2000, Prof. Boris Ivanov Tomov (Bulagria) 2000, Prof. Yoseph Katz (Israel) 2001, Prof. Janez Kopac (Slovenia) 2001, Prof. Marcel Zitnansky (Slovakia) 2001, Prof. Belén Levenfeld (Spain) 2002, Prof. Mario Rosso (Italy) 2002, Prof. Božo Smoljan (Croatia) 2002, Prof. Jaroslav Koutsky (Czech Republic) 2003-2005, Prof. Yuriy Rudavskiy (Ukraine) 2003-2005, Prof. Yong Taek Im (South Korea) 2003-2005, Prof. Paul Siffert (France) 2003-2005, Prof. Jerry Sokolowski (Canada) 2006, Prof. Spillios Fassois (Greece) 2006, Prof. Toshio Haga (Japan) 2006, Prof. Gregorij M. Drapak (Ukraine) 2007, Prof. Ming-.Jen Tan (Singapore) 2007, Prof. Prasad.K.D.V. Yarlagadda (Australia) 2007, Prof. Hong Hocheng (Taiwan) 2008, Prof. Franc Cus (Slovenia) 2008, Prof. Gilmar Batalha (Brazil) 2009, Prof. Emin Bayraktar (France) 2009, Prof. Stanislav Rusz (Czech Republic) 2009, Prof. Jurij Bobalo (Ukraine) 2010, Prof. Rudolf Kawalla (Germany) 2010, Prof. Mirko Sokovic (Slovenia) 2010, Prof. Zinoviy Stotsko (Ukraine) 2010, Prof. Ana Maria Fernandez (Spain) 2011, Prof. Kim Ill-Soo (Korea) 2011, Prof. Borut Kosec (Slovenia) 2011, Prof. Sadek Absi-Alfaro (Brazil) 2012, Prof. Cemal Meran (Turkey) 2012, Prof. Abdalla Wifi (Egypt) 2012, Prof. Peter Palcek (Slovak Republic) 2013, Prof. Elena David (Romania) 2014, Prof. Bekir Yilbas (Saudi Arabia) 2014 and Prof. Lothar Kroll (Germany) 2015.

Many of them participate constantly also this year in the AMME'2017 Conference.

The Professor Boris Tomov Crystal Owl as the Honorary Award of the World Academy of Materials and Manufacturing Engineering for a promising Polish young Professors will take place during this AMME'2017 Conference also. Professor Boris Tomov died in May 2013 and was former many-year Rector of the University in Russe, Bulgaria, a former visiting professor of the Silesian University of Technology in Gliwice in Poland, a fellow of the World Academy of Materials and Manufacturing Engineering WAMME. He was a brilliant scientist, a great organizer of science, a great friend of Poland and Polish people, respected for his bread knowledge and big heart, respect for every human being, and an open attitude towards other people, nations and ideas. The Chapter hands the Professor Boris Tomov Crystal Owl as the Honorary Award of the World Academy of Materials and Manufacturing Engineering to:

- Prof. Piotr Bała from Academy of Mining and Metallurgy in Krakow, Poland (2015) and
- Prof. Emilia Wołowiec-Korecka from the University of Technology in Łódź, Poland (2016)

The awards have been achieved previously by Prof. Michał Szota from the Częstochowa University of Technology and Prof. Piotr Malara from the Silesian University of Technology.

For the 9th time the handing of the Professor Jan Adamczyk Bronze Owl as the Honorary Award of the World Academy of Materials and Manufacturing Engineering for a young scientist for a distinguished PhD or DSc thesis will take place during this AMME'2017 Conference. Professor Jan Adamczyk, died suddenly in 2007, was a Founder Fellow of the World Academy of Materials and Manufacturing Engineering, and for many years was the Director of the Institute of Metals Science and 9 years Deputy Director of the Institute of Engineering Materials and Biomaterials of the Silesian University of

Technology in Gliwice, Poland. Prof. Jan Adamczyk was also a fan of classical music, for many years he sang in the Academic Choir of the Silesian University of Technology and he knew many famous opera and opera artefacts, which he repeatedly performed a capella during previous AMME conferences. The Chapter hands this year the Professor Jan Adamczyk Bronze Owl as the Honorary Award of the World Academy of Materials and Manufacturing Engineering to:

- Habilitated Doctor in Arts Wojciech Waleczek very famous pianist from the University of Silesia in Katowice-Cieszyn for making a rewarded DSc thesis on the Liszt paraphrases of Paganini who gave traditionally piano concerts on Opening Ceremonies of the successive AMME Conferences. It is the Special Award in this category, firstly, because it was awarded for a habilitation dissertation, and secondly that it was awarded as an achievement in the field of art not technical sciences.
- Dr Weronika Wolany for making a rewarded PhD thesis on *The newly developed nanocomposites consisting of nanostructured rhenium combined with carbon nanomaterials* prepared under Prof. Anna Dobrzańska-Danikiewicz's supervision.
- Dr Anna Achtelik-Franczak for making a rewarded PhD thesis on *Engineering composite materials reinforced by microporous titanium selective laser sintered* prepared under Prof. Leszek A. Dobrzański's supervision.

The award has been achieved so far by Dr Tomasz Tański from the Silesian University of Technology in Gliwice, Poland, Dr Piotr Bała from the AGH University of Science and Technology in Kraków, Poland, Dr Marek Kremzer from the Silesian University of Technology in Gliwice, Poland, Dr Rafał Babilas from the Silesian University of Technology in Gliwice, Poland, Dr Wojciech Borek from the Silesian University of Technology in Gliwice, Poland, Dr Marcin Bilewicz from the Silesian University of Technology in Gliwice, Poland and Dr Błażej Tomiczek from the Silesian University of Technology in Gliwice, Dr Dariusz Łukowiec from the Silesian University of Technology in Gliwice and Dr Agnieszka Kaczmarek-Pawelska from University of Zielona Góra.

For the second time the handing of the Professor Juriy Shalapko Silver Owl as Honorary Award of the World Academy of Materials and Manufacturing Engineering for international cooperation - in 2017 Polish-Italian cooperation will take place during this AMME'2017 Conference. Professor Juriy Shalapko died tragically in October 2015 and was a former very active Professor of the State University in Khmelnitsky in Ukraine and a Head of the Chair, visiting many times the Silesian University of Technology in Gliwice in Poland and was a Fellow of the World Academy of Materials and Manufacturing Engineering WAMME, a Member of the Editorial Board of the journals published by the Association of the Computational Materials Science and Surface Engineering. He was an outstanding scientist, a great organizer of science, a great friend of Poland and Polish people, respected for his open attitude towards other people, nations and ideas.

This year the Chapter hands the Professor Juriy Shalapko Silver Owl as Honorary Award of the World Academy of Materials and Manufacturing Engineering to

- Prof. Mario Rosso – Politechnico di Torino, Italy
- Dr Zbigniew Brytan – Silesian University of Technology, Gliwice, Poland, Secretary of Main Board of the ACMS&SE Association.

The Professor Juriy Shalapko Silver Owl as Honorary Award of the World Academy of Materials and Manufacturing Engineering were handed previously to Prof. Zinoviy Stotsko - Ukraine and Dr Mirosław Bonek – Poland.

On behalf of the members of the Chapter, of the AMME'2017 Conference delegates and my own I congratulate and wish further successes in the scientific and organisational activeness to the awarded eminent Scientists and also wish them happiness in their private lives and further years in good health.

The World Academy of Materials and Manufacturing Engineering focusing altogether ca. 250 worldwide known outstanding scientists, and is the founder of the Worldwide Journal of Achievements of Materials and Manufacturing Engineering, published together with two other journals: Archives of Materials Science and Engineering and Open Access Library by by the Association of Computational Materials Science and Surface Engineering and the World Academy of Materials and Manufacturing Engineering and under the auspices of the Committee of Materials Science of the Polish Academy of Sciences, achieving the highest possible evaluation by the Ministry of Science and Higher Education, referred by Scopus, the Directory of Open Access Journals, Google Scholar, Scirus, Ulrich's Periodical Directory, Library Catalogue Dragon, BazTech Journalseeker, Worldcat, Libsearch, Harzing's Publish or Perish. Thanks to timely free-of-charge service of

Reading Direct and their abstracts available in DOAJ widely disseminated in the World and available for many researchers, and that is why frequently cited by domestic and foreign authors.
AMME'2017 Conference is one of the main prestigious conferences organised by the Association of Computational Materials Science and Surface Engineering and the World Academy of Materials and Manufacturing Engineering out of over 100 events organised during the associations' existence. The Conference taking place in the period of 22nd – 25th October 2017 is organised again in Wisła, which plays a special role for the WAMME Academy as a place of many meetings of its General Assembly, this time in the Conference Rooms of the Stok Resort and Spa Hotel****. As usual the Conference is content-relatedly and financially supported by the Ministry of Science and Higher Education in Poland.
This conference will be as usual a regular encounter of scientists coming from various areas of materials and mechanical engineering to facilitate an exchange of ideas between researchers from all over the world. It gives also the opportunity to present results of efforts of the young PhD students, who make their first steps in the scientific society. To make these meetings even more fruitful, many accompanying events give the opportunity to meet participants of various scientific projects and networks. The event's participants feature an excellent forum to witness awarding those contributors, who have the greatest merits to the development of the activities exerted , in this field. The AMME`2017 Conference will have a character of 4-day adult training and serves to accomplish knowledge and raise professional qualifications for its delegates including the level of professional knowledge and abilities of making current engineering and research works mainly in the field of the newest technological achievements, methodology of scientific researches and engineering calculations, the newest trends in the field of education and distance learning. The trainings includes the following main issues: engineering materials, materials properties and methodology of research, analysis and modelling of materials structure and properties, materials manufacturing and processing, nanotechnology, cleaner production, industrial management and organisation education, distance learning and research trends.
The International Scientific Conferences on Achievements in Mechanical and Materials Engineering AMME and the next General Assemblies of the World Academy of Materials and Manufacturing Engineering took place in many important places in Poland. Those places became close to WAMME fellows and its sympathisers of whom a few thousands participated in those events, from ca. 50 countries from all world continents. A special role for the WAMME Academy plays Zakopane, a winter capital of Poland, also very beautiful in summer time. The WAMME Academy was established here and the meetings of the General Assembly of the WAMME Academy and AMME and CAM3S Conferences have taken place here already for several times. Those conferences took place in Kraków, a city having a special meaning for world culture, including on the Wawel Hill, in the former seat of the Polish Kings and in the Collegium Novum of the Jagiellonian University, the oldest Polish academic university and the Gallery of 19th-Century Polish Art at Sukiennice. The important meaning for the WAMME Academy has also Wisła – a pearl of the Silesian Beskidas and Rydzyna with its castle of the King Stanisław Leszczyński. One of venues of the AMME conferences was once Sopot with the oldest pier at the Baltic Sea and a historical Grand Hotel and historical Gdańsk at the beautiful Polish seaside with its City Hall in the Old Town, the conference rooms of the very modern Mercure Hevelius Hotel and the Great Hall of Artus Court in Gdańsk, Wrocław with beautiful Leopoldina Hall in the main building of the University of Wrocław. Surely Gliwice – with a seat of the WAMME Academy is an important venue for the WAMME Academy, and also a venue of many conferences of the AMME and CAM3S series.

During the Opening Ceremony of the International Scientific Conferences on Achievements in Mechanical and Materials Engineering AMME'2017 the wonderful music of famous composers will be played by the famous Polish pianist of the young generation Wojciech Waleczek from Silesia.
the General Assembly of the World Academy of Materials and Manufacturing Engineering and the Annual Meeting of the Association of Computational Materials Science and Surface Engineering will be very important accompanying events of AMME'2017.

I wish nice time spent in Poland and wish all the delegates the nice impressions from the stay in Poland and in hospitable Wisła, very many scientific expressions to all delegates, fruitful scientific debates and new constant relationships of scientific cooperation. However, I am convinced the most important reason for the satisfaction in the AMME'2017 Conference will be the participation in very attractive scientific and content-related debates in the Plenary Sessions, and also

the active participation in the Poster Sessions. I wish that my conviction was shared with as great number of the AMME'2017 Conference delegates as possible.
In that place with great pleasure I would like to thank the P.T. Authors of lectures and papers included in the Conference Programme for the efforts put in their preparation, the reviewers for their evaluation, the members of the Editorial Office for their outworking and preparation for print. I hope that this activity will bring advantages to all AMME'2017 Conference delegates. The special thanks goes to Fellows of the World Academy of Materials and Manufacturing Engineering and the Members of the Association of Computational Materials Science and Surface Engineering, who personally and numerously participate in the AMME'2017 Conference, taking in that way the patronage of those institutions over that important worldwide scientific event. I would like to thank Guests and Delegates who arrived from many world countries. I am proud similarly to many delegates from Poland that our country is so numerously visited by you for what I thank you very much.

The warm thanks goes to the members of Associations of Computational Materials Science and Surface Engineering for the efforts connected with all organisational and publication activities put in the preparation the AMME'2017 Conference and the realisation of that important and big scientific event. I direct the special thanks to Ms Marzena Kraszewska, MA due to whose persistent work this year AMME'2017 Conference was organised as the Secretary of the Organising and Programme Committees and main Manager of the Conference.

Prof. Leszek A. Dobrzański M. Dr hc
Chairman of the AMME Conference
President of the WAMME
President of the ACMS&SE
Editor-in-Chief of the JAMME, AMSE and OAL

Gliwice - Wisła, in October 2017

DETAILED INPO-AMME2017 CONGRESS PROGRAMME

SUNDAY — 22nd October 2017

Stok Ski & Spa Hotel** in Wisła**

Time	Schedule
16^{00} – 19^{00}	Registration - Stok Ski & Spa Hotel**** in Wisła
20^{00} – 23^{30}	Folkloristic Dinner - Stok Ski & Spa Hotel**** in Wisła

MONDAY

23rd October 2017

Stok Ski & Spa Hotel** in Wisła**

Time	Schedule	
7^{30} – 9^{00}	Breakfast	
10^{00} – 10^{20}	Opening Ceremony and WAMME Prof. F. Staub Golden Owl Award and Prof. L. Jeziorski Golden Medal Handing Ceremony*	
10^{20} – 11^{00}	Opening lectures**	
11^{00} – 11^{35}	Concert	
11^{35} – 12^{00}	/Coffee break	
12^{00} – 14^{00}	BOSS Session***	
14^{00} – 15^{00}	Lunch	
15^{00} – 16^{30}	INPO Session 01	 AMME Invited Lectures Plenary Session I WAMME Prof. J. Adamczyk, Prof. B. Tomov and Prof. J. Shalapko Awards Handing Ceremony 
16^{30} – 16^{45}	**Coffee break**	
16^{45} – 18^{00}	INPO-AMME Poster session	
18^{00} – 19^{00}	General Assembly of WAMME	
20^{00} – 23^{00}	Banquet Dinner	

* ** ***During the sessions simultaneous translations from English to Polish and Polish to English are respectively foreseen

I. OPENING CEREMONY
WAMME Prof. F. Staub Golden Owl Award and Prof. L. Jeziorski Golden Medal Handing Ceremony
OPENING LECTURES
II. CONCERT

Monday 23rd October 2017
Stok Ski & Spa Hotel** in Wisła**

$10^{00} – 11^{35}$

Congress Room A+B+C

INTERNATIONAL SCIENTIFIC CONGRESS INPO 2017 AMME

Chairpersons:
Prof. Leszek A. Dobrzański (Poland)
Prof. Tadeusz Frączek (Poland)
Prof. Michał Szota (Poland)
Prof. Norbert Szczygioł (Poland)
Prof. Paweł Zięba (Poland)
Ms Marzena Kraszewska, MA (Poland)

I.1. **Opening Address of the INPO-AMME Organisers**
Prof. Michał Szota
Chairman of Organising Committee of INPO Conference
Ms Marzena Kraszewska, MA
Secretary of Programme and Organising Committees and Manager of AMME Conference

I.2. **Opening Address of Prof. Tadeusz Frączek**
Chairman of Programme Committee of INPO Conference

I.3. **Opening Address of Prof. Leszek A. Dobrzański**
President of the World Academy WAMME
Chairman of Programme and Organising Committees of AMME Conference

I.4. **Handing the honorary awards of the Prof. Fryderyk Staub Golden Owl for achievements in promoting the Polish science and higher education on the international arena and for achievements in collaboration with the Polish scientific community of materials engineering for 2016-2017**
Prof. Dhanesh Chandra (USA)
Prof. Thomas Sabu (India)
Prof. M. Muruganant (India)

I.5. **Handing Prof. Leopold Jeziorski Golden Medal as the Honorary Special Award of the World Academy of Materials and Manufacturing Engineering for distinguished scientists for 2016-2017**
Prof. Miklos Tisza (Hungary)
Prof. Zoia Duriagina (Ukraine)
Prof. Jerzy Nowacki (Poland)
Prof. Jerzy Pacyna (Poland)
Prof. Tadeusz Frączek (Poland)
Prof. Michał Szota (Poland)

I.6. **INPO Opening lecture**
Prof. Jan Kusiński (Cracow, Poland)
Laser treatment (Special Invited Lecture)

I.7. **AMME Opening lecture**
Prof. Sabu Thomas (Kottayam, India)
A Strategy for Developing High Performance Functional Eco-Friendly Polymer Nanocomposites (Award Lecture)

II.1 **Concert**
Wojciech Waleczek – piano

II.2. **Handing Prof. Jan Adamczyk Bronze Owl as the Special Honorary Award of the World Academy of Materials Manufacturing Engineering for a young scientist for a distinguished DSc thesis for 2016-2017**
Prof. Wojciech Waleczek (Poland)

III. BOSS SESSION

Monday 23rd October 2017
Stok Ski & Spa Hotel** in Wisła**
Congress Room A+B+C

$12^{00} – 14^{00}$

Chairpersons:
Prof. Miklos Tisza (Hungary)
Prof. Peter Palček (Slovak Republic)
Prof. Tadeusz Wierzchoń (Poland)
Prof. Jerzy Pacyna (Poland)

III.1 ***Prof. Leszek A. Dobrzański, WAMME President (Gliwice, Poland)***
Special Occasional Lecture
Composite structures and nanocomposite materials

III.2 ***Dr Mirosław Bonek (Gliwice, Poland)***
Eulogy on the occasion of Prof. Leszek A. Dobrzański's 70th Birthday Anniversary and presentation of 60 promoted PhD theses which was prepared under his personal supervisory guidance

III.3 Open discussion

IV. INPO SESSION 01

$15^{00} – 16^{30}$

Monday 23rd October 2017
Stok Ski & Spa Hotel** in Wisła**
Congress Room A

10TH COUNTRY-WIDE SCIENTIFIC CONFERENCE INP 2017

Chairpersons:
Prof. Marek Hetmańczyk
Prof. Lucjan Swadźba
Prof. Maria Trzaska

IV.1 ***dr hab. inż. Agnieszka Kopia***
Cienkie warstwy perowskitów wytwarzane metodą PLD do zastosowań jako czujniki gazów

IV.2 ***dr inż. Bartosz Witala***
Powłoki żaroodporne wytwarzane metodą CVD

IV.3 ***prof. dr hab. inż. Jerzy Michalski***
Azotowanie antykorozyjne części maszyn

IV.4 ***dr inż. Sławomir Kąc***
Mikrostruktura i właściwości powłok (Co,Al)WC nanoszonych techniką naddźwiękowego natryskiwania zimnym gazem

IV.5 ***prof. nzw. dr hab. inż. Grzegorz Moskal***
Odporność na utlenianie nowych stopów kobaltu modyfikowanych itrem, cyrkonem i hafne

V. WAMME Prof. J. Adamczyk, Prof. Boris Tomov, Prof. Juriy Shalapko Awards Handing Ceremony
VI. AMME Invited Lectures Plenary Session I
$15^{00} – 16^{30}$

Monday 23rd October 2017
Stok Ski & Spa Hotel** in Wisła**
Congress Room B

SILVER JUBILEE INTERNATIONAL SCIENTIFIC CONFERENCE AMME

Chairpersons:
Prof. Leszek A. Dobrzański (Poland)
Prof. Jerzy Nowacki (Poland)
Prof. Mario Rosso (Italy)
Prof. Sabu Thomas (India)

V.1 **Handing the Professor Jan Adamczyk Bronze Owl as the Honorary Award of the World Academy of Materials and Manufacturing Engineering for a young scientist for a distinguished PhD thesis 2015-2016**
Dr Weronika Wolany (Poland)
Dr Anna Achtelik-Franczak (Poland)

V.1 **Handing the Professor Boris Tomov Crystal Owl as the Honorary Award of the World Academy of Materials and Manufacturing Engineering for a promising Polish Young Professor for 2015-2016**
Prof. Piotr Bała (Poland)
Prof. Emilia Wołowiec-Korecka (Poland)

V.2 **Handing the Professor Juriy Shalapko Silver Owl as Honorary Award of the World Academy of Materials and Manufacturing Engineering for international cooperation - in 2016 Polish-Italian cooperation**
Prof. Mario Rosso (Italy)
Dr Zbigniew Brytan (Poland)

VI.1 ***Pacyna J. (Cracow, Poland)***
Crack resistance of tool steels corresponding with the chemical composition of their matrices *(Award lecture)* (1.43)

VI.2 ***Chandra D. (Reno, United States of America)***
Co-author: Sarker S. (Reno, United States of America)
Atom Dynamics and Structure of Glassy Alloys (Ni0.60Nb0.4)100-xZrx (x=0 to 30) by Neutron Spectroscopy and X-ray Photon Correlation Spectroscopy Studies *(Award Lecture)* (1.16)

VI.3 ***Lewandowska M. (Warsaw, Poland)***
Co-authors: Krawczynska A.T. (Warsaw, Poland), Sitek R. (Warsaw, Poland)
Grain refinement and post processing surface modification in hydrostatycally extruded stainless steel *(Special Invited Lecture)* (1.18)

VI.4 ***Wolany W. (Gliwice, Poland)***
Co-author: Dobrzańska-Danikiewicz A.D. (Gliwice, Poland)
The new carbon-rhenium nanomaterials *(Award Lecture)* (1.65)

VI.5 ***Achtelik-Franczak A. (Gliwice, Poland)***
Co-author: Dobrzański L.A.
Composite materials produced by hybride technology of the selective laser sintering and pressure infiltration *(Award Lecture)* (1.64)

VI.6 ***Brytan Z. (Gliwice, Poland)***
Why stainless steels are continuously interesting for science and engineering *(Award lecture)* (1.60)

VII. INPO POSTER SESSION

Monday 23rd October 2017
Stok Ski & Spa Hotel** in Wisła**
Congress Room A+B+C

$16^{45} – 18^{00}$

10TH COUNTRY-WIDE SCIENTIFIC CONFERENCE INP 2017

Chairpersons:
Prof. Barbara Kucharska
Prof. Jacek Sawicki

VII.1. *dr inż. Marta Paczkowska*
Morfologiczne i mikrostrukturalne aspekty zużycia powierzchni obręczy kół pojazdów szynowych używanych w transporcie miejskim

VII.2. *dr inż. Anna Jasik*
Analiza stanu naprężeń i rozkładu temperatury w dwuwarstwowych powłokach TBC typu 8YSZ/La2Zr2O7

VII.3. *dr inż. Katarzyna Szmigielska*
Powłoki kompozytowe Zn/PTFE wytwarzane metodą redukcji elektrochemicznej

VII.4. *dr inż. Marta Mikuśkiewicz*
Charakterystyka właściwości cieplnych ceramiki typu Sm2Zr2O7

VII.5. *prof. dr hab. inż. Maria Trzaska*
Właściwości tribologiczne warstw kompozytowych Ni-B/Si3N4 wytwarzanych metodą bezprądową na podłożu stalowym

VII.6. *mgr inż. Dominika Panfil*
Mikrostruktura i odporność na zużycie azotowanej gazowo stali 42CrMo4 po laserowej modyfikacji

VII.7. *mgr inż. Daria Mikołajczak*
Laserowo stopowana borem i niklem stal austenityczna 316L

VII.8. dr inż. Agnieszka Tomaszewska
Nowe stopy żarotrwałe na bazie kobaltu przeznaczone na warstwy podkładowe w systemach TBC

VII.9. *prof. nzw. dr hab. inż. Wojciech Żórawski*
Mikrostruktura i właściwości mechaniczne natryskanych zimnym gazem powłok tytanowych

VII.10. *dr inż. Aneta Bartkowska*
Wpływ borochromowania dyfuzyjnego na mikrostrukturę, mikrotwardość i odporność korozyjną stali narzędziowej o różnej zawartości węgla

VII.11. *dr inż. Wojciech Gęstwa*
Zmiany wymiarowe hartowanej stali konstrukcyjnej a skład chemiczny ośrodków modyfikowanych nanocząsteczkami ciała stałego (nanofluidów)

VII.12. *dr inż. Bogdan Bogdański*
Wybrane właściwości warstw hybrydowych otrzymywanych w procesie chromowania dyfuzyjnego połączonym z następną obróbką PVD

VII.13. *dr hab. inż. Michał Kulk*a
Modelowanie rozmiarów ścieżek laserowych wytwarzanych przez laserową modyfikację warstwy azotowanej gazowo

VII.14. *mgr inż. Kamil Kowalski*
Wpływ warstw fluorkowych i węglanowych na odporność korozyjną materiałów na bazie magnezu

VII.15. dr inż. Piotr Dziarski
Wpływ borowania gazowego na odporność korozyjną stopu Inconel 600

VII.16. dr inż. Natalia Makuch- Dziarska
Wpływ parametrów obróbki laserowej na rozkład temperatury i grubość warstw stopowanych laserowo wytworzonych na stopie Nimonic 80A

VII.17. dr inż. Iwona Bauer
Analiza efektów laserowej obróbki cieplnej stali po chromowaniu metodą proszkową

VII.18. dr inż. Łukasz Cieniek
Wpływ parametrów procesu ablacji elektronowej na strukturę i wybrane własności optyczne cienkich warstw poliuretanowych (BIONATE II55D®)

VII.19. dr hab. inż.Robert Starosta
Wpływ temperatury podłoża na przyczepność natryskiwanych cieplnie powłok Ni-5%Al

VII.20. dr hab. inż. Jacek Sawicki
Numeryczna analiza wpływ konfiguracji kolektora dyszowego na szybkość hartowania w komorze HPGQ typu D Quenching

VII.21. prof. nzw. dr hab. inż. Bogusław Mendala
Odporność powłok metaloceramicznych na działanie wysokiej temperatury i ognia

VII.22. dr inż. Paweł Figiel
Badanie mechanizmu ochronnego warstw TiO2 na kompozytach tytanowych wytworzonych metodą SPS

VII.23. dr inż.Magdalena Rozmus-Górnikowska
Modyfikacja warstwy wierzchniej stopu Inconel 625 metodą laserowego odkształcania

VII.24. prof. dr hab. inż. Jolanta Baranowska
Kinetyka wzrostu warstw węglo-azotowanych na stali austenitycznej

VII.25. mgr inż. Paulina Kordas
Kinetyka przemian fazowych przechłodzonego austenitu staliwa bainitycznego przeznaczonego na krzyżownice kolejowe.

VII.26. mgr inż. Adam Zych
Wpływ rozpylania katodowego w niskotemperaturowej plazmie na przyczepność powłok Ni(P) do azotowanej uprzednio stali 1.2343 (WCL)

VII.27. dr hab. inż. Michał Tacikowski
Modyfikacja właściwości azotowanych stali w procesach wysokotemperaturowej obróbki cieplnej

VII.28. prof. dr hab. Jerzy Ratajski
Właściwości mechaniczne i przeciwzużyciowe wielomodułowych powłok Cr/CrN

VIII. AMME POSTER SESSION

16^{45}– 18^{00}

Monday 23rd October 2017
Stok Ski & Spa Hotel** in Wisła**
Congress Room A+B+C

SILVER JUBILEE INTERNATIONAL SCIENTIFIC CONFERENCE AMME

Chairpersons:
Prof. Małgorzata Lewandowska (Poland)
Prof. Tomasz Lipiński (Poland)
Prof. Janusz Mazurkiewicz (Poland)
Prof. Piotr Bała (Poland)

XIII.1. *Batalha A.E. (Sao Paulo, Brazil), De Araujo R.M. (Sao Paulo, Brazil)*
Development of removable partial dentures by using additive manufacture and casting processes (1.58)

XIII.2. *Betini E.G. (São Paulo, Brazil), Mucsi C. S. (Sao Paulo, Brazil), Luz T. S. (Vitória, Brazil), Orlando M. T. (Vitória, Brazil), Avetand Fenoel M.A. (Lille, France), Rossi J.L. (Sao Paulo, Brazil)*
Effect of post-weld heat treatment on thermal diffusivity in thin plates of UNS S32304 duplex stainless steel welds (1.37)

XIII.3. *De Sousa Jr R. R. (Sao Paulo, Brazil), Miranda E. A. (Sao Paulo, Brazil), Batalha G. F. (Sao Paulo, Brazil), dos Santos D. J. (Sao Paulo, Brazil)*
Bio-based polyurethane applied as matrix of glass fibre reinforced composite (1.4)

XIII.4. *Dias R.B. (São Paulo, Brazil), Coto N.P. (São Paulo, Brazil), Batalha G.F. (Sao Paulo, Brazil), Driemeier L. (São Paulo, Brazil)*
Systematic study of Ethylene-Vinyl Acetate (EVA) in the manufacturing of protector devices for the orofacial system (1.53)

XIII.5. *Dobrzańska-Danikiewicz A.D. (Gliwice, Poland)*
Composite materials consisting of carbon nanostructures and nanoforms of selected metals (1.54)

XIII.6. *Guba P. (Windsor, Canada), Gesing A. (Toronto, Canada), Sokolowski J. (Windsor, Canada), Conle A. (Windsor, Canada), Sobiesiak A. (Windsor, Canada), Kasprzak M. (Gliwice, Poland)*
Combined thermal, microstructural and microchemical analysis of solidification of Al25Si3Cu alloy (1.56)

XIII.7. *Honysz R. (Gliwice, Poland), Dobrzanski L.A. (Gliwice, Poland)*
Virtual laboratories methodology in scientific researches and education (1.49)

XIII.8. *Jin B.J. (Muan-Gun, South Korea), Park M.H. (Muan-Gun, South Korea), Yun T.J. (Muan-Gun, South Korea), Shim J.Y. (Jeonju, South Korea), Kang B.Y. (Jeonju, South Korea), Kim I.S. (Muan-Gun, South Korea)*
A Study on welding quality for the automatic vertical-position welding process based on mahalanobis distance method (1.19)

XIII.9. *Kaczmarek-Pawelska A. (Zielona Gora, Poland), Winiarczyk K. (Zielona Gora, Poland), Mazurek J. (Zielona Gora, Poland)*
Alginate based hydrogel for tissue regeneration: optimization, antibacterial activity and mechanical properties (1.24)

XIII.10. *Kaganski S. (Tallin, Estonia), Toompalu S. (Tallin, Estonia)*
Development of key performance selection index model (1.5)

XIII.11. *Koralnik M. (Warsaw, Poland), Adamczyk-Cieslak B. (Warsaw, Poland), Kulczyk M. (Warsaw, Poland), Mizera J. (Warsaw, Poland)*
The effect of deformation degree on the dicrostructure of the 6060 aluminium alloy (1.33)

XIII.12. *Koralnik M.K. (Warsaw, Poland), Cygan R. (Rzeszów, Poland), Mizera J. (Warsaw, Poland)*
New production method of ceramic filters used in investment casting process (1.50)

XIII.13. Lenkovskiy T.M. (Lviv, Ukraine), Kulyk V.V. (Lviv, Ukraine), Duriagina Z.A. (Lviv, Ukraine), Kovalchuk R.A. (Lviv, Ukraine), Topilnytskyy V.G. (Lviv, Ukraine), Vira V.V. (Lviv, Ukraine), Tepla T.L. (Lviv, Ukraine), Bilash O.V. (Lviv, Ukraine), Lishchynska K.I. (Lviv, Ukraine)
An effective crack tip region finite element sub-model for fracture mechanics analysis (1.55)

XIII.14. Madej A. (Lodz, Poland), A. Brewka A. (Swiebodzin, Poland), Wołowiec-Korecka E. (Lodz, Poland)
Study on homogeneity and repeatability of single-piece flow carburizing system (1.70)

XIII.15. Makówka M. (Lodz, Poland)
Correlation between plasma parameters and properties of optical TiO2 thin films deposited by means of different magnetron sputtering methods (1.32)

XIII.16. Małdziński L. (Poznan, Poland), Ostrowska K. (Poznan, Poland), Okoniewicz P. (Poznan, Poland), Kowalska J. (Poznan, Poland)
ZeroFlow gas nitriding and nitrocarburizing as a method of precise layer creation on machines, vehicles and tools parts with the minimal use of ammonia consumption and gas emission (1.15)

XIII.17. Palán J. (Dobřany, Czech Republic), Maleček L. (Dobřany, Czech Republic), Hodek J. (Dobřany, Czech Republic), Zemko M. (Dobřany, Czech Republic), Dzugan J. (Dobrany, Czech Republic)
Possibilities of biocompatible material production using conform SPD technology (1.57)

XIII.18. Presz W. (Warsaw, Poland), Kulik T. (Warsaw, Poland)
Ultrasonic vibrations as an impulse for glass transition in microforming of metallic glass (1.51)

XIII.19. Rokicki P. (Rzeszów, Poland), Bąk E. (Rzeszow, Poland), Mrówka-Nowotnik G. (Rzeszów, Poland), Nowotnik A. (Rzeszów, Poland)
Single-frequency induction hardening of structural steels (1.42)

XIII.20. Väer K. (Tallin, Estonia), Anton J. (Tallin, Estonia), Eerme M. (Tallin, Estonia), Õunapuu E. (Tallin, Estonia), Tšukrejev P. (Tallin, Estonia)
Material characterization for laminated glass composite panel (1.6)

TUESDAY — 24th October 2017

Stok Ski & Spa Hotel** in Wisła**

Time	Schedule		
7^{30} – 9^{00}	Breakfast		
9^{00} – 10^{45}	INPO Session 02	AMME Invited Lectures Plenary Session II	
10^{45} – 11^{15}	Coffee break		
11^{15} – 13^{00}	INPO Session 03	AMME Invited Lectures Plenary Session III	
13^{00} – 15^{00}	Lunch		
15^{00} – 16^{45}	INPO Session 04	AMME Invited Lectures Plenary Session IV	
16^{45} – 17^{15}	Coffee break		
17^{15} – 18^{00}	INPO Session 05	AMME Invited Lectures Plenary Session V	
18^{00} – 19^{00}	Meeting of Scientific Committee of INPO2017 Conference		
20^{00} – 22^{00}	Dinner		

IX. INPO SESSION 02

Tuesday 24th October 2017
Stok Ski & Spa Hotel** in Wisła**
Congress Room A

$9^{00} – 10^{45}$

Chairpersons:
Prof. Jolanta Baranowska
Prof. Jerzy Robert Sobiecki
Prof. Jerzy Smolik

IX.1 ***dr inż. Adam Piasecki***
Wpływ lubrykantów stałych CaF2 i BaF2 na odporność na zużycie laserowo borowanej stali łożyskowej 100CrMnSi6-4

IX.2 ***dr inż. Agnieszka Kochmańska***
Warstwy aluminidkowe na stopie Inconel 617 wytworzone metodą zawiesinową z użyciem spoiwa nieorganicznego

IX.3 ***dr inż. Anna Góral***
Mikrostruktura i właściwości kompozytowych powłok natryskanych zimnym gazem

IX.4 ***mgr inż. Beata Kucharska***
Wpływ rodzaju cząstek Al2O3 na kształtowanie struktury i właściwości mechanicznych powłok kompozytowych Ni/Al2O3

IX.5 ***prof. nzw. dr hab. Ewa Kasprzycka***
Wybrane właściwości warstw hybrydowych otrzymywanych w procesie chromowania dyfuzyjnego

IX.6 ***mgr inż. Jarosław Tarcz***
Wpływ grubości barierowych powłok pęczniejących na ochronne elementów wykonanych ze stopu aluminium

X. AMME INVITED LECTURES PLENARY SESSION II

Tuesday 24th October 2017
Stok Ski & Spa Hotel** in Wisła**
Congress Room B

$09^{00} – 10^{45}$

Chairpersons:
Prof. Dhanesh Chandra (USA)
Prof. Toshio Haga (Japan)
Prof. Emilia Wołowiec-Korecka (Poland)
Prof. Elena David (Romania)

X.1 ***Nowacki J. (Szczecin, Poland)***
Co-author: Sieczkiewicz N. (Szczecin, Poland)
New NDT methods for assessing the quality of polymer composites under production conditions *(Award lecture)* (1.61)

X.2 ***Rosso M.R. (Torino, Italy)***
Co-authors: Fracchia E. (Torino, Italy), Gobber F. (Torino, Italy)
About weldability and welding of Al alloys: case study and problem solving *(Award lecture)* (1.22)

X.3 ***Bała P. (Kraków, Poland)***
Ni-based complex phase alloy for high temperature aplications *(Award lecture)* (1.52)

X.4 ***Smoljan B. (Rijeka, Croatia)***
Co-authors: Iljkic D. (Rijeka, Croatia), Smokvina Hanza S. (Rijeka, Croatia), Stic L. (Rijeka, Croatia), Boric A. (Rijeka, Croatia)
Mathematical modeling of thermal processing of metal alloys (1.44)

X.5 ***Tisza M. (Miskolc, Hungary)***
High strength steels and aluminium alloys in lightweight body manufacturing (1.38)

X.6 ***Meran C. (Denizli, Turkey)***
Co-authors: Korkmaz E. (Denizli, Turkey), Gülsöz A. (Denizli, Turkey)
Investigations of the joint properties of the friction welding of aluminum alloy tube to tube plate using an external tool (1.14)

X.7 ***Duriagina Z.A. (Lviv, Ukraine)***
Co-authors: Ostash O.P. (Lviv, Ukraine), Kulyk V.V. (Lviv, Ukraine), Poznyakov V.D. (Kyiv, Ukraine), Haivorons'kyi O.A. (Kyiv, Ukraine), Markashova L.I. (Kyiv, Ukraine), Vira V.V. (Lviv, Ukraine), , Tepla T.L. (Lviv, Ukraine)
Fatigue crack growth resistance of welded joints simulating the weld-repaired railway wheels metal (Award lecture) (1.21)

XI. INPO SESSION 03

$11^{15} – 13^{00}$

Tuesday 24th October 2017
Stok Ski & Spa Hotel** in Wisła**
Congress Room A

10TH COUNTRY-WIDE SCIENTIFIC CONFERENCE INPO 2017

Chairpersons:
Prof. Tadeusz Frączek
Prof. Zbigniew Gawroński
Prof. Jerzy Ratajski

XI.1. Prezentacja firmy LOT Quantum Design

XI.2. ***dr inż. Bartosz Witala***
Powłoki żaroodporne wytwarzane metodą CVD.

XI.3. ***dr inż. Karol Kyziol***
Modyfikacja powierzchni wybranych stopów tytanu z otrzymaniem powłok na bazie struktur SiN i DLC do zastosowań na implanty ortopedyczne.

XI.4. ***dr inż. Radosław Swadźba***
Utlenianie wysokotemperaturowe powłok aluminidkowych modyfikowanych Si na stopie γ-TiAl

XI.5. ***mgr inż. Milena Pilarska***
Wpływ plazmy wyładowania jarzeniowego na proces azotowania tytanu technicznego.

XII. AMME INVITED LECTURES PLENARY SESSION III Tuesday 24th October 2017

$11^{15} – 13^{00}$

Stok Ski & Spa Hotel** in Wisła**
Congress Room B

SILVER JUBILEE INTERNATIONAL SCIENTIFIC CONFERENCE AMME

Chairpersons:
Prof. Cemal Meran (Turkey)
Prof. Ill Soo Kim (South Korea)
Prof. Waldemar Wołczyński (Poland)
Prof. Thierry Djenizian (France)

XII.1. ***Muruganant M. (India)***
Integrated Computational Materials Engineering in Novel alloy design *(Award lecture)* (1.68)

XII.2. ***Wołowiec-Korecka E. (Lodz, Poland)***
Methods of data mining for modelling of low-pressure heat treatment *(Award lecture)* (1.59)

XII.3. ***Haga T. (Osaka, Japan)***
Co-author: Miyazaki K. (Osaka, Japan)
Semi-continuous caster for plate (1.48)

XII.4. ***Kopač J.K. (Ljubljana, Slovenia)***
Co-author: Pušavec F.P. (Ljubljana, Slovenia)
Development and manufacturing of customized milling cutters for individual tool-making industry (1.29)

XII.5. ***Wendler B.G. (Lodz, Poland)***
Co-author: Makowka M. (Lodz, Poland)
Carbon based coatings for applications in friction couples with cearing cteel and cluminium alloy (1.31)

XII.6. ***David E. (Rm. Valcea, Romania)***
Co-author: Şandru C. (Rm. Valcea, Romania), Armeanu A. (Rm. Valcea, Romania)
Zeolitization characteristics of fly ash and its use to manufacture porous materials (1.26)

XII.7. ***Malara P. (Gliwice, Poland)***
Co-author: Dobrzański L.B. (Gliwice, Poland)
Computer aided design in maxillo-facial surgery (1.63)

XIII. INPO SESSION 04

$15^{00} – 16^{45}$

Tuesday 24th October 2017
Stok Ski & Spa Hotel** in Wisła**
Congress Room A

10TH COUNTRY-WIDE SCIENTIFIC CONFERENCE INPO 2017

Chairpersons:
Prof. Jan Kusiński
Prof. Ewa Kasprzycka
Prof. Marcin Nabiałek

XIII.1. ***mgr inż. Katarzyna Mydłowska***
Metoda i narzędzie do oceny funkcjonalności systemów warstwowych alternatywnych dla powłok z twardego chromu i kadmu

XIII.2. ***dr Łukasz Szparaga***
Analiza stanu naprężeń własnych w powłokach ZrC z wykorzystaniem metody elementu skończonego

XIII.3. ***dr inż. Mikołaj Popławski***
Próba interpretacji efektów akustycznych procesu zużycia przez tarcie.

XIII.4. ***dr inż. Anna Bień***
Analiza defektów zmęczeniowych oraz stanu naprężeń w laserowo obrabianym cięgle podwozia samolotu

XIII.5. ***prof. nzw. dr hab. inż. Barbara Kucharska***
Cechy struktury i właściwości powłok PVD ze stali z dodatkami z Al i Si

XIV. AMME INVITED LECTURES PLENARY SESSION IV Tuesday 24th October 2017

Stok Ski & Spa Hotel** in Wisła**

$15^{00} – 16^{45}$ **Congress Room B**

SILVER JUBILEE INTERNATIONAL SCIENTIFIC CONFERENCE AMME

Chairpersons:

Prof. Bozo Smoljan (Croatia)
Prof. Zoia Duriagina (Ukraine)
Prof. Anna Dobrzańska-Danikiewicz (Poland)
Prof. M. Muruganant (India)

XIV.1. ***Kim I.S. (Muan-Gun, South Korea)***
Co-authors: Park M.H. (Muan-Gun, South Korea), Jin B.J. (Muan-Gun, South Korea), Yun T.J. (Muan-Gun, South Korea), Son J.S (Yeongam, South Korea), Kim C.G. (Muan-gun, South Korea),
Control of the weld quality using infrared sensors in a robotic welding process (1.20)

XIV.2. ***Wołczyński W. (Krakow, Poland)***
Co-authors: Kwapisiński P. (Lubin, Poland), Ivanova A.A. (Donetsk, Ukraine), Olejnik E. (Krakow, Poland)
Dominant role of the columnar structure in the brass ingots continuous casting (1.46)

XIV.3. ***Çam G. (Iskenderun-Hatay, Turkey)***
Co-authors: Ipekoglu G. (Iskenderun-Hatay, Turkey), Küçükömeroğlu T. (Trabzon, Turkey), Aktarer S.M. (Rize, Turkey)
Applicability of friction stir welding to steels (1.7)

XIV.4. ***Lipiński T.L. (Olsztyn, Poland)***
Effect of Combinative Cooled Addition of Strontium and Aluminium on Mechanical Properties AlSi12 Alloy (1.36)

XIV.5. **Djenizian T. (Gardanne, France)**
High performance thin-film Li-ion microbatteries (1.47)

XIV.6. ***Belingardi G. (Torino, Italy)***
Co-authors: Cavatorta M.P. (Torino, Italy), Paolino D.S. (Torino, Italy)
Composite material components damaged by impact loading: a methodology for the assessment of their residual elastic properties (1.23)

XIII.1. ***Küçükömeroğlu T. (Trabzon, Turkey)***
Co-author: Aktarer S.M. (Rize, Turkey)
Microstructure, microhardness and tensile properties of FSWed DP 800 steel (1.27)

XV. INPO SESSION 05

17^{15}– 18^{00}

Tuesday 24th October 2017
Stok Ski & Spa Hotel** in Wisła**
Congress Room A

10TH COUNTRY-WIDE SCIENTIFIC CONFERENCE INPO 2017

Chairpersons:
Prof. Michał Kulka
Prof. Jerzy Michalski
Prof. Wojciech Gęstwa

XV.1. Prezentacja firmy TECHNOLUTIONS

XV.2. ***dr inż. Paweł Kochmański***
Warstwy azotowane niskotemperaturowo na stali Nanoflex

XV.3. ***prof. dr hab. inż. Jan Kusiński***
Wpływ interferencyjnego nagrzewania laserowego na mikrostrukturę oraz właściwości amorficznych stopów FeSiB(X).

XVI. AMME INVITED LECTURES PLENARY SESSION V — Tuesday 24th October 2017

Stok Ski & Spa Hotel** in Wisła**

$17^{15} – 18^{00}$ **Congress Room B**

SILVER JUBILEE INTERNATIONAL SCIENTIFIC CONFERENCE AMME

Chairpersons:

Prof. Janez Kopač (Slovenia)
Prof. Gürel Çam (Turkey)
Prof. Bogusław Wendler (Poland)
Prof. Piotr Malara (Poland)

XVI.1. ***Valentinčič J. (Ljubljana, Slovenia)***
Co-authors: Lebar A. (Ljubljana, Slovenia), Sabotin I. (Ljubljana, Slovenia), Drešar P. (Ljubljana, Slovenia), Jerman M. (Ljubljana, Slovenia)
Development of ice abrasive waterjet cutting technology (1.2)

XVI.2. ***Karakaş Ö. (Denizli, Turkey)***
Co-author: Türkan M. (Denizli, Turkey),
The effect of welding defects to the tensile behavior in corrosive environment of AISI 304L stainless steel joined with shielded metal electrode (1.45)

XVI.3. ***Dobrowolski T. (Kraków, Poland)***
Co-author: Jarmolinski A. (Kraków, Poland),
Fluxon dynamics in the curved Josephson junction (1.28)

WEDNESDAY 25th October 2017

Stok Ski & Spa Hotel** in Wisła**

Time	Schedule	
7^{30} – 9^{00}	Breakfast	
10^{00} – 10^{20}	INPO-AMME Closing Ceremony Plenary Lecture	
10^{20} – 10^{35}	INPO-AMME Closing Ceremony	
10^{35} – 11^{15}	Coffee break	
11^{30} – 12^{30}	Lunch	

XVII. INPO-AMME CLOSING CEREMONY
PLENARY LECTURE
$10^{00} – 10^{35}$

Wednesday 25th October 2017
Stok Ski & Spa Hotel** in Wisła**
Congress A+B Room

Chairpersons:
Prof. Leszek A. Dobrzański (Poland)
Prof. Jerzy Nowacki (Poland)
Prof. Michał Szota (Poland)

XVII.1. ***Prof. Tadeusz Wierzchoń (Warsaw, Poland)***
Special Invited Lecture
Structure and properties of surface layers produced in low temperature plasma on NiTi alloy with shape memory

XVII.2. ***Prof. Michał Szota (Częstochowa, Poland)***
Closing Address of the Chairman of the Programme and Organising Committees of the INPO'2017 Conference

XVII.3. ***Prof. Leszek A. Dobrzański (Gliwice, Poland)***
Closing Address of the Chairman of the Programme and Organising Committees of the AMME'2017 Conference

INVITED AND CONTRIBUTED PAPERS (in English)

2.1.

Effect of diffusion borochromizing on microstructure, microhardness and corrosion resistance of tool steel with different carbon content

Bartkowska A. (Poznań, Poland), Bartkowski D. (Poznań, Poland), Piasecki A. (Poznań, Poland)

Purpose: The aim of this paper is to present the study results concerning the influence of carbon content on the surface layer condition, microstructure, microhardness and corrosion resistance of diffusion borochromized layer.
Design/methodology/approach: In the paper, the three types of tool steel were analysed: CT90, 145Cr6 and 165CrV12. The borochromzing process was carried out in a powder mixture containing B_4C, Fe-Cr, Al_2O_3 at temperature 950°C for 6 h. The source of chromium was Fe-Cr while the source of boron was B_4C.
Findings: As a result of borochromizing process the layer with a microstructure similar to boronized layer was obtained. The thickness of the resulting surface layer was dependent on the carbon content of steel. Microhardness of the borochromized layer was similar to the microhardness of the boronized layer. Additionally, the corrosion resistance tests in 5% NaCl solution were performed using a potentiodynamic method. It was found that the best corrosion resistance was characterized a layer on the steel with less carbon content.
Originality/value: Value of the paper is an analysis of corrosion resistance by the potentiodynamic method of the tool steel with borochromized layer.

2.2.

Effects of laser heat treatment of steel following diffusion chromizing

Bauer I. (Olsztyn, Poland), Paczkowska M. (Poznań, Poland)

Purpose: This paper presents the findings of a study of laser heat treatment of C45 steel following diffusion chromizing. The aim of the study was to assess the effect of laser heating of steel subjected on the microstructure of its surface layer.
Design/methodology/approach: diffusion chromizing was conducted at the temperature of 1050°C for 8 hours in a LABOTHERM LH15/14 laboratory furnace. A powder mixture of the following composition was used to produce the layer: Cr_2O_3 with an addition of Al, kaolin and an activator – ammonium chloride NH_4Cl. Diffusion chromizing of C45 steel was followed by laser heat treatment with a dual diode TRUDISK 1000 laser device. The treatment was carried out in four variants with a laser beam of 400 to 900 W. The microstructure of the surface layer was assessed with a scanning electron microscope Tescan Vega 5135. Hardness tests were carried out by the Vickers method on crosswise microsections. The chemical composition of the diffusion layer was assessed by optical emission spectrometry.

Findings: The results revealed the presence of a modified surface layer following laser heat treatment in each of the variants.
Research limitations/implications: this study focuses on the effect of laser heating of C45 steel subjected to diffusion chromizing on the microstructure of its top layer. Presented research is the first step of the investigation of the surface layer of steel after diffusion chromizing and laser treatment. Next one will consist in a detailed investigation of the microstructure (phases identification) of the achieved surface layer using (among other methods) X-ray diffraction.
Practical implications: laser heat treatment of C45 steel after diffusion chromizing can be applied to parts of machines and devices used in various branches of industry exposed to tribological wear and corrosion.
Originality/value: the results of the experiment were affected by the composition of the powder mixture and process parameters of the diffusion chromizing and the laser treatment.

2.3.

The influence of burnishing parameters on the hardness and roughness on the surface layer stainless steel

Dyl T. (Gdynia, Poland)

Purpose: The aim of the study was a description of the influence of technological parameters of burnishing process on the degree of relative strain hardening and surface roughness reduction ratio.
Design/methodology/approach: Burnishing process carried out for stainless steels X2CrNiMo17-12-2. After the experimental research, it was determined that there was an increase in hardness and a decrease in roughness. The hardness was measured with the use of Vickers hardness tester. Observation of the microstructure of stainless steel samples was carried out using scanning electron microscopy and optical microscopy. The parameters of surface roughness measurements were performed to the principles contained in ISO standards.
Findings: In the production and regeneration of metal products used in machine elements is important to technological quality surface layer. In surface engineering one of the ecological and economic treatments used for endurance and technological properties is burnishing. This is a surface forming a local plastic deformation based on the overall impression given by smooth and hard tool.
Practical implications: The burnishing due the technological and economic aspect in the production and regeneration of machine parts in exchange for the abrasive processing can be used. In production engineering or technology of repair cylindrical outer surfaces (e.g. plugs propulsion shaft centrifugal pumps seawater) are finishing. You can therefore propose burnishing in exchange for abrasive machining.
Originality/value: Important question to determine in the article of the research was to received appropriate technological quality. After the tests, it was found that the technological parameters are influenced by the hardness and the roughness of the outer cylindrical surfaces and the material ratio curve a convex shaped, which, taking into account the load capacity of the surface will be directly affected by its resistance to wear and corrosion of the surface layer.

2.4.

Influence of gas boriding on corrosion resistance of Inconel 600-alloy

Dziarski P. (Poznań, Poland), Makuch N. (Poznań, Poland), Kulka M. (Poznań, Poland)

Purpose: The aim of this study was to analyse the corrosion behaviour of gas-borided layers produced on Inconel 600-alloy. Two types of the borided layers were produced: fully borided and partially borided layer. The results obtained for gas-borided specimens were compared to untreated Inconel 600-alloy.

Design/methodology/approach: In this paper, gas boriding in N_2-H_2-BCl_3 atmosphere was applied to produce the boride layers on Inconel 600-alloy. This process was carried out at 910°C (1193 K) for 2 h. Microstructure observations were carried out using a light microscope. The hardness measurements were performed using a Vickers method under a load of 0.981 N. In order to evaluate the corrosion resistance, the immersion corrosion test in a boiling solution of H_2O, H_2SO_4 and $Fe_2(SO_4)_3$ was used.

Findings: The gas-borided layers consisted of a mixture of nickel borides (Ni_3B, Ni_2B, Ni_4B_3, NiB) and chromium borides (CrB, Cr_2B). The high thickness of compact boride layer (76-79 μm) as well as high hardness (up to 2061 HV) were obtained. Based on corrosion resistance tests it was found that in case of untreated sample the strong intergrannular attack was observed. Whereas the corrosion behaviour of gas-borided Inconel 600-alloy was more complicated and resulted from the surface condition.

Research limitations/implications: The obtained results indicated that gas-boriding in N_2-H_2-BCl_3 atmosphere could be a suitable corrosion protection if the whole surface would be covered with boride layer.

Practical implications: The parameters of gas boriding in N_2-H_2-BCl_3 atmosphere used in this study (temperature of 910°C for 2 h) allowed to produced layers of a higher thickness in comparison with other acceptable method of boriding e.g. powder-pack boriding.

Originality/value: Based on the results it was found that gas-boriding in N_2-H_2-BCl_3 atmosphere is a suitable method to protect Inconel 600-alloy from corrosion.

2.5.

The influence of chemical composition of nanofluids on dimensional changes of hardened constructional steel

Gęstwa W. (Poznań, Poland)

Purpose of this paper, then the possibility definition of utilization of the quenching from the nanofluids group is to the hardened of elements created from constructional steels. The definition of influence size of nanofluids on the dimension changes of the element created from low carbon constructional steel is also the important aspect of this work.

Methodology used during investigations enclosed two areas. First area enclosed the investigation of quenching mediums propriety in the support about the English method, which permitted estimate of their warmth receipt ability in the support about cooling curved in the arrangement the temperature – the time or the cooling speed. Second area enclosed the investigations of the hardened element which let

define dimension changes and hardness on the transverse section. The formed structure was also estimated on the cross-section in the support about the light microscope.
Findings of this article are show the possibility obtainment of minimum dimension changes the element of the cooled in nanofluids near the retained of hardness and structure on the level which was got in the quenching mediums until now used for the studied material. The summery up the use of quenching mediums of the nanofluids group at the base of distilled water, ammoniac water and Al_2O_3 nanoparticles causes decrease of dimension changes near keep on the same of hardness of hardened elements from constructional steel.
Research limitations result from the quantity of the quenching mediums used in the investigations which one can use as the point of the reference for nanofluids. This arose from initial investigations over this aspect, which is the dimension change of elements. It should also use real the parts of machines or tool in farther investigations.
Practical implications of results presented in this article, we will get in the range of the construction projecting of steel elements, where should consider technological surpluses for this element and material proprieties which has to which meet. For full utilization in the practice, however you should conduct additional investigations still both in the laboratory scale, how and industrial.
Originality of this article is the performance of the influence of quenching mediums from the group nanofluids on the dimension changes of hardened steel elements.

2.6.

Microstructure and properties of cold sprayed composite coatings

Góral A. (Kraków, Poland), Żórawski W. (Kielce, Poland), , Makrenek M. (Kielce, Poland), Kowalski S. (Kraków, Poland)

Purpose: The composite coatings containing incorporated ceramic achieve a wide spectrum of enhanced properties, resulting from a combination of features from a ductile matrix and hard particles. This article attempts to explain how the alumina addition to Ni powder influences the microstructure and mechanical properties of the composite Ni-Al_2O_3 coatings cold sprayed on the 7075 Al alloy.
Design/methodology/approach: The coatings were formed during a deposition of the powder particles step by step which impacts with high velocities onto the substrate, deform, and adhere to it or to other particles.
Findings: The incorporation of Al_2O_3 in the Ni matrix induced a larger plastic deformation of the powder particles and reduced the porosity of the coatings. The Ni-Al_2O_3 coatings were characterized by a lower surface roughness compared to Ni deposits. The Young modulus of the Ni-Al_2O_3 coatings were found to be higher than Ni coating.

2.7.

Aluminide coatings on Inconel 617 obtained by slurry method with inorganic binder

Kochmańska A.E. (Szczecin, Poland)

Purpose: The aim of this study was to manufacture and examine the structure of aluminide coatings formed on Ni-base super alloy Inconel 617 in an argon atmosphere.

Design/methodology/approach: The coatings were produced by the slurry method at temperatures from 900 to 1100°C and times from 2 to 6 hours. The newly-developed slurry composition was: powders of aluminium and silicon; NaCl, KCl, NaF halide salts as an activator and a water solution of a soluble glass as an inorganic binder. The microstructure (SEM), chemical composition (EDS) and phase composition (XRD) of the coatings were determined. Additionally the correlation between the technological parameters and the coating thickness was analysed.
Findings: Slurry aluminide coatings with newly-developed composition have been successfully produced. The obtained coatings had a multi-zone structure depending on manufacturing parameters.
Research limitations/implications: The next stage of this research will be to determine the performance of the coatings under high temperature cyclic oxidation. Optimization of the production parameters will therefore be possible after oxidation and cyclic oxidation tests.
Practical implications: The slurry method is economical due to low consumption of powder material. Another advantage of the applied slurry composition is the possibility of forming protective coatings on other substrates.
Originality/value: The use of the inorganic binder in the slurry allowed to produce the coatings in one single step without additional annealing at an intermediate temperature as it is when applied organic binder. The grain size of aluminium and silicon powders was less than usually used. The applied activator dissolved the passive layers present on the surface both of the aluminum powder and of the nickel alloy and accelerated the reactions that occur during coating formation.

2.8.

Microstructural study of plasma sprayed hydroxyapatite coatings

Kowalski S. (Kraków, Poland), Belka R. (Kielce, Poland), Żórawski W. (Kielce, Poland), Sztorc M. (Kielce, Poland), Góral A. (Kraków, Poland), Makrenek M. (Kielce, Poland)

Purpose: The aim of this study is to present microstructure and mechanical properties of hydroxyapatite coatings sprayed by means novel plasma system with an axially injection of powder.
Design/methodology/approach: Coatings were deposited with Axial III plasma spraying system and examined by SEM, XRD and by a nanoindentation technique (Nanovea) with a Berkovitz indenter. Surface of coatings was analysed by means of a Talysurf CCI-Lite non-contact 3D profiler.
Findings: This study shows the microstructure and mechanical properties of hydroxyapatite coatings (HA) obtained by plasma spraying from the powder with a cauliflower-like high porous structure consisting of nanograins with dimension below 100 nm. The cross-section of plasma sprayed HA coating reveals lamellar structure containing pores in the interior of the lamellae. Moreover, between lamellae, some microcracks were detected. Hardness and elastic modulus measured by nanoindentation were found to be around 0.085 and 6.82 GPa respectively, what was comparable with HA coatings sprayed by a modified cold spray system. Both XRD patterns are practically identical, so no new phases were created in hydroxyapatite coating in comparison with feedstock powder during the spray process. High values of a geometry of HA coating; maximum peak height, maximum pit height and maximum height confirmed significant roughening of a surface, which is a result of the interaction of melted powder grains with the surfaces during the plasma spraying.
Research limitations/implications: Obtained properties of coatings will be the base for comparison with suspension plasma sprayed coatings.
Practical implications: Hydroxyapatite coatings deposited by means novel plasma system are designated for spraying implants.

Originality/value: Properties of hydroxyapatite coatings plasma sprayed with novel axially injection of powder.

2.9.

Modelling of the effects of laser modification of gas-nitrided layer

Kulka M. (Poznań, Poland), Panfil D. (Poznań, Poland), Michalski J. (Warszawa, Poland), Wach P. (Warszawa, Poland)

Purpose: The effects of laser processing parameters on the dimensions of simple laser tracks, produced on the previously nitrided layer, were analysed.

Design/methodology/approach Gas nitriding is one the most commonly used thermochemical treatment, resulting in many advantageous properties: high hardness, enhanced corrosion resistance, improved wear resistance and fatigue strength. However, an unfavourable increase in the thickness of compound zone close to the surface was observed after conventional gas nitriding. This was the reason for undesirable embrittlement and flaking of the layer. Therefore, a controlled gas nitriding was intensively developed, reducing the percentage of the most brittle □ ($Fe_{2-3}N$) iron nitrides. In this study, the hybrid surface layer was produced. The controlled gas-nitriding was followed by laser heat treatment (LHT). Laser modification was carried out using various laser beam powers and scanning rates. The dimensions of laser tracks (i.e. depths and widths of re-melted zone and heat-affected zone) were measured. Numerical methods were used in order to formulate a mathematical model.

Findings: Laser processing parameters (laser beam power and scanning rate) influenced the microstructure obtained. The microstructure of laser modified nitrided steel with re-melting consisted of re-melted zone (MZ), heat-affected zone (HAZ), nitrided layer without visible effects of laser treatment and the substrate. The use of laser beam power of 0.26 kW resulted in only a partial re-melting of the compound zone. The two characteristic values of laser beam power were estimated. P0MZ corresponded to the laser beam power at which the re-melted zone disappeared (i.e. width and depth of MZ were equal to 0). P0HAZ was a value of laser beam power at which the effects of laser irradiation were invisible in microstructure (i.e. width and depth of HAZ were equal to 0). The model was proposed in order to predict the effects of LHT on microstructure.

Research limitations/implications: The presented model was limited to the scanning rates in the range of 2.24-3.84 m/min. In the future research, this range should be exceeded, especially, taking into account the lower values of scanning rate.

Practical implications: The presented model could be used in order to control the microstructure and properties of hybrid surface layers, obtained as a consequence of the controlled gas-nitriding and LHT.

Originality/value: This work is related to the new conception of laser modification of nitrided layers. Such a treatment provided the hybrid layers of new advantageous properties.

2.10.

The effect of laser treatment parameters on temperature distribution and thickness of laser-alloyed layers produced on Nimonic 80A-alloy

Makuch N. (Poznań, Poland), Dziarski P. (Poznań, Poland), Kulka M. (Poznań, Poland)

Purpose: The aim of this paper was to determine the influence of laser treatment parameters on temperature distribution and thickness of laser-alloyed layers produced on Nimonic 80A-alloy.
Design/methodology/approach: In this paper laser alloying was used in order to produce layers on Nimonic 80A-alloy surface. The three types of the alloying materials were applied: B, B+Nb and B+Mo. Microstructure observations were carried out using an optical microscope. The hardness measurements were performed using a Vickers method under a load of 0.981 N. For evaluation of temperature distribution the equations developed by Ashby and Esterling were used.
Findings: The produced layers consisted of re-melted zone only and were characterized by high hardness (up to 1431 HV0.1). The increase in laser beam power caused an increase in thickness and decrease in hardness of re-melted zones. The temperature distribution was strongly dependent on laser treatment parameters and physical properties of alloying material. The higher laser beam power, used during laser alloying with boron, caused an increase in layer thickness and temperature on the treated surface. The addition of Mo or Nb for alloying paste caused changes in melting conditions.
Research limitations/implications: The obtained results confirmed that laser beam power used for laser alloying influenced the thickness and hardness of the produced layers. Moreover, the role of type of alloying material and its thermal properties on melting condition was confirmed.
Practical implications: Laser alloying is the promising method which can be used in order to form very thick and hard layers on the surface of Ni-base alloys. The obtained microstructure, thickness and properties strongly dependent on laser processing parameters such as laser beam diameter, laser beam power, scanning rate as well as on the type of alloying material and its thickness, or type of substrate material.
Originality/value: In this paper the influence of alloying material on temperature distribution, thickness and hardness of the laser-alloyed layers was in details analysed.

2.11.

Abrasion resistance of Ni-B/Si_3N_4 composite layers produced by electroless method

Mazurek A. (Warszawa, Poland), Cieślak G. (Warszawa, Poland), Bartoszek W. (Warszawa, Poland), Trzaska M. (Warszawa, Poland)

Purpose: The paper presents the results of investigations of Ni-B/Si_3N_4 composite layers produced on steel substrate by electroless method.
Design/methodology/approach: Amorphous silicon nitride powder (Si_3N_4) with nanometric particle sizes was used as a dispersion phase for the production of composite layers. Ni-B/Si_3N_4 composite layers were produced in baths of varying Si_3N_4 powder content. For comparative purposes, the study also includes results related to Ni-B layer. The Si_3N_4 powder and the structure of the produced layers were characterized. The topography and morphology of the surface of the produced layers are presented. The adhesion of the layers to the substrate material was determined. Microhardness and tribological properties of test materials were determined.
Findings: The results of the studies show that Ni-B/Si_3N_4 composite layers and Ni-B composite layers are characterized by compact structures and good adhesion to the substrate material. The incorporation of Si_3N_4 particles into the Ni-B layers increases the degree of surface development of the layers. The Ni-B/Si_3N_4 composite layer material exhibits less microhardness and less abrasive wear compared to Ni-B layers. However, the extent of wear damage of the Ni-B/Si_3N_4 is relatively small comparing to Ni-B layers.

2.12.

Laser alloying of 316L steel with boron and nickel

Mikołajczak D. (Poznań, Poland), Kulka M. (Poznań, Poland), Makuch N. (Poznań, Poland), Dziarski P. (Poznań, Poland)

Purpose: The aim of the study was to improve the hardness and tribological properties of austenitic 316L steel by laser alloying with boron and nickel.
Design/methodology/approach: The relatively low wear resistance of austenitic 316L steel could be improved by an adequate surface treatment. Laser alloying was developed as an alternative for time- and energy-consuming thermo-chemical treatment, e.g. diffusion boriding. In the present study, laser alloying of 316L steel with boron and nickel was carried out as the two-stage process. Firstly, the outer surface of the sample was coated with the paste, consisting of the mixture of boron and nickel powders, blended with a diluted polyvinyl alcohol solution. Second stage consisted in laser re-melting of the paste coating together with the base material. Laser treatment was carried out with the use of the TRUMPF TLF 2600 Turbo CO_2 laser. The multiple laser tracks were formed on the surface. The microstructure was observed with the use of an optical microscope (OM) and scanning electron microscope (SEM) Tescan Vega 5135. The phase analysis was carried out by PANalytical EMPYREAN X-ray diffractometer using Cu Kα radiation. Hardness profile was determined along the axis of laser track. Wear resistance was studied using MBT-01 tester.
Findings: The use of the adequate laser processing parameters (laser beam power, scanning rate, overlapping) caused that free of cracks and gas pores and the uniform laser-alloyed layer in respect of the thickness was produced. In the microstructure, only two zones were observed: laser re-melted zone (MZ) and the substrate. There were no effects of heat treatment below MZ. Heat-affected zone (HAZ) was invisible because the austenitic steel could not be hardened by typical heat treatment (austenitizing and quenching). The produced laser-alloyed layer was characterized by improved hardness and wear resistance compared to the base material.
Research limitations/implications: The application of proposed surface treatment in industry will require the appropriate corrosion resistance. In the future research, the corrosion behaviour of the produced layer should be examined and compared to the behaviour of 316L steel without surface layer
Practical implications: The proposed layer could be applied in order to improve the hardness and tribological properties of austenitic steels.
Originality/value: This work is related to the new conception of surface treatment of austenitic steels, consisting in laser alloying with boron and some metallic elements.

2.13.

Influence of substrate temperature on adhesion of thermally sprayed Ni-5%Al coatings

Ostrowski D. (Gdynia, Poland), Starosta R. (Gdynia, Poland)

Purpose: In the paper effect of pre-heating the steel substrate on the adhesion of thermally sprayed Ni-5%Al alloy coatings was presented. The reason for the topic was the discrepancy between the literature data on the effect of the preheating of the substrate on the adhesion of the coatings and the guidelines of the coating material manufacturer.

Design/methodology/approach: As a coating material the ProXon 21021 was used. It is an alloy of nickel aluminium and molybdenum. This material is often used during the regeneration of machine parts in the shipbuilding industry. The coatings by flame spraying using the Casto-Dyn DS 8000 torch were obtained. The samples were made of steel C45. The specimens to which the coating was applied were characterized by a similar surface roughness. Before applying the coatings, the samples were preheated to a temperature of 50 to 400°C. The coatings tested were similar in thickness. Adhesion strength of the coatings was determined by the pull-off method.
Findings: The quantitative comparative assessment of the adhesion strength of thermally sprayed coatings can be implemented by a pull-off. The highest value of adhesion strength for coatings applied on substrates of 50, 300 and 400°C was found. Considering that the technical thermally sprayed coatings of Ni-5% Al, often require an additional machining, they must be applied to the steel substrate surface at 50°C.
Research limitations/implications: The adhesion test of the coatings has not been executed in accordance with the requirements of PN-EN 582 Thermal spraying - Determination of tensile adhesive strength. Therefore, the quantitative results obtained are only comparative.
Practical implications: The results obtained show that the regeneration coatings of ProXon 201021 material should only be applied to pre-heated by flame (among other things, to degrease the surface of the substrate) to a temperature of approximately 50°C. At the time the coatings are characterized by the greatest adhesion to the steel substrate.
Originality/value: The study demonstrated the usefulness of cheaper method of pull-offs to evaluate the adhesion of flame sprayed coatings. The results show that there is no need for a pre-heating of the substrate between 150 and 250°C before thermal spraying. This article may be useful for technologists designing the process of regeneration of machine parts using flame spraying.

2.14.

Microstructure and wear resistance of gas-nitrided steel after laser modification

Panfil D. (Poznań, Poland), Kulka M. (Poznań, Poland), Wach P. (Warszawa, Poland), Michalski J. (Warszawa, Poland)

Purpose: The aim of this work was to study the microstructure and wear resistance of hybrid surface layers, produced by a controlled gas nitriding and laser modification.
Design/ Methodology/Approach: Nitriding is well-known method of thermo-chemical treatment, applied in order to produce surface layers of improved hardness and wear resistance. The phase composition and growth kinetics of the diffusion layer can be controlled using a gas nitriding with changeable nitriding potential. In this study, gas nitriding was carried out on 42CrMo4 steel at 570°C (843 K) for 4 hours using changeable nitriding potential in order to limit the thickness of porous □ zone. Next, the nitrided layer was laser-modified using TRUMPF TLF 2600 Turbo CO_2 laser. Laser tracks were arranged as the multiple tracks with scanning rate v_l=2.88 m/min and overlapping of about 86% using the two laser beam powers (P): 0.21 kW and 0.26 kW. Microstructure was observed by an optical microscope. Phase composition was studied using XRD. Hardness profiles in the produced hybrid layers was determined using a Vickers method. Wera resistance tests were performed using MBT-01 tester.
Findings : Gas nitriding resulted in formation of compound zone, consisting of ε nitrides close to the surface and a zone, composed of ε + γ' nitrides. Below the white compound zone, the diffusion zone occurred with nitric sorbite and precipitates of γ' nitrides. In the microstructure after laser heat treatment

(LHT) of nitrided layer, the zones were observed as follows: the re-melted zone (MZ) with nitrides, nitric martensite and non-equilibrium $FeN_{0.056}$ phase, the heat-affected zone (HAZ) with nitric martensite and precipitates of γ' phase and the diffusion zone (DZ) without visible effect of laser treatment. Laser beam power influenced the depth of MZ and HAZ, so the thickness of hardened zone. The hardness of MZ was slightly decreased compared to the hardness of compound zone after gas nitriding. However, the significant increase in hardness was observed in HAZ. The formation of hybrid layers advantageously influenced the tribological properties. The laser-heat treated nitrided layers were characterized by improved wear resistance compared to the only gas-nitrided layer.
Research limitations/implications: The effect of LHT on the microstructure and properties of gas-nitrided layer was limited to the two laser beam powers. In the future research, this range should be exceeded, especially, taking into account the lower values of laser beam power. It will result in laser modification without re-melting.
Practical implications: The selection of suitable LHT parameters could provide the hybrid layers of modified microstructure and improved wear resistance.
Originality/value: This work was related to the new concept of modification of nitrided layer by laser heat treatment.

2.15.
Surface morphology of wheels in rail vehicles in urban transport
Paczkowska M. (Poznań, Poland), Wojciechowski Ł. (Poznań, Poland), Piasecki A. (Poznań, Poland)

Purpose: The general purpose of presented research was evaluation of surface morphology of chosen tram wheels: LUCCHINI (of Siemens Combino tram), PST (of Moderus Beta tram), and GT no 1 (of Duewag tram) operating in Poznan agglomeration.
Design/methodology/approach: 3D surface profile study, macro and microscopic research with light and scanning electron microscopes, and Vickers hardness measurements were done.
Findings: Wear effects were observed on the rolling surface, as well on the surface of the top of the wheel flange. Rolling contact fatigue was dominant type of wear. Abrasion was also noticed, especially on the top of the wheel flange. Changes in the surface layer were also noticed, like sever plastic deformation as: overhangs, flattened grains and delamination. Plastic deformation was the reason of hardness increase. Though the rolling surface is the surface responsible for the load transfer, more plastically deformed was the surface layer of the top of the wheel flange. Although investigated wheels was operated in different trams wear effects were similar.
Research limitations/implications: The research represents part of a project considering identification of phenomena occurring in the contact zone between tram wheel and the rail funded by the National Centre for Research and Development of the LIDER program. Further research should concentrate on designing of the new wheel (new profile and modified material).
Practical implications: On the base of performed research it also was possible to determine some suggestions in the order to extend tram wheel life.
Originality/value: The surface morphology of tram wheels has been describe quantitatively on the base of 3D roughness parameters. Main type of wear that dominate in case of chosen tram wheels in Poznan agglomeration was identified. Main material changes in the surface layer were described in those wheels.

2.16.

The effect of CaF_2 and BaF_2 solid lubricants on wear resistance of laser-borided 100CrMnSi6-4 bearing steel

Piasecki A. (Poznań, Poland), Kotkowiak M. (Poznań, Poland), Kulka M. (Poznań, Poland)

Purpose: In this paper, laser alloying with boron and solid lubricants was used in order to produce the self-lubricating layer on 100CrMnSi6-4 bearing steel. The influence of CaF_2 and BaF_2 on microstructure, hardness, chemical and phase composition as well as wear resistance of the layers was studied.
Design/methodology/approach: The two-step process was used during laser alloying. First, the surface of the specimen was coated by a paste with alloying material. The alloying material consisted of the mixture of amorphous boron and self-lubricating additions (CaF_2 and BaF_2). Next, the surface was re-melted by a laser beam using TRUMPF TLF 2600 Turbo CO_2 laser. The laser beam power 1.43 kW was used for laser alloying. The layer was characterized using X-ray diffraction, Scanning Electron Microscopy, Energy Dispersive Spectroscopy, microhardness tester. The dry sliding wear behaviour of the layer was investigated using the Amsler type wear test.
Findings: The tribofilm, consisting of solid lubricants, was observed on the worn surfaces of laser-alloyed layers. It caused an increase in the wear resistance at room temperature. The presence of calcium fluoride and barium fluoride was confirmed in laser-alloyed layers using XRD and X-ray microanalysis by EDS method.
Practical implications: Laser surface modification with solid lubricants had the important cognitive significance and gives grounds to the practical employment of this technology for reducing the abrasive wear.
Originality/value: The wear mechanism of surface layer with solid lubricants was determined. The produced layer with laser alloying layers of boron and solid lubricant (CaF_2 and BaF_2) was compared.

2.17.

Properties of titanium coating deposited using spheroidal powders by cold spraying

Żórawski W. (Kielce, Poland), Mądry J. (Mielec, Poland), J. Sienicki (Mielec, Poland), Makrenek M. (Kielce, Poland), Góral A. (Kraków, Poland), Kowalski S. (Kraków, Poland)

Purpose: The purpose of this study was to investigate the microstructure and the properties of the Ti coatings cold sprayed using spheroidal powder on the Al 7075 alloy.
Design/methodology/approach: The Ni powder with irregular shape of grains was applied in the cold spraying process. The coatings were sprayed by means of a Impact Innovations 5/8 system with of nitrogen as process gas.
Findings: The high kinetic energy of titanium particles causes their significant deformation and splats strongly adhere to the substrate and to each other. Cold sprayed titanium coatings exhibit negligible porosity and different mechanical properties caused by varying deformation degree of titanium powder. There were no phase changes in titanium powder during the spray process, and the coating consist of crystalline titanium.

Practical implications: Titanium and its alloys have unique properties such as a high strength to weight ratio, excellent corrosion resistance and bio-compatibility. These features make it a material that is ideally suited for use in the aerospace, medical, and corrosive industries.
Originality/value: The main advantage of cold spraying is elimination of influence of temperature on the particles of the coating material and the substrate that occurs in conventional thermal spraying methods. Therefore, the properties of such formed coatings are not available in other technologies.

INPO INVITED AND CONTRIBUTED PAPERS (in Polish)

2.18.

Wpływ parametrów procesu ablacji elektronowej na strukturę i wybrane własności optyczne cienkich warstw poliuretanowych (BIONATE II55D®)

Cieniek Ł, Kowalski K., Nocuń M.

Celem pracy była analiza struktury i zbadanie wybranych własności optycznych poliuretanowych cienkich warstw BIONATE II55D® wytworzonych techniką pulsacyjnego osadzania z wykorzystaniem skupionej wiazki elektronów (*PED - pulsed electron deposition*). Cienkie warstwy wytworzono w atmosferze argonu na epitaksjalnie czystych, monokrystalicznych podłożach Si o orientacji [001], przy użyciu zmiennych parametrów procesu ablacji elektronowej, takich jak: energia elektronów (8 ÷ 11 kV), liczba impulsów (5 k, 20 k i 50 k) oraz częstotliwość powtórzeń (1 ÷ 5 Hz). Do przygotowywania próbek wykorzystano system Neocera PEBS-20 współpracujący z komorą próżniową Pioneer 180.

Mikrostrukturę i skład chemiczny otrzymanych warstw poliuretanowych analizowano za pomocą wysokorozdzielczego skaningowego mikroskopu elektronowego (FEI Nova NanoSEM 450 wyposażonego w detektor EDS EDAX oraz oprogramowanie GENESIS) oraz transmisyjnego mikroskopu elektronowego (Jeol 200CX wyposażonego w detektor EDX INCA i oprogramowanie Oxford Instruments). Powierzchniową topografię cienkich warstw analizowano przy użyciu mikroskopu sił atomowych (Veeco Dimension®Icon™ SPM) pracującego w trybie mieszanym (*tapping mode*), a parametry chropowatości powierzchni wyznaczono z pomocą oprogramowania Nanoscope Analysis. Testy przyczepności warstw do podłoża i pomiary ich nanotwardości przeprowadzono przy użyciu aparatury CSM Instruments NHT-NST. Średnią grubość wytworzonych warstw poliuretanwych i wartość współczynnika załamania światła wyznaczono z zastosowaniem technik elipsometrii i spektroskopii odbiciowej w zakresie długości fali 400 ÷ 1100 nm.

Uzyskane wyniki wyraźnie sugerują, że istnieje ścisły związek między właściwościami optycznymi a grubością i chropowatością cienkich warstw poliuretanowych. Topografia powierzchni oraz adhezja warstw do podłoża są z kolei silnie uzależnione od kluczowych parametrów procesu ablacji elektronowej.

Badania w ramach niniejszej pracy są finansowane przez Akademię Górniczo-Hutniczą im. Stanisława Staszica w Krakowie, umowa nr 11.11.110.295.

2.19.

Badanie mechanizmu ochronnego warstw TiO2 na kompozytach tytanowych wytworzonych metodą SPS

Figiel P., Biedunkiewicz A, Garbiec D., Woitas A.

Ze względu na korzystne połączenie cech wytrzymałościowych i odporności korozyjnej kompozyty tytanowe są stosowane wszędzie tam, gdzie materiałom stawiane są wysokie wymagania eksploatacyjne, np. w przemyśle lotniczym, samochodowym, chemicznym czy do zastosowań w implantologii. O poprawie tych właściwości w dużej mierze decyduje stan powierzchni oraz rodzaj, udział i wielkość użytej fazy umacniającej. W pracy zaprezentowano wyniki badań warstw pasywnych TiO2 tworzących się na kompozytach Ti/TiC, otrzymywanych metodą iskrowego spiekania plazmowego (SPS). Ponadto analizowano wpływ wielkości fazy umacniającej węglika tytany (TiC) na mikrostrukturę i właściwości korozyjne. W tym celu wykorzystano TiC o mikro- (<4 μm) oraz nanometrycznej (<200 nm i <60 nm) wielkości cząstek, o udziałach od 1 do 20% mas. w stosunku do osnowy tytanowej. Wyniki badań skaningowej mikroskopii elektronowej (SEM) wykazały homogenny rozkład TiC w osnowie. Analiza wykresów widm spektralnych fotoelektronów (XPS) ujawniła występowanie głównie warstw TiO2 na wszystkich próbkach. Badania korozyjne metodą polaryzacji anodowej oraz potencjału obwodu otwartego (OCP) przeprowadzono w roztworze Ringera. Zaobserwowano poprawę właściwości korozyjnych kompozytów Ti/nc-TiC, w stosunku do kompozytów Ti/μc-TiC.

2.20.

Analiza stanu naprężeń i rozkładu temperatury w dwuwarstwowych powłokach TBC typu 8YSZ/$La_2Zr_2O_7$

Jasik A.

W opracowaniu przedstawiono wyniki obliczeń numerycznych rozkładu temperatury i naprężeń cieplnych w dwuwarstwowych powłokowych barierach cieplnych (DLC double-ceramic- layer) naniesionych na elemencie z nadstopu niklu metodą natrysku cieplnego. Jako punkt odniesienia przyjęto konwencjonalne jednowarstwowe powłoki TBC (thermal barrier coatings) otrzymane z proszku 8YSZ (6-8% mas. Y 2 O 3 ×ZrO 2) i La 2 Zr 2 O 7 (LZ) o grubości warstwy izolacyjnej na poziomie wynoszącym 300 μm. Analizie numerycznej poddano powłoki TBC, w których zewnętrzną warstwę ceramiczną otrzymano z proszku cyrkonianowego, natomiast warstwę wewnętrzną stanowiła strefa na bazie tlenku cyrkonu. Parametrem zmiennym była grubość obu typu warstw ceramicznych. We wszystkich przypadkach przyjęto, że warstwa podkładowa to powłoka typu NiCoCrAlY otrzymana metodą natrysku plazmowego, podobnie jak zewnętrzna warstwa izolacyjna. Grubość warstwy podkładowej wynosi 125 μm. Jako materiał podłoża przyjęto nadstop niklu typu In 625. W pracy analizie numerycznej poddano powłoki dwuwarstwowe o różnym stosunku grubości obszarów ceramicznych, składające się z warstwy YSZ i cyrkonianu lantanu. Punktem wyjścia była powłoka TBC o równiej grubości obu stref (po 150μm), kolejne warianty obejmowały powłoki o wzajemnej relacji grubości obu materiałów na poziomie 40/60, 30/70, 20/20, 10/90 i 5/95. Celem tych analiz było określenie optymalnej wartości stosunku grubości poszczególnych stref ceramicznych w powłokach DCL istotnych nie tylko z punktu widzenia efektu izolacyjnego, ale przede wszystkim stanu naprężeń decydującego o trwałości całego systemu TBC. Analiza rozkładu naprężeń i temperatury wskazuje, że cykl życia powłok DCL jest silnie zależny od stosunku grubości stref ceramicznych typu LZ i YSZ, a powłoki dwuwarstwowe wykazują korzystniejsze sumaryczne właściwości izolacyjne i związane ze stanem naprężeń.

2.21.

Wybrane właściwości warstw hybrydowych otrzymywanych w procesie chromowania dyfuzyjnego połączonym z następną obróbką PVD

Kasprzycka E. , Bogdański B.

W pracy omówiono wyniki badań dotyczących wybranych właściwości warstw hybrydowych typu CrC+CrN, wytwarzanych na stali w procesie chromowania dyfuzyjnego połączonym z następną obróbką – osadzaniem azotku chromu metodą ARC PVD. Przedmiot badań stanowiła morfologia i struktura warstw, ich adhezja do podłoża stali oraz odporności na zużycie przez tarcie. Dla porównania przeprowadzono również badania właściwości pojedynczych warstw węglikowych, typu CrC, wytwarzanych w procesie chromowania dyfuzyjnego, wykonywanego metodą proszkową. Wykonano pomiary grubości otrzymanych warstw, zbadano ich budowę, skład fazowy i twardość. Adhezję warstw do podłoża stali oceniano za pomocą testu zarysowania. Odporność na zużycie przez tarcie próbek z warstwami określono metodą trzy wałeczki-stożek przy naciskach jednostkowych 50, 100, 300 i 400 MPa. Badania porównawcze wykazały, że odporność na zużycie przez tarcie warstw hybrydowych typu CrC+CrN jest znacznie większa od odporności warstw węglikowych typu CrC wytworzonych w procesie chromowania dyfuzyjnego, bez obróbki PVD. Ponadto, warstwy hybrydowe CrC+CrN wykazują lepszą adhezję do podłoża stali niż warstwy węglikowe CrC.

2.22.

Mikrostruktura i właściwości powłok (Co,Al)WC nanoszonych techniką naddźwiękowego natryskiwania zimnym gazem

Kąc S. , Kowalski K, Kusiński J, Dosta S, Matteazzi P, Georgiou E.

Celem badań było wytworzenie nano-strukturalnych powłok (Co,Al)WC o grubości ok. 100 µm. Nano proszki charakteryzujące się strukturą krystaliczną i równomiernym rozmieszczeniem składników otrzymywano stosując wysokoenergetyczną syntezę mechaniczną. Proszek, o strukturze nanokrystalicznej, był nanoszony na podłoże, bez istotnych zmian jego struktury i właściwości, z wykorzystaniem nowej technologii (naddźwiękowego natryskiwania zimnym gazem - SCGS) pozwalającej uzyskiwać powłoki o dużej gęstości. Mikrostrukturę oraz skład chemiczny nano-proszków i otrzymanych powłok analizowano wykorzystując mikroskopię świetlną, TEM/HRTEM, STEM, SEM/EDS oraz XRD. Ponadto, mierzono twardość, moduł Younga, współczynnik tarcia oraz odporność na ścieranie powłok. Przeprowadzone badania wykazały, że mikrostruktura powłok odpowiada strukturze nanoszonych proszków. Dzięki nano-strukturalnej budowie powłok, właściwej proporcji fazy twardej (WC) i miękkiej osnowy (Co-Al), natryskiwane zimnym gazem powłoki wykazują lepsze własności tribologiczne w porównaniu do materiału porównawczego.

2.23.

Kinetyka wzrostu warstw węgloazotowanej gazowo stali austenitycznej

Kochmański P., Baranowska J.

W artykule przedstawiono wyniki badań kinetyki wzrostu warstw węgloazotowanych gazowo na austenitycznej stali odpornej na korozję. Podczas procesu węgloazotowania stali austenitycznej w niskiej temperaturze (poniżej 500°C) dochodzi do wytworzenia warstwy typu duplex. Składa się ona z bogatej w azot strefę zewnętrzną zbudowanej z fazy SN oraz bogatej w węgiel strefy wewnętrznej zbudowanej z fazy SC. Warstwy otrzymano w różnej temperaturze (400, 450 i 500°), w dwóch atmosferach o zawartości 2% C2H2 oraz 49 i 98% amoniaku. Obróbkę prowadzono w czasie od 0,5 do 16 h. Przed obróbką gazową stosowano aktywacje powierzchni metoda plazmową. Kinetyka wzrostu poszczególnych stref jest dyskutowana w kontekście budowy fazowej i morfologii warstw. Grubość warstw oraz mikrostrukturę badano metodą mikroskopii optycznej i skaningowej. Budowę fazową określono w oparciu o badania metodą dyfrakcji rentgenowskiej. Badania wykazały, że wzrost zarówno strefy węglowej jak i azotowej jest kontrolowany dyfuzją. Ponadto obecność węgla w atmosferze ma pozytywny wpływ na kinetykę wzrostu warstw węgloazotowanych oraz zmniejsza tendencje do ich pękania. Jednakże obecność węgla wpływa również na skłonność do wydzieleń azotków chromu.

2.24.

Cienkie warstwy perowskitów do zastosowań w czujnikach gazów

Kopia A., Jędrusik M., Cyza A., Cieniek Ł., Maziarz W., Leroux Ch., Turquat Ch., Arab M.

Czujniki do detekcji gazów należą do grupy czujników chemicznych, w których informacje chemiczne płynące z otoczenia są przekształcane w użyteczny analitycznie sygnał. Zaliczamy do tej grupy czujniki elektrochemiczne, elektryczne, grawimetryczne, termochemiczne, optyczne. Czujniki do detekcji gazów powinny charakteryzować się dużą czułością , selektywnością, krótkim czasem odpowiedzi, stabilnością chemiczną. Bardzo trudno jest spełnić wszystkie te wymagania, stąd poszukiwanie nowych materiałów lub nowych rozwiązań mogących spełnić te założenia. W pracy określono własności elektryczne w obecności gazu NO2 dla dwóch typów czujników elektrycznych i elektrochemicznych wytworzonych metodą PLD. Pierwszą grupę stanowiły czujniki na bazie perowskitów La1-xSrxCoO3 oraz La1-xSrxFeO3 dla x=0; 0,1; 0,2 wytworzone na podłożach Si (100). Czujniki elektryczne charakteryzowały się budową kolumnową, domieszkowanie spowodowało zmianę parametrów sieci oraz zmniejszenie wielkości krystalitów z 38 nm do 20 nm. Warstwy niedomieszkowane charakteryzowały się dużą czułością, czas odpowiedzi na obecność NO2 to kilka sekund. Czujniki wykorzystujące własności elektrolitów (ciekłych i stałych) stanowią grupę czujników elektrochemicznych –potencjometrycznych. W tej grupie czujników zastosowano elektrolit stałym ZrO2 domieszkowany tlenkiem Y2O3. Jako elektrody pomiarowe zastosowano LaCoO3 oraz LaFeO3. W wyniku osadzania metodą PLD uzyskano nanokrystaliczne warstwy o budowie kolumnowej i rozwiniętej powierzchni. Testy przeprowadzone w obecności gazu NO2 wykazały zmiany własności elektrycznych w wyniku zmian koncentracji gazu.

2.25.

Wpływ warstw fluorkowych i węglanowych na odporność korozyjną materiałów na bazie magnezu

Kowalski K., Jurczyk M.

Materiały na bazie magnezu wzbudzają coraz szersze zainteresowanie dzięki niskiej gęstości oraz dobrym właściwościom mechanicznym. Do głównych wad materiałów na bazie magnezu można zaliczyć słabe właściwości w podwyższonych temperaturach, a także wysoką reaktywność i niska odporność korozyjną.
Do poprawy właściwości materiałów na bazie magnezu można wykorzystać szereg metod, wśród których można wyróżnić zmiany w składzie chemicznym, dodatki cząstek ceramicznych, a także modyfikację warstwy wierzchniej. Celem tej pracy jest zaprezentowanie wpływu modyfikacji warstwy wierzchniej ultradrobnoziarnistych stopów na bazie układów Mg-Zn-Mn-Zr, a także Mg-RE-Zr poprzez obróbkę w kwasie HF, a także w roztworze wodorowęglanu sodu przed i po procesie spiekania. Ultradrobnoziarniste stopy zostały wytworzone metodą mechanicznej syntezy, a następnie poddane procesom prasowania i spiekania. Analizę fazową i mikrostruktury wykonano przy użyciu dyfraktometru rentgenowskiego, jak również skaningowego mikroskopu elektronowego, odporność korozyjną wyznaczona przy użyciu potencjostatu. Modyfikację warstwy wierzchniej przeprowadzono w 40% roztworze kwasu fluorowodorowego oraz w roztworze wodorowęglanu sodu. Wyniki badań korozyjnych potwierdziły znaczące obniżenie prądu korozyjnego, a także przesunięcie potencjałów korozyjnych w kierunku bardziej dodatnich wartości w porównaniu do niemodyfikowanych próbek.
Ultradrobnoziarniste materiały na bazie magnezu dzięki wytworzonym warstwom fluorkowym i węglanowym posiadają lepsze właściwości i mogą być brane pod uwagę do zastosowania ich w aplikacjach biomedycznych.

2.26.

Wpływ rodzaju cząstek Al2O3 na kształtowanie struktury i właściwości mechanicznych powłok kompozytowych Ni/Al2O3

Kucharska B., Kwiatkowski K., Sobiecki J., Sobiecki R.

Celem badań zrealizowanych w ramach niniejszej pracy było określenie wpływu różnych odmian proszku Al2O3 na strukturę i właściwości mechaniczne powłok kompozytowych Ni/Al2O3 wytwarzanych metodą elektrochemiczną. Badania obejmowały powłoki kompozytowe wytworzone w kąpieli Wattsa modyfikowanej sacharyną z fazą dyspersyjną Al2O3 w postaci odmiany δ (proszek monomorficzny) oraz mieszaniny odmian , , i (proszek polimorficzny). Warstwy wytwarzano przy różnych zawartościach faz w kąpieli mieszczących się w zakresie 1- 20 g/dm3 w zależności od osiągniętego stanu nasycenia w kąpieli. Trwałość zawiesiny fazy dyspersyjnej w kąpieli zapewniało zastosowanie odpowiedniego dla danego proszku sposobu mieszania. W celach porównawczych badano również warstwy niklowe wytwarzane metodą elektrochemiczną.
Za pomocą skaningowej mikroskopii elektronowej (SEM) zbadano topografię i morfologię zastosowanych proszków tlenku glinu oraz strukturę wytworzonych powłok niklowych i kompozytowych Ni/Al2O3. Metodą dyfrakcji rentgenowskiej przeprowadzono analizę strukturalną wytworzonych powłok i wyznaczono wielkości krystalitów. Metodą Vickersa wyznaczono mikrotwardość wytworzonych warstw za pomocą aparatu Zwicka.
Zrealizowane badania wykazały, że rodzaj zastosowanego proszku Al2O3 determinuje sposób mieszania, zapewniający najkorzystniejsze rozmieszczenie cząstek w objętości powłoki. Stwierdzono że zawartość cząstek Al2O3 w kąpieli w różny sposób wpływa na zawartość cząstek w materiale warstwy i ich mikrotwardość w zależności od zastosowanej odmiany proszku.

2.27.

Wpływ interferencyjnego nagrzewania laserowego na mikrostrukturę oraz właściwości amorficznych stopów FeSiB(X)

Kusiński J., Czyż O., Morgiel J., Kapusta Cz., Ostrowski R., Strzelec M., Czyż K., Rycyk A

Przedmiotem badań jest krystalizacja amorficznych taśm magnetycznych z grupy FeSiB(X). Wykorzystując możliwości jakie stwarza interferencyjne, impulsowe, laserowe nagrzewanie materiałów badano wpływ procesu na mikrostrukturę, oraz właściwości magnetyczne i mechaniczne amorficznych taśm ze stopów FeSiB. Wykorzystano prosty układ optyczny pryzmatu czworościennego w torze wyjściowym systemu lasera Nd:YAG, generującego impulsy 8-10 ns, o energii do 2 J, na długości fali 1064 nm. Analizowano wpływ gęstości energii promieniowania laserowego oraz ilości impulsów (ilości strzałów) i ich periodycznego, przestrzennego, rozmieszczenia na powierzchni taśmy, w obszarze o wymiarach 7 x 7 mm, na proces krystalizacji amorficznych taśm z tego stopu. Badania obejmowały: obróbkę laserową taśm amorficznych, kompleksową analizę struktury z wykorzystaniem mikroskopu skaningowego, transmisyjnego elektronowego, mikroskopu elektronowego Lorentza i dyfraktometru rentgenowskiego oraz analizę własności magnetycznych za pomocą magnetometru wibracyjnego (VSM), jak również pomiary kalorymetryczne. Badania wykazały, że taśmy amorficzne FeSiB(X) poddane interferencyjnemu impulsowemu nagrzewaniu laserowemu o Gaussowskim rozkładzie natężenia promieniowania ulegają powierzchniowej nanokrystalizacji, w periodycznie rozmieszczonych 62500 obszarach (punktach) o średnicy ok. 10 m. Badania z wykorzystaniem transmisyjnej mikroskopii elektronowej (w tym HREM) wykazały, że w warunkach laserowego interferencyjnego nagrzewania stopu zachodzi równoczesna krystalizacja faz -Fe(Si) oraz Fe2B, w warstwach powierzchniowych stopu amorficznego, podczas gdy w strefach położonych głębiej pod nagrzewaną powierzchnią oraz w bezpośrednim sąsiedztwie nagrzanych obszarów w amorficznej osnowie pojawiają się zarodki faz krystalicznych. Gęstość występowania zarodków faz krystalicznych w amorficznej osnowie malała w miarę oddalania się od centrum nagrzanego obszaru. W czasie następnego nagrzewania stanowiły one centra krystalizacji faz -Fe(Si) oraz Fe2B.Wykorzystując efekt Fresnel'a w mikroskopie elektronowym transmisyjnym Lorentza wykazano, że w wyniku procesu laserowego nagrzewania dochodzi do znacznego rozdrobnienia domen magnetycznych. Wykazano również, że zmiany strukturalne, jakie zachodzą w zakresie zastosowanych dotychczas parametrów obróbki laserowej nie mają istotnego wpływu na własności magnetyczne taśm ze stopów FeSiB(X).

2.28.

Modyfikacja powierzchni wybranych stopów tytanu z otrzymaniem powłok na bazie struktur SiN i DLC do zastosowań na implanty ortopedyczne

Kyzioł K., Kaczmarek Ł., Klich M., Grzesik Z.

Tytan i jego stopy znajdują szerokie zastosowanie w wielu dziedzinach medycyny. Ze względu na wysoką wytrzymałość względną (w stosunku do gęstości), niski ciężar właściwy, dobrą odporność korozyjną i biozgodność materiały te są szeroko wykorzystywane w implantologii. Stanowią między innymi części implantów stawu kolanowego i biodrowego, implanty dentystyczne jak również

zespolenia mostkowe i protezy części kręgosłupa. Ich wadą jest jednak niższa twardość i większa podatność na zużycie cierne w porównaniu do innych biomateriałów metalicznych oraz często brak wystarczającego poziomu osteointegracji. Z tego względu w dalszym ciągu trwają prace nad modyfikacją ich powierzchni. Jedna z technologii, która pozwala na modyfikację wspomnianych materiałów obejmuje procesy otrzymywania materiałów z fazy gazowej, w tym te wspomagane plazmą wzbudzaną częstotliwościami radiowymi (RF PA CVD - Radio Frequency Plasma Assisted Chemical Vapour Deposition). Odpowiednie przygotowanie podłoża oraz dobór kolejnych procesów obróbki plazmochemicznej umożliwia otrzymanie warstwy wierzchniej o pożądanych właściwościach użytkowych.
W niniejszej pracy przedstawiono rezultaty prowadzonych prac w zakresie modyfikacji powierzchni wybranych stopów medycznych (Ti Grade 2 i Ti6Al7Nb). Między innymi określono wpływ zastosowania obróbki z otrzymaniem na ich powierzchni układów warstwowych, opartych na strukturach gradientowych - typu SiN i DLC, jak i wcześniejszej obróbki powierzchni w plazmie N_2-H_2, w reaktorze RF PA CVD. Wykazano między innymi, że otrzymane warstwy gradientowe na powierzchni stopu Ti-6Al-7Nb cechuje charakterystyczna budowa o złożonej mikrogeometrii, zwiększonym rozwinięciu powierzchni, co stanowi ważny aspekt poprawy osteointegracji wszczepu. Ponadto modyfikowany stop cechuje się biokompatybilnością, obserwuje się również wyraźnie ograniczone przechodzenia metali (Ti, Al) do roztworu Ringera jak i obniżenie wartości modułu Younga powierzchni.

2.29.

Odporność powłok metaloceramicznych na działanie wysokiej temperatury i płomienia

Mendala B., Tracz J., Swadźba L., Witala B., Swadźba R.

Powłoki antykorozyjne wykonywane są z różnego rodzaju materiałów w zależności od m.in. środowiska i temperatury w jakim będą pracować. Obecnie stosowane technologie pozwalają na wytwarzanie powłok, które w pełni przez wiele lata mogą stanowić skuteczną ochronę antykorozyjną. Coraz częściej stosuje się do ochrony przed korozją powłoki zawiesinowe, typu slurry, wytwarzane metodami lakierniczymi, które określa się mianem metaloceramicznych. Ze względu na wysoką cenę wykorzystuje się je głównie w przemyśle lotniczym i w energetyce np. na łopatki turbin parowych.
Szeroka gama materiałów jaka jest do dyspozycji w ochronie przed korozją wymusza jednocześnie zastosowanie materiałów ekologicznych. W związku z tym powstaje coraz więcej farb, które w swoim składzie nie posiadają, bądź mają ograniczaną ilość toksycznych związków. Przede wszystkim dąży się do wyeliminowania z użycia takich pierwiastków jak Cd czy Cr^{6+}, ze względu na ich kancerogenny charakter. Na rynku pojawiają się farby, nie zawierające szkodliwych substancji określane mianem „chrome free".
Powłoki te nie tylko są przyjazne środowisku, ale także stanowią doskonałą ochronę elementów przez działaniem korozji, również w wysokiej temperaturze i w warunkach jej cyklicznych zmian. Farby tego typu zawierają drobny proszek aluminium w kwaśnym lub alkalicznym, chromianowo-fosforanowym spoiwie i są wodorozcieńczalne. Standardowo powłoki tego typu mogą pracować w temperaturze do ok. 600°C, natomiast w niniejszej pracy podjęto próbę modyfikacji składu chemicznego stosowanych farb bezchromowych typu „Ceral 34 green" nanoproszkiem AlN, w celu zwiększenia ich odporności na działanie wysokiej temperatury i płomienia. W pracy dokonano charakterystyki wytworzonych powłok. Przeprowadzono badania wykorzystując stanowisko do testów ogniochronności wykonane zgodnie z

normą lotniczą PN-ISO 2685, wg której próbki muszą wytrzymać oddziaływanie płomienia o temperaturze 1100°C w czasie 15 minut.

2.30.

Charakterystyka właściwości cieplnychceramiki typu Sm2Zr2O7

Mikuśkiewicz M., Moskal G., Jucha S.

Rosnące wymagania dotyczące stabilności cieplnej i właściwości izolacyjnych materiałów przeznaczonych na warstwy izolujące powłokowych barier cieplnych przyczyniły się do zwiększenia zainteresowania nowym typem materiałów ceramicznych o właściwościach izolacyjnych lepszych niż w przypadku dotychczas stosowanych materiałów na bazie tlenku cyrkonu (np. 8YSZ). Tlenki trójskładnikowe o ogólnym wzorze A2B2O7 wykazują strukturę krystaliczną typu pirochloru lub fluorytu oraz przewodność cieplną o 30% niższą niż 8YSZ, co czyni je potencjalnymi kandydatami do zastosowania jako warstwy ceramiczne w powłokach TBC.
W niniejszym artykule scharakteryzowano morfologię i własności cieplne proszków cyrkonianu samaru o strukturze pirochloru Sm2Zr2O7, stosowanych do natrysku plazmowego powłokowych barier cieplnych. Analizowano skład chemiczny proszków (OES-ICP) i skład fazowy przy użyciu metod XRD i EBSD. Dokonano również oceny wielkości krystalitów. Wykonano również ocenę podstawowych właściwości fizycznych, takich jak gęstość piknometryczna oraz właściwości technologicznych. Ocenę właściwości cieplnych proszków wykonano za pomocą analizy metodą laserową impulsową LFA, analizy kalorymetrycznej (DSC) i analizy dylatometrycznej (DIL). Do pomiaru ciepła właściwego cp(T) i wartości obliczeniowej gęstości ρ(T) wykorzystano metody dynamicznej analizy termicznej – różnicową kalorymetrię skaningową DSC i technikę dylatometryczną, co pozwoliło na obliczenie współczynników przewodzenia ciepła λ(T).

2.31.

Powłokowe bariery cieplne typu Sm2Zr2O7+8YSZ

Moskal G., Mikuśkiewicz M., Jucha S.

W artykule przedstawiono wyniki badań obejmujące charakterystykę morfologii powłokowych barier cieplnych (TBC) zaliczanych w literaturze do grupy kompozytowych. W odróżnieniu od powłok jednowarstwowych np. typu 8YSZ, czy też Sm2Zr2O7 i dwuwarstwowych (tzw. DCL- double ceramic layer) np. typu 8YSZ/Sm2Zr2O7 powłoki TBC typu kompozytowego charakteryzują się tym, iż ceramiczna warstwę izolacyjną uzyskuje się z mieszaniny proszków różnego rodzaju. W tym przypadku jest to mieszanina bazowych proszków 8YSZ i Sm2Zr2O7 w proporcji 50/50, 25/75 i 75/25. Ten rodzaj morfologii wewnętrznej warstwy izolacyjnej pozwala na wykreowanie w strefie ceramicznej dużej liczby granic międzyfazowych, co powinno wpłynąć korzystnie na zmniejszenie przewodnictwa cieplnego. Z drugiej strony ten typ rozlokowania różnych składników fazowych zapewnić może wzajemną kompensację różnic w wartościach współczynnika rozszerzalności liniowej i modułu sprężystości Younga, co ma istotne znaczenie w warunkach eksploatacyjnych. W ramach przeprowadzonych badań zrealizowano szczegółowe badania morfologii wszystkich analizowanych powłok TBC, które obejmowały badania dyfrakcyjne składu fazowego w stanie wyjściowym oraz

badania dyfrakcyjne stanu naprężeń własnych. Scharakteryzowano również topografię powierzchni zewnętrznej warstwy izolacyjnej w zakresie jakościowej i ilościowej analizy profilometrycznej oraz oceny jakości powierzchni w badaniach mikroskopowych SEM. Dokonano również szczegółowej oceny budowy wewnętrznej powłok ceramicznych opisując ich grubość i porowatość, oraz rozlokowanie składników strukturalnych typu 8YSZ i Sm2Zr2O7. W drugim etapie badan dokonano oceny właściwości izolacyjnych powłok określając ich dyfuzyjność cieplną oraz obliczając współczynnik przewodnictwa cieplnego. Ostatni element przedstawionych badań dotyczy charakterystyki odporności na utlenianie powłok TBC typu 8YSZ+Sm2Zr2O7 w warunkach utleniania statycznego w temperaturze 1100°C. Dokonano charakterystyki wzrokowej próbek oraz szczegółowo przeanalizowano zjawiska w strefie TGO (thermaly grown oxides) odpowiedzialnej za trwałość całego systemu TBC w warunkach utleniania. Określono czasową zależność przyrostu grubości strefy TGO w każdym z badanych wariantów, jak również zrealizowano szczegółowe badania morfologii tej strefy. Badania te objęły analizę składu chemicznego i fazowego w mikroobszarach metodami EDS i EBSD.

10TH COUNTRY-WIDE SCIENTIFIC CONFERENCE INPO 2017

2.32.

Metoda i narzędzie do oceny funkcjonalności systemów warstwowych alternatywnych dla powłok z twardego chromu i kadmu

Mydłowska K., Gilewicz A., Szparaga Ł., Ratajski J.

Zgodnie z dyrektywą europejską dotyczącą chemikaliów (REACH), powłoki twardego chromu, wytwarzane z wysoce toksycznych i rakotwórczych kąpieli, powinny były być zastąpione „zielonymi" rozwiązaniami. Było to inspiracją do realizacji międzynarodowego projektu badawczego Alti2de w ramach inicjatywy Cornet, którego celem było opracowanie alternatywnych systemów warstwowych dla powłok z twardego chromu i kadmu z wykorzystaniem różnych technologii m.in. natryskiwania cieplnego, galwanizacji, PVD, CVD, technologii duplex. Wstępnie wytypowane systemy zostały poddane testom korozyjnym, mechanicznym i tribologicznym oraz analizie powierzchni. Zawierały one standardowe testy: mikrotwardości, calotest, test rysy, analizę mikroskopową, testy tribologiczne trzpień–tarcza, nanondentację. Testy te dostarczyły ilościowej informacji niezbędnej do oceny opracowanych technologii i wyboru najlepszych systemów ze względu na przyjęte kryteria. Były również danymi wyjściowymi do ostatecznej oceny poprzedzonej analizą technologii przez końcowych odbiorców (ze względu m.in. na kryteria ekonomiczne, ekologiczne, konstrukcji linii produkcyjnych). W niniejszym artykule opisano opracowaną metodę oceny funkcjonalności wytworzonych powłok, alternatywnych dla powłok twardego chromu i kadmu. W szczególności, opisano aplikację komputerową, opartą na teorii programowania kompromisowego, która wykorzystując wyniki badań eksperymentalnych oraz oceny ekspertów umożliwia przeprowadzenie wielokryterialnej oceny powłok przeciwzużyciowych pod kątem przyszłych zastosowań.

10TH COUNTRY-WIDE SCIENTIFIC CONFERENCE INPO 2017

2.33.

Kinetyka przemian fazowych przechłodzonego austenitu staliwa bainitycznego przeznaczonego na krzyżownice kolejowe

Parzych S., Bęczkowski R., Kordas P.

Niniejsza praca przedstawia wyniki badań kinetyki przemian fazowych przechłodzonego austenitu staliwa bainitycznego przeznaczonego jako materiał na krzyżownice kolejowe, dotyczy możliwości łączenia (spawania, zgrzewania) materiałów stosowanych na krzyżownice do rozjazdów kolejowych z obecnie stosowanymi materiałami na szyny kolejowe. Obecnie stosowane materiały kute o strukturze perlitycznej nie spełniają rygorystycznych warunków eksploatacji nawierzchni kolejowych zgodnie z Decyzją UIC nr 1692/96, która dopuszcza osiąganie prędkości 200 km/h. Jednym z rozwiązań jest zastosowanie staliw o mikrostrukturze austenitycznej (Hadfielda) oraz coraz częściej stosowanych staliw o mikrostrukturze bainitycznej lub bainityczno-martenzytycznej, które posiadają zaletę nad dotychczas stosowanymi materiałami tym, że ulegają „samo serwisowaniu". Nie wymagają okresowego szlifowania powierzchni tocznych jak to jest w przypadku obecnie stosowanych materiałów. Zastosowanie staliw bainitycznych umożliwia uzyskanie wysokich własności wytrzymałościowych (R_m=1400 MPa, $R_{p0,2}$=900 MPa, twardości do 400 HBW).

2.34.

Próba interpretacji efektów akustycznych procesu zużycia przez tarcie

Popławski M., Piasecki A.

A analizie procesu zużycia przez tarcie rejestrowane są różne parametry tego zjawiska. Do najważniejszych należy zaliczyć współczynnik tarcia pomiędzy powierzchnią próbki badanej i przeciw próbką. W procesie zużycia rejestrujemy także zmianę (w większości przypadków ubytek) masy ścieranej próbki poprzez określenie zmiany objętości w pomiarze ciągłym wykorzystuje się w tym celu między innymi czujnik wydłużenia próbki, a okresowo kontrolujemy zmianę masy z wykorzystaniem wagi analitycznej. Złożoność procesów takich jak ścieranie, tworzenie narostów z produktów zużycia, okresowe ich odpadnie i odsłanianie nowej powierzchni reakcji możemy śledzić na podstawie wrażeń słuchowych. W niniejszej pracy podjęto próbę wyodrębnienia i przyporządkowania poszczególnych efektów akustycznych odpowiednim etapom procesu zużycia przez tarcie.

2.35.

Modyfikacja warstwy wierzchniej stopu Inconel 625 metodą laserowego odkształcania

Rozmus-Górnikowska M., Kusiński J., Cieniek Ł.

Celem pracy była ocena wpływu laserowego odkształcania na topografię, mikrostrukturę i chropowatość warstwy wierzchniej stopu niklu Inconel 625. Proces laserowego odkształcania przeprowadzono przy wykorzystaniu impulsowego lasera ReNOVALaser Nd:YAG z modulacją Q.Badania mikrostruktury oraz topografii powierzchni prowadzono za pomocą mikroskopu optycznego oraz elektronowego mikroskopu skaningowego. Chropowatość powierzchni zmierzono profilometrem WYKO NT930.

W wyniku laserowego odkształcania stopu niklu Inconel 625 wytworzono warstwę wierzchnią o dużym stopniu rozwinięcia powierzchni. Ponadto, na wytrawionych zgładach poprzecznych stopu niklu po obróbce laserowej pod cienką warstwą przetopioną ujawniono obecność licznych pasm poślizgu.

2.36.

Numeryczna analiza wpływ konfiguracji kolektora dyszowego na szybkość hartowania w komorze HPGQ typu 4D Quenching

Sawicki J., Kurpanek K., Staszczyk A., Byczkowska P., Wołowiec-Korecka E.

Komora HPGQ (High Pressure Gas Quenching) typu 4D składa się z układu dysz chłodzących okalających detal zapewniając jak najbardziej równomierny przepływ gazu chłodzącego wokół obracającego się detalu. W ramach pracy poddano analizie Metodą Elementów Skończonych różne konfiguracje geometryczne układu dwuwymiarowego dyszy i próbki, zmieniając parametry takie jak: średnica i długość dyszy, jej odległość od próbki oraz kąt nachylenia względem płaszczyzny próbki. Następnie na podstawie otrzymanych wyników dla symulacji 2D stworzono model dyskretny 3D kolektora dyszowego uwzględniając najlepsze otrzymane konfiguracje parametrów geometrycznych pojedynczych dysz. Uzyskane wyniki pozwoliły wskazać optymalną konfigurację geometryczną kolektora dyszowego pod względem szybkości chłodzenia próbki stalowej oraz zachowania się strugi czynnika chłodzącego.

2.37.

Utlenianie wysokotemperaturowe powłok aluminidkowych modyfikowanych Si na stopie γ-TiAl

Swadźba R., Swadźba L., Hetmańczyk M., Mendala B., Witala B., Tracz J., Marugi K., Pyclik Ł.

Rozwój stopów ɣ-TiAl w ciągu ostatnich dekad umożliwił ich zastosowanie komercyjne na łopatki turbin niskiego ciśnienia (LPT – Low Pressure Turbine) silników General Electric GEnx™ oraz Pratt & Whitney PW1000G-JM. Niemniej jednak, dużym wyzwaniem w dalszym rozwoju tych stopów jest ich niska odporność na utlenianie wysokotemperaturowe powyżej 800 °C. W odróżnieniu do utleniania w czystym tlenie stopy ɣ-TiAl nie tworzą ciągłej i ochronnej warstwy tlenkowej podczas ekspozycji wysokotemperaturowej w powietrzu. Dalszy rozwój stopów ɣ-TiAl nie jest możliwy bez zastosowania nowych rodzajów powłok zapewniających odporność na utlenianie wysokotemperaturowe. W artykule przedstawiono wyniki prac badawczych prowadzonych nad rozwojem powłok aluminidkowych modyfikowanych krzemem dla stopów ɣ-TiAl. Przeprowadzono szczegółową charakterystykę procesów utleniania wysokotemperaturowego stopu ɣ-TiAl powłokami ochronnymi z wykorzystaniem Skaningowo Transmisyjnej Mikroskopii Elektronowej (STEM) oraz metody Focused Ion Beam (FIB).
Powłoki zostały wytworzone za pomocą metody aluminiowania kontaktowo-gazowego (pack cementation) z wykorzystaniem różnej zawartości Si i Al w mieszaninie proszkowej. Przeprowadzono badania mikrostruktury powłok otrzymanych w pięciu różnych mieszaninach proszkowych z wykorzystaniem skaningowego mikroskopu elektronowego FEI INSPECT F. Otrzymane powłoki zostały poddane testom cyklicznego utleniania w 23 godzinnych cyklach i temperaturze 850 °C, podczas których prowadzono pomiary zmian masy próbek w celu określenia odporności na utlenianie wysokotemperaturowe. Badania mikrostruktury na granicy rozdziału powłok i warstw tlenkowych przeprowadzono z wykorzystaniem wysokorozdzielczego mikroskopu skaningowo transmisyjnego FEI TITAN 80-300 oraz metody Focused Ion Beam do preparatyki próbek.
Wyniki przeprowadzonych badań ujawniły, że powłoki aluminidkowe modyfikowane krzemem na stopie ɣ-TiAl zbudowane są z zewnętrznej strefy $TiAl_3$ oraz wewnętrznej strefy $TiAl_2$. Analiza STEM

substruktury powłok ujawniła występowanie w nich nanometrycznych wydzieleń krzemków Ti_5Si_3. Ujawniono, że modyfikacja krzemem powłok aluminidkowych zapewnia wyższą odporność na utlenianie wysokotemperaturowe w temperaturze 850 °C w porównaniu do niemodyfikowanych powłok. Podczas 131 cykli utleniania (3013 godzin w 850 °C) powłoki Si-Al osiągnęły przyrost masy =< 1 mg/cm^2. Przeprowadzono szczegółową analizę mikrostruktury, składu chemicznego oraz fazowego warstw tlenkowych powstających na otrzymanych powłokach podczas testu cyklicznego utleniania oraz scharakteryzowano zjawiska następujące na granicy rozdziału warstw tlenkowych z powłokami. Wykazano, że powłoki aluminidkowe modyfikowane krzemem tworzą przyczepną oraz ciągłą warstwę tlenkową zbudowaną z α-Al_2O_3 oraz ograniczają powstawanie tlenków Ti. Ponadto, ujawniono, że zastosowanie odpowiedniego stosunku Al do Si w mieszaninie proszkowej umożliwia otrzymanie powłok, które nie tworzą azotków tytanu Ti_2AlN oraz TiN w temperaturze 850 °C, ograniczających odporność na utlenianie wysokotemperaturowe.

10TH COUNTRY-WIDE SCIENTIFIC CONFERENCE INPO 2017

2.38

Analiza defektów zmęczeniowych oraz stanu naprężeń w laserowo obrabianym cięgle podwozia samolotu

Szkodo M., Bień A.

W artykule przedstawiono wyniki badań strukturalnych i mikrostrukturalnych oraz stanu naprężeń własnych obrobionej laserowo części podwozia samolotu, której wytrzymałość zmęczeniowa wzrosła kilkakrotnie w wyniku nadtapiania laserowego określonych fragmentów jej powierzchni. Poddając badaniom tomograficznym fragmenty materiału obrobione laserowo i bez obróbki, scharakteryzowano wielkość i rozkład defektów w obu strefach części podwozia po próbie zmęczeniowej. Stosując nanoindentację przedstawiono stan naprężeń własnych w strefie obróbki laserowej. W wyniku analizy mikrostruktury na mikroskopie skaningowym, uzyskano informacje o kształcie defektów w poszczególnych obszarach części maszyny lotniczej.
Na podstawie wyników poszczególnych metod badawczych stwierdzono, że obróbka laserowa znacząco zmienia właściwości materiału na korzyść wytrzymałości zmęczeniowej.

10TH COUNTRY-WIDE SCIENTIFIC CONFERENCE INPO 2017

2.39.

Powłoki kompozytowe Zn/PTFE wytwarzane metodą redukcji elektrochemicznej

Szmigielska K., Bartoszek W., Trzaska M.

Kompozytowe powłoki z osnową cynkową wytwarzane metodą elektrochemiczną są obiecującym nowoczesnym materiałem ochronnym. Przedmiotem badań były kompozytowe powłoki cynkowe z wbudowaną fazą dyspersyjną w postaci proszku PTFE. Zrealizowane badania obejmują charakterystykę fazy dyspersyjnej PTFE, dobór składu elektrolitu oraz parametrów procesu osadzania powłok cynkowych i kompozytowych Zn/PTFE, wytworzenie powłok Zn i Zn/PTFE o różnej zawartości fazy dyspersyjnej oraz badanie ich struktury i wybranych właściwości. Morfologię powierzchni proszku PTFE oraz powłok cynkowej i kompozytowych Zn/PTFE analizowano za pomocą skaningowego mikroskopu elektronowego FE-SEM (Merlin, Zeiss) i mikroskopu metalograficznego

VHX 5000 z komputerową analizą obrazu (KEYENCE). Do analizy składu chemicznego wytworzonych powłok oraz pomiaru ich grubości stosowano spektrofotometr fluorescencji rentgenowskiej FISCHERSCOPE ® X-RAY XDV-SDD (Fischer). Pomiary mikrotwardości badanych powłok wykonano metodą Vickersa przy obciążeniu 25 G (HV 0,025) za pomocą mikrotwardościomierza T1202 (Wilson-Hardness). Badanie zużycia ściernego realizowano za pomocą kulotestera (IMP). Powłoki osadzano na podłożu ze stali węglowej S235JR. Wytworzone powłoki Zn i Zn/PTFE charakteryzowały się zawartą budową oraz równomierną grubością na pokrywanej powierzchni. Osadzanie powłok Zn/PTFE przebiega z mniejszą wydajnością procesu w porównaniu do procesu osadzania powłok Zn. W badanym zakresie zawartości fazy dyspersyjnej, wbudowanie miękkiej fazy PTFE w osnowę cynkową zmniejsza mikrotwardość i zużycie ścierne tych powłok w porównaniu z powłoką cynkową.

2.40.

Analiza stanu naprężeń własnych w powłokach ZrC z wykorzystaniem metody elementów skończonych

Szparaga Ł., Bartosik P., Gilewicz A., Mydłowska K., Ratajski J.

Stan naprężeń własnych w powłokach osadzanych technikami PVD warunkuje w dużym stopniu ich potencjalne właściwości użytkowe, m.in. zużycie przez tarcie, odporność na pękanie, stan adhezji, odporność korozyjną. Obecnie stosowane są standardowe doświadczalne metody badawcze, umożliwiające ocenę stanu naprężeń własnych, tj. z wykorzystaniem dyfrakcji rentgenowskiej oraz bazujące na pomiarze promienia krzywizny próbki z osadzoną powłoką. W przypadku drugiej z tych metod do obliczeń wykorzystuje się tzw. formułę Stoney'a, która została wyprowadzona w oparciu o szereg założeń i uproszczeń.

Analizę stanu naprężeń własnych dokonuje się również z wykorzystaniem symulacji numerycznych opartych o MES (metodę elementów skończonych). Ma ona szczególne znaczenie przy projektowaniu tzw. twardych powłok przeciwzużyciowych osadzanych technikami PVD, m.in. TiN, CrN, TiC, TiCN, CrAlN, ZrN czy ZrC.

Celem badań opisanych w niniejszym artykule było porównanie wartości naprężeń własnych w powłokach ZrC osadzanych na podłożach krzemowych techniką magnetronowego rozpylania reaktywnego, wyznaczonych za pomocą formuły Stoney'a oraz za pomocą symulacji numerycznych metodą elementów skończonych (MES). W tym celu przeprowadzono pomiary profili krzywizny wygięcia próbek po osadzeniu powłok ZrC i zestawiono z modelowymi profilami otrzymanymi na drodze symulacji numerycznych. Ponadto zilustrowano wpływ hipotetycznych naprężeń wzrostu w powłokach na kształt profili wygięcia próbek oraz wyznaczono trójwymiarowe mapy odkształceń i naprężeń własnych w próbkach z osadzoną powłoką. Przewiduje się, że uzyskane rezultaty zostaną wykorzystane jako komponenty eksperckich systemów projektowania powłok przeciwzużyciowych.

2.41.

Właściwości mechaniczne i przeciwzużyciowe wielomodułowych powłok Cr/CrN

Szparaga Ł., Mydłowska K., Gilewicz A., Ratajski J.

Dyrektywa europejska dotycząca chemikaliów (REACh), która ograniczyła m.in. stosowanie powłok ochronnych zawierających sześciowartościowy chrom, była inspiracją do prowadzenia międzynarodowego projektu badawczego Alti2de w ramach inicjatywy Cornet, którego celem było opracowanie alternatywnych systemów warstwowych dla powłok z twardego chromu i kadmu. Galwaniczne powłoki twardego chromu stosowane są od dziesięcioleci m.in. w przemyśle lotniczym i kosmicznym do pokrywania elementów maszyn w celu zwiększenia ich odporności na zużycie. W niektórych zastosowaniach powłoki te mogą zostać zastąpione powłokami osadzanymi technikami PVD, wśród których na uwagę zasługują powłoki na bazie azotku chromu ze względu m.in. na względnie niewielką wartość naprężeń własnych oraz dobrą odporność na utlenianie w wysokich temperaturach. Powłoki wielomodułowe np. Cr/CrN, CrN/CrCN czy powłoki gradientowe CrN/CrCN znane są również jako powłoki inteligentne ponieważ ich budowa determinuje szybkość zużycia w zależności od warunków eksploatacji. Zakres badań prowadzonych w ramach projektu polegał na opracowaniu procedur optymalizacyjnych wspomagających prototypowanie budowy wielomodułowych powłok Cr/CrN i CrN/CrCN oraz powłok gradientowych CrN/CrCN i badanie właściwości powłok osadzonych na azotowanych i nie azotowanych stalowych podłożach. Badania przedstawione w niniejszej pracy są kontynuacją pracy autorów dotyczącej projektowania powłok Cr/CrN ze względu na ich właściwości mechaniczne. Zaproponowano cztery architektury wielomodułowych powłok Cr/CrN, które były analizowane ze względu na stan naprężeń w powłoce podczas testów twardości wgłębnikiem Rockwella (symulacja MES), adhezję powłoki do podłoża, odporność na pękanie i na zużycie. Pokazano, że powłoki w których występuje niewielki udział objętościowy Cr w module Cr/CrN (1:8) charakteryzują się wyższymi naprężeniami głównymi w potencjalnych obszarach pęknięć, a efektywne odkształcenia plastyczne są większe niż dla powłok w których stosunek grubości warstw Cr do CrN jest równy 1:1. Co więcej ujawniono dwa różne mechanizmy degradacji powłok w teście rysy w zależności od ich budowy.

2.42.

Modyfikacja właściwości azotowanych stali w procesach wysokotemperaturowej obróbki cieplnej

Tacikowski M., Kajzer B., Karpiniak P., Rudnicki J., Brojanowska A., Marciniak Sz.

Stosunkowo rzadko podejmowanym i wykorzystanym w praktyce zagadnieniem wydaję się kształtowanie własności stali azotowanych w procesach następującej po wytworzeniu warstw obróbki cieplnej, wykorzystującej przemiany fazowe zarówno w samej warstwie, jak i w podłożu. Istnieją przesłanki, że wysokotemperaturowa obróbka cieplna, mogłaby być przydatnym narzędziem korzystnej modyfikacji właściwości użytkowych zarówno warstw uzyskanych w procesie azotowania, jak i podłoża. Stąd, jako cel pracy proponuje się przeprowadzenie wstępnego rozpoznania wpływu obróbki wysokotemperaturowej, realizowanej w temperaturach położonych powyżej przemiany tj. w zakresie austenitycznym na strukturę i własności stali azotowanych. Oczekiwać można, że w szczególności sposób i warunki chłodzenia będą determinować mikrostrukturę obrabianych cieplnie układów warstwa-podłoże, w tym zwłaszcza rodzaj i dyspersję tworzących ją faz, a konsekwencji wpływać na uzyskiwane własności, dając w efekcie narzędzie ich kształtowania. W pracy przedstawiono wstępne wyniki badań efektów różnych wariantów obróbek hybrydowych łączących azotowanie stali z wysokotemperaturową obróbką cieplną. Podejmowaną tematykę cechuje duży potencjał poznawczy, a w perspektywie również aplikacyjny.

2.43.

Wpływ grubości barierowych powłok pęczniejących na ochronne elementów wykonanych ze stopu aluminium

Tracz J., Swadźba L., Hetmańczyk M., Mendala B., Witala B., Swadźba R., Supernak W., Piwowar K., Pater J.

Jednym z najczęściej stosowanych przez konstruktorów materiałem na elementy samolotów są stopy aluminium. Wynika to z ich korzystnego stosunku wysokich właściwości wytrzymałościowych do relatywnie niskiej masy własnej. Dzięki swoim właściwościom znalazły one zastosowanie w przemyśle lotniczym zarówno na elementy poszycia kadłuba, jak i na odpowiedzialne elementy przeniesienia napędu czego przykładem może być obudowa przekładni silnika lotniczego.
Problem jaki należy rozwiązać to stosunkowo niska odporność stopów aluminium na oddziaływanie wysokiej temperatury oraz ognia.
Istnieje zatem konieczność zabezpieczania elementów wykonanych ze stopów aluminium specjalistycznymi powłokami ochronnymi. Przykładem takich powłok mogą być barierowe powłoki pęczniejące które szeroko stosowane są do zabezpieczenia elementów konstrukcji wykonanych ze stali.
Barierowe powłoki pęczniejące wraz ze wzrostem temperatury tworzą zwartą porowatą warstwę która stanowi izolację cieplną przed oddziaływaniem płomienia oraz ogranicza dostęp tlenu do powierzchni materiału podłoża. Innowacją jest opracowanie systemu powłok do zabezpieczania elementów konstrukcyjnych przeniesienia napędu wykonanych ze stopów aluminium dla przemysłu lotniczego.
Opis warunków prowadzenia badań odporności na oddziaływanie ognia materiałów wykorzystywanych na elementy konstrukcyjne eksploatowane w „ strefach zagrożenia pożarowego" stosowane w przemyśle lotniczym ujęte zostały w międzynarodowej normie PN-ISO 2685. Głównym wymaganiem stawianym tego typu konstrukcją jest ognioodporność, określana jako odporność materiałów na działanie znormalizowanego płomienia o temperaturze 1100±80°C i strumieniu natężenia ciepła wynoszącym ok. 115 kW/m^2, w czasie 15 minut.
W pracy przedstawiono metodykę badań ognioodporności materiałów i powłok z wykorzystaniem znormalizowanego stanowiska spełniającego wymagania powyższej normy. Przeprowadzono badania mikrostruktury i składu chemicznego barierowych powłok ochronnych. Badania ognioodporności stopu aluminium potwierdziły konieczność stosowania powłok ochronnych w celu jego zabezpieczenia. Badania wykazały znaczący wpływ grubości zastosowanych barierowych powłok pęczniejących na obniżenie temperatury podłoża badanych próbek, rejestrowanej za pomocą kamery termowizyjnej od strony niezabezpieczonej powłoką. Przeprowadzone badania potwierdzają skuteczność działania barierowych powłok ogniochronnych zastosowanych dla ochrony badanego stopu aluminium przed deformacją i zniszczeniem.

2.44.

Powłoki wielowarstwowe typu TiB/TiSiC nakładane metodą PLD na podłoża stalowe

Twardowska A., Rajchel B., Kopia A.

Amorficzne powłoki (TiB/TiSiC) x3 nałożono metodą ablacji laserowej na podłoża ze stali AISI 316L oraz M2 wykorzystując tarcze TiB2 oraz Ti3SiC2. Po nałożeniu powłok, próbki wyżarzono

w temperaturze 500 °C przez 5 min, a następnie przeprowadzono badania mikrostrukturalne pokrytych podłoży metodami mikroskopii elektronowej skaningowej i transmisyjnej a także badania właściwości mechanicznych oraz trarciowo-zużyciowych. Właściwości mechaniczne wyznaczono w teście nanoindentacji, stosując wgłębnik diamentowy o geometrii Berkovicha obciążony w zakresie 1- 5 mN. Twardość HIT i moduł Younga EIT obliczono metodą Olivera i Pharra. Współczynnik tarcia i współczynnik zużycia wyznaczono w teście kula-tarcza, stosując przeciwpróbkę korundową. Krótkie wyżarzanie po procesie nakładania powłok pozwoliło na zwiększenie zarówno właściwości mechanicznych jaki i odporności na zużycie pokrytych stali, co było związane z aktywowana cieplnie częściowej krystalizacja warstw TiB w nałożonych powłokach.

2.45.

Antykorozyjne azotowanie gazowe przykłady zastosowań przemysłowych

Wach P., Michalski J., Tacikowski J.

W Instytucie Mechaniki Precyzyjnej w Warszawie od szeregu lat prowadzone są badania azotowania gazowego Nitreg™ m.in. w zakresie wytwarzania warstw zwiększających odporność na korozję azotowanych części maszyn. [1]. Obróbka ta w wielu przypadkach może zastąpić chromowanie galwaniczne. W artykule scharakteryzo-wano dwa typy warstw azotowanych zwiększających odporność na korozję stali konstrukcyjnych.

Warstwy azotowane typu pierwszego posiadają warstwę azotków żelaza stanowią-cą mieszaninę faz $Fe_{2-3}N$ (ε) i Fe_4N (γ') o grubości 12÷20 mm ze strefa porowatą $Fe_{2-3}N$ (ε) o grubości 5÷7 mm na jej powierzchni. Właściwości antykorozyjne warstwy te uzyskują po impregnacji preparatem z inhibitorem korozji. Impregnat wypełnia pory strefy zewnętrznej warstwy azotków żelaza uniemożliwia przenikanie środowiska korozyjnego do stali [2].

Warstwy azotowane typu drugiego posiadają monofazową, nieporowatą warstwę azotków żelaza Fe_4N (γ') o grubości 10÷15 mm. Warstwy te bez impregnacji chronią azotowaną stal przed oddziaływaniem środowiska korozyjnego. Wytwarzanie monofazowych nieporowatych warstw azotków żelaza, wymaga kształtowania potencjału azotowego atmosfery azotującej N_p w taki sposób, aby jego wartość nie przekroczyła wartości granicy N_p ε/γ' wg układu Lehrera [3].

W badaniach odporności korozyjnej w obojętnej mgle solnej wykazano, że w przypadku warstw typu pierwszego do 264 h ekspozycji w komorze nie stwierdzono śladów korozji, natomiast w przypadku warstw typu drugiego do 72 h (tab.1).

2.46.

Struktura i właściwości warstw powierzchniowych wytwarzanych w niskotemperaturowej plazmie na stopie NiTi z pamięcią kształtu

Wierzchoń T.

Stopy NiTi z pamięcią kształtu są coraz szerzej stosowane w medycynie m. in. jako implanty kardiologiczne i kostne. Z uwagi jednak na obecność niklu i jego przechodzenie do otaczających tkanek (zjawisko metalozy) poddawane są różnym obróbkom powierzchniowym zwiększającym ich odporność korozyjną oraz kształtujących ich właściwości biologiczne w zależności od ich przeznaczenia.

W referacie przedstawione zostaną wyniki badań struktury i właściwości warstw powierzchniowych na stopie NiTi wytwarzanych w procesach obróbek jarzeniowych takich jak: azotowanie, utlenianie oraz procesach hybrydowych łączących w/w metody z procesem RFCVD.
Zaprezentowane będą badania struktury, badania składu chemicznego, składu fazowego, topografii i morfologii powierzchni oraz ich wpływ na właściwości wytwarzanych warstw, w szczególności właściwości biologiczne. Wykazane będzie, że struktura, skład fazowy, morfologia i topografia powierzchni wytwarzanych warstw pozwalają kształtować właściwości biologiczne stopu NiTi zgodnie z jego przeznaczeniem i z zachowaniem jego szczególnych cech takich jak: nadplastyczność i pamięć kształtu.

2.47.

Wpływ rozpylania katodowego w niskotemperaturowej plazmie na przyczepność powłok Ni(P) do azotowanej uprzednio stali 1.2343 (WCL)

Zych A., Kulikowski K., Rożniatowski K., Borowski T., Wierzchoń T.

Powłoki niklowo-fosforowe wytwarzane metodą chemiczną, bezprądową ze względu na odporność korozyjną, właściwości smarne, odporność na zużycie ścierne oraz możliwość uzyskania równomiernej powłoki nawet na detalach o skomplikowanych kształtach są szeroko stosowane w wielu gałęziach przemysłu, takich jak: przemysł, chemiczny, spożywczy, lotniczy oraz w motoryzacji. Powłoki Ni(P) mogą zostać poddane dodatkowej obróbce cieplnej, w celu zwiększenia ich twardości i odporności na ścieranie, co jest związane z wydzielaniem fazy międzymetalicznej Ni3P. Osadzenie powłok niklowo-fosforowych na azotowanym uprzednio podłożu ze stali 1.2343 (WCL) ma na celu wytworzenie powierzchniowych dyfuzyjnych warstw kompozytowych typu (od podłoża): warstwa roztworowa z lub bez powierzchniowej strefy azotków żelaza + powłoka Ni(P) o wyższej odporności korozyjnej i odporności na zużycie przez tarcie oraz niższym współczynniku tarcia niż azotowana stal 1.2343 (WCL). Realizacja tych założeń jest możliwa jedynie przy zapewnieniu odpowiedniej przyczepności powłoki Ni(P) do azotowanego podłoża. Celem pracy jest określenie wpływu rozpylania katodowego w niskotemperaturowej plazmie realizowanego bezpośrednio po procesie azotowania na przyczepność powłoki niklowo fosforowej do azotowanego podłoża ze stali 1.2343 (WCL).

2.48.

Cechy struktury i właściwości powłok PVD ze stali z dodatkami Al i Si

B.Kucharska, M.Spalik

Metaliczne powłoki PVD wykazują strukturę mikro- lub nanokrystaliczną. Drobnokrystaliczna struktura powłoki przeznaczonej do pracy w podwyższonej temperaturze korzystnie wpływa na właściwości ochronne zgorzeliny i jej adhezję z podłożem. Kształtowanie struktury i właściwości powłoki PVD odbywa się poprzez dobór parametrów procesu jej osadzenia oraz rodzaj i stężenie wprowadzonych do powłoki domieszek. Dokonano prezentacji wyników badań powłok PVD wykonanych metodą magnetronowego rozpylania z żaroodpornej stali austenitycznej X8CrNi25-21 z domieszkami Al i/lub Si. Nie stwierdzono korzystnego wpływu Si na odporność powłok na utlenianie w temperaturze 800°C.

INVITED PAPERS*

1.64

Composite materials produced by hybride technology of the selective laser sintering and pressure infiltration

Achtelik-Franczak A. (Gliwice, Poland), Dobrzański L.A. (Gliwice, Poland),

Purpose: The aim of this presentation is to present the structure and properties of the new composite materials with a cast aluminum alloys matrix AlSi12 and AlSi7Mg0.3 with a reinforcement made of titanium skeleton microporous materials.
Design/methodology/approach: Titanium microporous materials characterised by the different size of pores were manufactured by selective laser sintering. The microporus titanium were subjected to infiltration with AlSi12 and AlSi7Mg0.3 alloys in the liquid state, receiving a new class of composite materials AlSi12/Ti and AlSi7Mg0.3/Ti.
Findings: The results of examinations of mechanical properties of aluminium alloys AlSi12, AlSi7Mg0.3 and composite materials AlSi12/Ti, AlSi7Mg0.3/Ti show that, during bending and compressive stress, composite materials AlSi12/Ti, AlSi7Mg0.3/Ti have significantly higher strength properties compared to aluminum alloys AlSi12, AlSi7Mg0.3.
Practical implications: The newly developed composite materials AlSi12/Ti or AlSi7Mg0.3/Ti and technology where this composite materials are produced, create an opportunity to fabricate parts with relatively small sizes, which are dedicated, in particular, to the automotive, machine and aviation sector. It is signified by investigations into the feasible uses of microporus titanium for the fabrication of composite materials by way of infiltration, that their use as are inforcement in composite materials has a significant effect on the structure change because multi-component phases are created between the reinforcement material and the matrix material and by improving mechanical properties of such a material.
Originality/Value: The originality of the solution lies in the combination of selective laser sintering technology and pressure infiltration technology in the manufactured of composite materials with a cast aluminum alloys matrix AlSi12 and AlSi7Mg0.3 with a reinforcement made of titanium skeleton microporous materials with different pore sizes.

1.35

Influence of solution heat treatment on the microstructure and hardness of a high carbon alloy from the Ni-Co-Cr-Ta-Al system

Bała P. (Kraków, Poland)

* *Some abstracts have been exceptionally published in the Conference Programme in a form submitted by Authors not corresponding to the Organisers' requirements and it has been marked after the paper title. Abstracts and papers not submitted in the required deadline have been removed from the Conference Programme.*

Purpose: The main purpose of this paper was to determine the influence of the temperature of solution heat treatment on the microstructure and hardness of the newly designed model alloy, intended for working at high temperatures.
Design/methodology/approach: A mass weighing approx. 1 kg was test melted in a vacuum furnace and cast into a ceramic mould. Samples for investigations were solution heat treated at the temperature range of 1020-1170°C. After heating to the desired temperature, the samples were held at this temperature for 2 hours and then water-cooled.
Findings: The main constituents of the microstructure of the Ni-Co-Cr-Ta-Al-C alloy in as-cast state are: the γ phase, which constitutes the matrix, the γ' phase (γ' phase occurs as fine globular precipitates) as well as primary TaC and Cr_7C_3 carbides. Irregularly shaped primary carbides are uniformly distributed and do not form agglomerates. Solution heat treatment of the investigated alloy at exceedingly higher temperatures causes a slow decrease of chromium primary carbides.
Research limitations/implications: Taking into account the chemical composition of the investigated alloy, it is reasonable to expect the heat treatment should improve its properties. At 1020°C, γ' phase precipitations dissolve and it is possible to achieve a super saturated solid solution matrix. Next, correct aging treatment should by applied.
Practical implications: A new model alloy which allows to design a new material for high temperature applications.
Originality/value: New chemical compositions and microstructure of Ni-based materials for high temperature application with high carbon contents. Additionally, the new alloy is strengthened not only by a high carbon volume fraction but also by intermetallic phases.

1.35

Development of removable partial dentures by using additive manufacture and casting processes

Batalha A.E.F. (São Paulo, Brazil), De Araujo R.M. (São Paulo, Brazil)

Purpose: This work aims to present the methodology developed for dimensional analysis of removable partial dentures, following a route with a model manufactured by additive manufacture and a further casting process of a Co-Cr alloy part.
Design/methodology/approach: The method for designing and manufacturing removable partial dentures (RPD) is focused on their completely virtual design. They are manufactured with resin additive manufacturing chrome-cobalt cast alloys. A 3D image correlation scanner was used for dimensional and geometrical tolerance analysis.
Findings: The prostheses manufactured by CAD-CAM route are more accurate than conventional ones, but they suffer distortion during the casting process. This distortion did not interfere with the patient's well-being or with the adaptation to the prosthesis.
Practical implications: Improving the precision in the manufacturing process of a removable partial denture is very important for professional dentists and their patients.

1.23

Composite material components damaged by impact loading: a methodology for the assessment of their residual elastic properties*

Belingardi G. (Torino, Italy), Cavatorta M.P. (Torino, Italy), Paolino D.S. (Torino, Italy)

The detection and evaluation of damage in composite material components is of concern for automotive engineers. The damage of this type of components can be originated both by impact and fatigue loading. The paper is devoted to the damage due to impact loading. Long fiber-reinforced plastics are considered for automotive components in the lightening perspective that brings along reduction of fuel consumption and of GHG emissions. We proposed an methodology for the assessment of the damage sustained by composite materials in case of repeated impact loads. The methodology gives accurate information on residual elastic and strength properties. The investigated composite laminate was made of carbon fabrics with epoxy resin. The methodology consists of two phases: assessment of residual elastic properties after impact and identification of a prediction model for residual elastic properties through nDTs. Thus the relationship between the impact energy and the residual elastic properties was obtained and the exploration impact load was identified. The exploration impact test, coupled with the use of the Damage Index (DI), was then adopted in the second phase for the non-destructive prediction of the local residual elastic properties in the damaged area. The proposed methodology was validated on plate specimens. Subsequently, the methodology was applied to a composite beam, with an omega shape transverse section, that represents one of the typical beams used in the frame of a car body. With the proposed methodology it would be possible to choose the proper maintenance activity after a damaging event: a – do not repair, since damage is not affecting the structure performance; b – repair, since damage is lightly affecting the structure performance; c – substitute, since damage is relevant and the component is no longer able to carry the characteristic service loads.

1.37

Effect of post-weld heat treatment on thermal diffusivity of UNS S32304 duplex stainless steel welds

*Betini E.G. (São Paulo, Brazil), Mucsi C.S. (São Paulo, Brazil), de S. Luz T. (Espírito Santo, Brazil), Orlando M.T.D. (Espírito Santo, Brazil), Avetand-Fenoel M.-N. (Lille, France), Rossi J.L. (São Paulo, Brazil)**

Thermal diffusivity of UNS S32304 duplex stainless steel was studied after pulsed GTA welding autogenous process without filler addition. The used shielding gas was pure argon and 98% argon plus 2% of nitrogen. The present work reports measurements using the laser-flash method. This property was investigated in the thickness direction of thin plates for pre-and post-heat treatment under 750°C for 8 hours and cooled by air. The thermal cycles were acquired during welding, in regions near the melting pool. The temperature profiles were obtained using thermocouples type K attached by spot welding to the thin plate surface and connected to a data acquisition multichannel system. It was observed that thermal diffusivity was affected not only by welding process but also by heat treatment. In the solidified zone (SZ) was observed an equal increase of the thermal diffusivity values for the plates welded with pure argon and argon plus nitrogen atmosphere. After heat treatment, the weld plate with Ar + 2%N_2 as shielding gas has shown thermal diffusivity values closer to the material as received.

1.60

Why stainless steels are continuously interesting for science and engineering

Brytan Z. (Gliwice, Poland)

Purpose: The review of stainless steel groups and their engineering applications are discussed. The paper gives brief review of three research concerning stainless steels: the laser surface alloying of sintered stainless steels, welding of wrought lean duplex stainless steels and the chemical surface passivation of stainless steels.
Design/methodology/approach: Surface modification of sintered stainless steels was carried out by laser surface alloying by HPDL laser. The influence of laser alloying process on the microstructural changes and properties of vacuum sintered stainless steels, both austenitic, ferritic and duplex were studied. The results of TIG welding of wrought lean duplex were also presented and the influence of the surface passivation after surface processing in nitric solution of various wrought stainless steel grades were studied be electrochemical impedance spectroscopy.
Findings: Beside sintered stainless steels the duplex one revealed highest hardening effect by laser alloying with SiC powder, where related microhardness was about 500-600 HV. The pitting intensity of TIG welded wrought lean duplex stainless steels does not affect the method of cleaning welds after welding (etching, brushing + etching), but the milling of the surface layer significantly reduces their intensity. The final corrosion resistance in chloride solution depends not only on the alloy's composition that influence surface passivation ability, but also on the initial surface roughness and the time of passivation process.
Research limitations/implications: The research on the stainless steel surface layer characteristic are still necessary, both in term of oxide layer behavior in different passivation media and the surface behavior after processing steps.
Practical implications: The corrosion resistance of stainless steels is strictly related to the surface conditions after processing. Therefore, the special care should be taken into account when the final surface finish is performed. Because, this step can either increase of decrease the stainless steel life-time in engineering applications.
Originality/value: Presented results should be interested to design engineers working with stainless steel.

1.7

Applicability of friction stir welding to steels

Çam G. (İskenderun-Hatay, Turkey), İpekoğlu G. (İskenderun-Hatay, Turkey), Kucukomeroglu T. (Trabzon, Turkey), Aktarer S.M. (Rize, Turkey)

Purpose: The friction stir welding (FSW) method is widely considered to be one of the most significant developments in joining technology to emerge in the last 30 years. The technique has originally been developed for joining difficult-to-fusion-weld Al-alloys, particularly for high strength grades and now widely used in various industrial applications, such as transport industries. On the other hand, the application of FSW to high temperature materials such as steels is hindered due to the problems

associated with the stirring tools although there is a wide interest for the application of this technique to these materials.
Design/methodology/approach: The aim of this review is to address the current state-of-the-art of FSW of steels, focusing particularly on microstructural aspects and the resulting properties of these joints and discuss the future prospects of this technique for steels. For instance, the use of FSW can be advantageous for joining steels in some special applications where conventional fusion welding processes fail to produce sound cost effective joints, and the high tooling costs of FSW can be justified (i.e. underwater joining of steel pipes or hot plate welding in steel mills). In this study, only structural steels (mainly plain C steels), ferritic stainless steels, austenitic stainless steels and duplex stainless steels will be considered and the other types of steels are out of the scope of this work although some examples are included in the discussion.
Research limitations/implications: The tools experience high temperatures in FSW of steels, i.e., above 1000°C. The number of tool materials which can withstand such temperatures is very limited. In addition, the welding of many common steels can be readily conducted by various conventional fusion welding methods. These joining methods are very flexible, easy-to-perform and well established in industrial applications, which further prevents the application of FSW to these materials. These limitations are to be overcome for commercial exploitation of this technique for joining steels.

1.26

Zeolitization characteristics of fly ash and its use to manufacture porous materials

David E. (Valcea, Romania), Şandru C.(Valcea, Romania) Armeanu A. (Valcea, Romania)

Purpose: At thermal power plants the fly ash (FA) is stored either through dry or wet disposal systems. These storage practices result in different features for fly ashes, such as their interaction with alkalis and hence the potential of zeolite synthesis will be different. With the aim to demonstrate this, it was conducted some investigations to study the physical, chemical ,morphological and mineralogical characteristics of the fly ash residues, then were used to synthesis zeolites by a double stage fusion-hydrothermal method.
Design/methodology/approach: The raw and converted fly ash samples were characterized with respect to their composition, crystallinity and morphology, by SEM and XRD analysis. The effects of environment conditions and process parameters on the zeolitization process were studied and analysed.
Findings: The analysis of these residues showed that dry ash attains a high cation exchange capacity (CEC) and SiO_2/Al_2O_3 ratios, which is in agreement to the formation of fly ash zeolites as compared to its counterpart. The experimental results indicate that the fusion temperature does not influence the synthesis mechanism in range of 500-800°C, having only an effect of acceleration. The increasing of alkaline activator/fly ash ratio enhances the zeolitization degree .
Research limitations/implications: The scientific basis for the issues on the zeolitization characteristics of fly ash and its use to manufacture porous materials calls yet for further elucidation and development.
Practical implications: This study helps to establish the superiority of dry ash over wet ash for synthesizing porous materials and their enhanced quantity and quality.
Originality/value: A new route for the fly ash use is demonstrated and this can become an unavoidable task for porous material manufacturing, a viable way to manage this industrial waste and to protect the environment.

1.53

Systematic study of Ethylene-Vinyl Acetate (EVA) in the manufacturing of protector devices for the orofacial system

Dias R.B. (São Paulo, Brazil), Coto N.P. (São Paulo, Brazil), Batalha G.F. (São Paulo, Brazil), Driemeier L. (São Paulo, Brazil)

Purpose: This study aims to provide a systematic evaluation of the EVA application in orofacial protectors while focusing on sports.
Design/methodology/approach: The research comprises a numerical analysis. During experimental tests, EVA was analysed in special more specific studies about its influence on the mechanical behaviour of EVA were performed. In the numerical analyses of the EVA orofacial protector, the studies focused on its effect in the zygomatic bone protection, in a simplified geometry.
Findings: According to the experimental and numerical results from a systematic study of EVA, its application to orofacial protection can be considered satisfactory.
Research limitations/implications: The limitations for this research is the complex geometry of the face, number of materials and parameters involved in this study.
Practical implications: For facial protection, a better performance is obtained with a combination of rigid and soft EVA material. Particularly for the zygomatic bone, a 3 mm thick plate of soft EVA overlapped by a 1 mm thick plate of rigid EVA is indicated.
Originality/value: The studies made for this researchers group show that the EVA use in facial protection for sports is effective.

1.47

High performance thin-film li-ion microbatteries*

Djenizian T. (Gardanne, France)

Lithium-ion batteries (LIBs) are widely used to power portable devices, microelectronics, vehicles, etc. With many advantages such as high surface area and improved charge transport, self-supported 3-D nanostructured metal oxides such as titania nanotubes (TiO2nts) are promising electrode materials for LIBs and their impact is particularly significant when considering the miniaturization of energy storage systems and the development of 3D microbatteries. This talk will review the concept and fabrication of all-solid-state Li-ion microbatteries using TiO2nts as negative electrode. Effects of material selection and processing on the performance and reliability are presented as a means to develop conceptual guidelines to understand and improve microbattery designs. Fundamentals such as electrode reactions, lithium ion diffusion and the conformal electrodeposition mechanism of polymer electrolytes onto the nanostructured electrodes will be presented. The fabrication of a full 3D microcell showing high electrochemical performance will be presented and the development of the next generation of 3D microbatteries will be discussed.

1.54

Composite materials consisting of carbon nanostructures and nanoforms of selected metals

Dobrzańska-Danikiewicz A.D. (Gliwice, Poland)

Purpose: The aim of this article is to present various carbon-metal nanocomposites considering their constituent elements and fabrication conditions.
Design/methodology/approach: The article outlines the results of microscopic examinations performed with a scanning and transmission electron microscope, presenting composites consisting of carbon nanomaterials and selected nanostructured metals.
Findings: The investigations performed indicate that high-temperature reduction and chemical reduction are the methods enabling to fabricate carbon-metal nanocomposites with the expected structure and special electrical properties.
Practical implications: The newly created composites will be applied as sensors in a gas or liquid environment. It has been evidenced that some of them have also good catalytic (MWCNTs-Re) and electrochemical (MWCNTs-Rh and MWCNTs-Pd) properties.
Originality/value: Summary and comparative analysis of composites being a combination of carbon materials and selected nanostructured metals.

1.22

About weldability and welding of al alloys: case study and problem solving*

Fracchia E. (Torino, Italy), Gobber F. (Torino, Italy), Rosso M. (Torino, Italy)

Among many disciplines within engineering, welding is probably one of the most inexact – rather more of an art than a science. As weldment is meant the complete joint comprising the weld metal, heat affected zones (HAZ) and the adjacent parent metal and should have the same properties as the parent metal. There are, however, a number of problems associated with the welding of aluminium and its alloys that make it difficult to achieve this ideal. The features and defects that may contribute to the loss of properties comprise the following: gas porosity, oxide inclusions and oxide filming, solidification (hot) cracking or hot tearing, reduced strength in the weld and HAZ, lack of fusion, reduced corrosion resistance and reduced electrical resistance. This paper aims provides a basic understanding of the metallurgical principles involved in how aluminium alloys achieve their strength and how welding can affect these properties. The most important and applied welding processes to Al alloys are here shortly introduced, as well as the preparation of parent metals prior to welding and good welding practice to avoid and/or keep under control defects and failures. Some case studies with possible failures will be introduced together with actions and suggestions to solve the observed problems.

1.56

Combined thermal, microstructural and microchemical analysis of solidification of Al25Si3Cu alloy

Guba P. (Windsor, Canada), Gesing A. (Toronto, Canada), Sokolowski J. (Windsor, Canada),, Conle A. (Windsor, Canada), Sobiesiak A. (Windsor, Canada), Kasprzak M. (Gliwice, Poland)

Purpose: This paper present thermal and microstructural and microchemical analyses were conducted on the unmodified experimental alloy Al20Si3Cu (B390.1) solidified in the High Temperature Universal Metallurgical Simulator and Analyser (HT UMSA) under atmospheric pressure (0.1 MPa) and a relatively low solidification rate (-1.2 K/s just after end of solidification), for identification of the thermal events during solidification and the phases in the as-cast structure.
Design/methodology/approach: The HT UMSA platform, using a low thermal mass stainless steel cup, enabled the acquisition of high resolution thermal analysis data.
Design/methodology/approach: A new approach for de-convolution of the first derivative thermal curves allowed detailed thermal and microstructural phase histories to be documented for solidification of Al-Si alloys. Recently developed SEM/EDS methodology allowed to determine composition and distribution of individual phases that are smaller than the X-ray volume.
Findings: Simultaneous consideration of thermal microstructural and microchemical information allowed detailed understanding of the series of events that take place during solidification of Al casting alloy with complex chemistry. In our hypereutectic alloy we document growth of Al(1) dendrites and formation of secondary Si(2) and Al(2) phases all at temperatures higher than the binary equilibrium Al-Si eutectic temperature of 850 K.
Practical implications: Even at this slow solidification rate detailed understanding of the solidification microstructure requires consideration of non-equilibrium processes during solidification.
Originality/value: We propose an original set of hypotheses that consistently explain the observed non-equilibrium solidification behaviour. Proof of these hypotheses is beyond the scope of this work.

1.48

Semi-continuous caster for plate

Haga T. (Osaka, Japan), Miyazaki K. (Osaka, Japan)

Purpose: Development of a semi-continuous caster that can cast a single plate and a clad plate of Al-40%Sn-1%Cu alloy used for sliding bearings.
Design/methodology/approach: A semi-continuous caster to cast a single plate and a clad plate directly from molten metal was designed and assembled. The cast single plate has a thickness ranging from 10 mm to 30 mm, a width of 400 mm, and a length of 500 mm to 1,000 mm. The cast clad plate has a thickness ranging from 10 mm to 30 mm, a width of 50 mm, and a length of 300 mm.
Findings: The semi-continuous caster successfully produced both a single plate and a clad plate of Al-40%Sn-1%Cu alloy. Influence of casting conditions on the properties of the plate, including the thickness, porosity, and surface quality were investigated in the single plate casting. The mixing and diffusion of the alloy elements at the interface was also investigated in the clad plate casting.
Research limitations/implications: The cast Al-40%Sn-1%Cu alloy plate has not yet been tested as a sliding bearing material, so the efficacy of the material still requires investigation.
Practical implications: The semi-continuous caster described in this paper enables the "small lot" production made from single and clad plates of aluminium alloy.
Originality/value: Development of a semi-continuous caster that can cast both single and clad plates of aluminium alloy. Investigation of the relationship between the casting conditions and plate quality.

1.49

Virtual laboratories methodology in scientific researches and education

Honysz R. (Gliwice, Poland), Dobrzanski L.A. (Gliwice, Poland)

Purpose: This article was written to describe the Material Science Virtual Laboratory. Presented laboratory is an open scientific, investigative, simulating and didactic medium helpful in the realisation of the scientific and didactic tasks in the field of material Science. This laboratory is implemented in the Institute of Engineering Materials and Biomaterials of Silesian University of Technology in Gliwice, Poland. Design/methodology/approach
Methodology: The laboratory is an aggregate of testers and training simulators, placed in the virtual reality and created in various languages and the programming techniques, which represents the properties, functionality and manual principles of real equipment installed and accessible in the real laboratories of scientific universities. Findings
Findings: Application of the equipment, that is practically imperishable, cheap in exploitation and easy in the use encourages students and scientific workers to independent audits and experiments in situations, where the possibilities of their execution in the real investigative laboratory will be limited because of the high material costs, difficult access to real equipment or the possible risk of his damage. Research limitations/implications
Research implications: The proposed solutions allow the usage of developed virtual environment as a new medium in both, the scientific work performed remotely, as well as in education during classes. Practical implications
Practical implications: The use possibilities of the virtual laboratory are practically unrestricted; it can be a base for any studies, course or training programme. Originality/value
Originality: The project of the virtual laboratory corresponds with the global tendency for expand the investigative and academic centres about the possibilities of training and experiments performance with use of the virtual reality. This enriches investigation and education programmes of the new abilities reserved so far exclusively for effecting only on real equipment.

1.28

Fluxon dynamics in the curved Josephson junction

Jarmoliński A. (Kraków, Poland), Dobrowolski T. (Kraków, Poland)

Purpose: The purpose of this report is to present the similarities and differences between modified sine-Gordon models used in description of the curved Josephson junctions. The leading dynamical variable in this system is a gauge invariant phase difference of the macroscopic wave functions of the superconducting electrodes that form the junction.
Findings: The main finding of this article is the observation that in the model used in description of junctions with quickly varying curvatures the significant part of the kink energy is confined in the curved regions of the junction.
Research limitations/implications: The paper is limited to the description of the dynamics of fluxions in the long Josephson junctions. These junctions due to small transverse sizes (smaller than the Josephson penetration depth) can be considered as a one dimensional systems.

Practical implications: It seems that junctions with appropriate geometry will find applications in future electronic devices. It is expected that curved Josephson junctions can be used in order to store a binary data.
Originality/value: The main idea of the paper is to use a Riemann geometry in order to describe the influence of the curvature on the kink motion in the junction.

1.19

A study on welding quality for the automatic vertical-position welding process based on Mahalanobis distance method

Jin B.-J. (Muan-gun, South Korea), Park M.-H. (Muan-gun, South Korea), Yun T.-J. (Muan-gun, South Korea), Shim J.-Y., Kang B.-Y. (Jeonju, South Korea), Kim I.-S. (Muan-gun, South Korea)

Purpose: Welding process has widely been used in many engineering application such as industrial constructions, shipbuilding, piping to transport the fluid oil or water, renewable energy constructions. This welding process plays an important role in the engineering application. However, there are many welding positions in the welding process such as horizontal and vertical position so that each welding position has different problems.
Design/methodology/approach: To achieve, a good weld was first defined as a reference; from this, MD, mean and standard deviation values were calculated. Then, values of MD obtained from the welding current and arc voltage were supposed to follow the normal distribution. The number of values of MD obtained from other experiments found to belong to the reference set was finally calculated to quantify welding quality. Two kinds of experiments has been carried out by changing welding parameters artificially to verify the sensitivity and feasibility of WQ(welding Quality) based on the concepts of MD and normal distribution.
Findings: The results represented that WQ was fully capable of quantifying and qualifying the welding faults.
Research limitations/implications: One of the challenges in the automated arc welding process is a vertical-position due to the difficulty. The arc welding process on the vertical-position compared to a horizontal-position welding is much more difficult because the metal transfer is influenced by the gravity force. To solve the problem, a new algorithm to monitor and control the welding fault during the arc welding process has been developed. Furthermore, optimization of welding parameters for the vertical-position was really difficult to use the developed algorithms because they are only useful in selecting stored data and not for evaluating the effect of the variation of welding parameters on the weld ability.
Practical implications: From the experimental result, it proved that developed algorithm could be achieved the highest welding quality at 15 mm CTWD setting which the welding quality is 99.50% for the start section and 99.68% at the middle section.
Originality/value: This paper proposed a new algorithm which employed the concepts of MD (Mahalanobis distance) and normal distribution to describe a good quality welding.

1.24

Alginate based hydrogel for tissue regeneration: optimization, antibacterial activity and mechanical properties

Kaczmarek-Pawelska A. (Zielona Góra, Poland), Winiarczyk K. (Zielona Góra, Poland), Mazurek J. (Zielona Góra, Poland)

Purpose: In this work our aim was to reveal the relationship between sodium alginate concentration and crosslinking level, also the ratio of release of the antibacterial additives: silver nanoparticles and metronidazole. Moreover, we examine obtained hydrogel as a potential dressing material for regenerative medicine.
Design/methodology/approach: In the research specimens of hydrogels were tested to define their mechanical and physicochemical properties like antibacterial activity against gram-negative *Escherichia coli* and gram-positive *Staphylococcus aureus*, viscosity and conductivity.
Findings: The concentration of alginate and presence of antibacterial additives influence on the crosslinking level. Mechanical properties of hydrogels are similar to human skin. Only hydrogels with addition of metronidazole and AgNP inhibits bacteria growth after 18 h. In case of gram-negative *Escherichia coli* both of the aseptic additives inhibits bacteria growth, but sodium alginate hydrogel with silver nanoparticles gives better results in tests with gram-positive *Staphylococcus aureus*.
Research limitations/implications: The presence of metronidazole in hydrogel, especially its incorporation and binding with mannuronic and guluronic acid residues must be clarified in more advanced research.
Practical implications: Obtained results shows that sodium alginate hydrogels with 0.1 mg/ml of alginate, due to its properties are proper as a dressing material. Based on the results, and more advanced tests with metronidazole, we can consider dressing design.
Originality/value: Unique value of this work is that we completed the gap in knowledge about the relation of crosslinking level and mechanical properties with are crucial to proper tissue healing and addition of popular aseptic agents.

1.5

Development of key performance selection index model

Kaganski S. (Tallinn, Estonia), Toompalu S. (Tallinn, Estonia)

Purpose: The main idea of this paper is to introduce the refined model for selection of the key performance indicators (KPI). The KPI selection model can be considered as a tool for analysis of the enterprise, which should be able to simplify the choice of the right metrics for the company, where study has been conducted. The enterprise analysis model (EAM) will provide the information regarding weak spots on the production and provide further steps to the management. Those actions will save time and reduce resources that are necessary to implement metrics in company.
Design/methodology/approach: Main activities performed include: optimization of EAM; Fuzzy AHP and SMARTER criteria's for ranking the KPIs; reliability analysis and weights appointment to questions and KPIs. In addition, the expert group has participated in the analysis of this work and has made a high impact on the results.
Findings: The main result of this work is the final version of the KPI selection model.
Research limitations/implications: The future research should be focused on optimization of the model and in adding additional module for automatic data collection. The Production Monitoring System (PMS) that should help to collect data about the status of the machine park, taking into account the downtime, overall equipment efficiency (OEE) and etc.

Practical implications: The proposed model can be used in SME (small and medium enterprises) in order to improve the productivity. The concept was tested in particular company.
Originality/value: The KPI selection model combine different methodologies into one general approach. Due to this fact, the process of finding right metrics can be reduced significantly. The proposed approach allows saving resources for the research of metrics.

1.29

Development and manufacturing of customized milling cutters for individual tool-making industry

Kopač J. (Ljubljana, Slovenia), Pušavec F. (Ljubljana, Slovenia)

Purpose: Purpose of this paper is to present results obtained during developing new cutting tools for individual tool industry. The aim of the research was to develop customized ball end milling tools with longer tool-life.
Design/methodology/approach: to this study of development of new tools was over four successive sets of experiments, where the tool material, cutting edge preparation (cutting edge radius), rake angle and coating were selected for achieving longer tool-life. Tool-life was monitored over measuring tool wear on the flank face of the tool; maximum allowed tool wear was set to VB = 0.3 mm.
Findings: of this study are showing that with right combination of the tool material, cutting edge radius, rake angle and appropriate coating, tool-life can be prolonged significant.
Research (and practical) implications: implications are reflected in the substituting of all used milling tools from renowned manufacturers with these newly developed tools in this tool industry.
Originality/value: of this paper is visible over significant improvement in tool-life of milling tools, especially for the company who will be using these tools in their production.

1.33

The effect of deformation degree on the microstructure of the 6060 aluminium alloy

Koralnik M. (Warsaw, Poland), Adamczyk-Cieślak B. (Warsaw, Poland), Kulczyk M. (Warsaw, Poland), Mizera J. (Warsaw, Poland)

Purpose: All results obtained in the present study allowed to analyse the changes in the microstructure and texture of the commercial 6060 aluminium alloy, after deformation process by severe plastic deformation. There were compare two deformation degree samples received by cumulative hydrostatic extrusion.
Design/methodology/approach: The samples of the 6060 alloy were subjected to a one-pass and three-passes extrusion process and next the age hardening. The microstructure changes were investigated by using transmission and scanning electron microscopy. To study the texture evolution the X-ray diffraction were made.
Findings: The microscopic observations results presented the refinement of microstructure as a result of deformation process. The evolution of fibrous character of texture was observed. There were noted the disappearance of fibrous component <100> during subsequent deformation processes and generation the fibrous component <111> after high deformation degree. In addition, for each state, the presence of cubic texture component was recorded.

Research limitations/implications: For the future research are planned to analyse changes in mechanical properties after hydrostatic extrusion combinate with age hardening of investigated materials.
Originality/value: The paper focuses on the investigation of microstructure and texture evolution after modern method of plastic deformation.

SILVER JUBILEE INTERNATIONAL SCIENTIFIC CONFERENCE AMME

1.50

New production method of ceramic filters used in investment casting process*

Koralnik M.K. (Warsaw, Poland), Cygan R. (Rzeszów, Poland), Mizera J. (Warsaw, Poland)

Ceramic filters used in investment casting process are porous structures. Filters are implement in ceramic forms directly into the fill bowl. The molten alloy is poured through the filter and where is purified from nonmetallic pollution. Moreover stabilizing the stream of liquid alloy. Ceramic filters should be stable in high temperature and be resistant to erosion and chemical reactions with molten alloy. The most popular, conventionally used filters are ceramic foams. The new method of manufacturing is rapid prototyping. The filter structure can be strictly define. Furthermore, any produce structure is directly the same as a model. It is worth to admit that this method allow to produce cheap in fully automatic process and the model could be change anytime. This work presents investigation of ceramic filters obtained in traditional way and by 3D printing method with different arrangement of the filament. Using scanning electron microscopy (SEM) with energy dispersive spectroscopy (EDS) the interface between solidified alloy and the wall of the filter has been investigated. Moreover SEM with EDS detector allowed to characterized chemical composition of the nonmetallic inclusions.

SILVER JUBILEE INTERNATIONAL SCIENTIFIC CONFERENCE AMME

1.14

Investigations on the joint properties of the friction welding of aluminium alloy tube to tube plate using an external tool

Korkmaz E. (Denizli, Turkey), Gülsöz A. (Denizli, Turkey), Meran C. (Denizli, Turkey)

Purpose: Aluminium and its alloys are frequently used in structural applications due to their good welding ability as well as their high strength and corrosion resistance. Several developments have been observed on the welding of aluminium in last decade. The manufacturing of heat exchangers, economizers and boilers is highly cost progress due to tube to tube plate welding's. The purpose of this study is investigation of friction weldability of tube to tube plate aluminium alloys using an external tools (FWTPET) which is a relatively newer solid state welding process used for joining tube to tube plate.
Design/methodology/approach: First, preliminary experiments were carried out to determining suitable the tool rotational speed, pressure load and temperature. An experimental setup has been designed and manufactured to keep the pressure load constant during the preliminary tests. Then, by changing the weld mouth on the plate, the gap between the tube and the plate, and the tube projection parameters, the effects of all parameters on shear strength values, micro hardness values and the formation of internal structure of the weld zone were investigated.

Findings: It was founded that aluminium tubes can successfully weld to tube plates with using an external tools. Also it is seen that vertical force between tool and sample, tube protection and temperature are very important parameters which are effect of welded joint properties.
Practical implications: FWTPET which is new welding method has been used in industrial field in last few years.
Originality/value: In the beginnings studies concentrate on non-ferrous metals such as Al, Cu, Mg etc. So this studies on FWTPET have remarkable importance.

1.27

Microstructure, microhardness and tensile properties of FSWed DP 800 steel

Kucukomeroglu T. (Trabzon, Turkey), Aktarer S.M. (Rize, Turkey)

Purpose: Dual phase (DP) steels are widely used in the automotive industry due to their properties of a high balance of strength and formability. However, it is known that conventional welding of high strength steel leads to some undesirable results such as hardness decrease in the heat affected zone. Friction stir welding (FSW) is a new solid state joining method, which is used to join these steels due to its advantage of low heat input. The aim of this study is to evaluate the microstructural change and mechanical properties of friction stir welded DP800 steel.
Design/methodology/approach: DP 800 steels with 1.5 mm thickness were subjected to friction stir welding, by using a tungsten carbide (WC) tool. The tool was tilted 2°, and downforce of the tool was kept constant at 6 kN. During processing, the tool rotation and traverse speed were fixed at 1600 rpm and 170 $mm \cdot min^{-1}$, respectively.
Findings: The friction stir welded region comprises martensite, bainite, refined ferrite. The average microhardness of stir zone has increased from 260 HV0.2 to about 450 HV0.2. The tensile sample shows a decrease in the ultimate tensile strength (σUTS) about 3%, from 827 MPa to 806 MPa for the joint. The yield strength (YS) of the joint is about 566 MPa and the value is near that of DP800.
Research limitations/implications: The tungsten carbide tool used for the friction stir welding has suffered deterioration in the pin profile after 1 meter welding operation. It may be advisable to drill a pre-hole in the specimens for a longer tool life.
Practical implications: Tool wear for industrial applications will be a major problem. Therefore, the use of tools with high wear resistance such as polycrystalline cubic boron nitride may be recommended.
Originality/value: Works on friction stir welding of dual phase steels are limited and they mostly focus on spot welding. Also, this study systematically investigates the microstructure and mechanical properties of dual-phase 800 steels after the friction stir welding.

1.55

An effective crack tip region finite element sub-model for fracture mechanics analysis

Lenkovskiy T.M. (Lviv, Ukraine), Kulyk V.V. (Lviv, Ukraine), Duriagina Z.A. (Lviv, Ukraine; Lublin, Poland), Kovalchuk R.A. (Lviv, Ukraine), Topilnytskyy V.G. (Lviv, Ukraine), Vira V.V. (Lviv, Ukraine), Tepla T.L (Lviv, Ukraine), Bilash O.V. (Lviv, Ukraine), Lishchynska K.I. (Lviv, Ukraine)

Purpose: To create an effective in engineering strength calculation three-dimensional sub-model of the near crack tip region in solids for hi-fidelity analysis of their stress-strain state by the finite element method.
Design/methodology/approach: To create a volume near the crack tip, regular three-dimensional 20-node prismatic isoparametric elements and 15-node special elements with edge length of 12.5 μm with shifted nodes in order to simulate the singularity of stress at the crack tip were used. Using these two types of elements, a cylindrical fragment of diameter of 100 μm was built. In its base is a 16-vertex polygon, and its axis is the crack front line. In the radial direction the size of the elements was smoothly enlarged by creating of 5 circular layers of elements, and in the axial direction 8 layers were created. For convenience of the sub-model usage, the cylindrical fragment was completed by regular elements to a cubic form with edge size 400 μm. For the sub-model approbation, the full-scale three-dimensional models of standard specimens with cracks were built. The stress intensity factor K at normal tension was calculated assuming small scale yielding conditions in a plane between 4^{th} and 5^{th} layers of special elements on the basis of analysis of displacement fields near the crack tip.
Findings: An effective three-dimensional sub-model of the near crack tip region is proposed. The sub-model was used to obtain the dependence of the stress intensity factor on the relative crack length at normal tension for four types of standard specimens. The obtained dependences show excellent correlation with known analytical solutions.
Research limitations/implications: The concept of finite element meshing at three-dimensional modeling of the near crack tip region for high-fidelity stress-strain state analysis was generalized. A sub-model of the near crack tip region was created and used to determine the stress intensity factor at normal tension of four types of standard specimens. It is shown that the proposed methodology is effective for precise analysis of the stress-strain state of solids with cracks within the framework of linear fracture mechanics.
Practical implications: By applying the generalized approach and the proposed three-dimensional sub-model of the near crack tip region, one can determine the stress-strain state of structure elements and machine parts when analyzing their workability by the finite element method.
Originality/value: An effective finite-element sub-model for the stress-strain state analysis in the vicinity of the crack tip within the framework of the linear fracture mechanics is proposed.

1.18

Grain refinement and post processing surface modification in hydrostatycally extruded stainless steel*

Lewandowska M. (Warsaw, Poland), Krawczynska A.T. (Warsaw, Poland), Sitek R. (Warsaw, Poland)

Hydrostatic extrusion is an effective way of grain refinement as proven for various materials, including aluminium, titanium and iron based alloys. It enables to produce high strength ultrafine grained materials in relatively large quantities. In this work, the samples 316 lvm austenitic stainless steel was subjected to hydrostatic extrusion at room and elevated (900oC) temperature. The sample HE processed at room temperature with a true strain of 2.3 features an uniformly refined microstructure consisting of nanotwins and shear bands on the cross section and a fiber-like microstructure on the longitudinal section. The sample HE processed at elevated temperature exhibits the microstructure with equiaxial subgrains. The samples were then nitrided in low-temperature plasma assisted nitriding process. The nitriding process results in the formation of nitride layer, whose thickness was to some extent influenced by the substrate grain structure. The results are discussed in terms of the role different types

of grain boundaries as fast diffusion paths as well as trapping sites for diffusing nitrogen atoms. The properties such as corrosion and wear resistance were also evaluated and attributed to specific features of the nitrided layers.

1.36

Effect of combinative cooled addition of strontium and aluminium on mechanical properties AlSi12 alloy*

Lipiński T. (Olsztyn, Poland)

Purpose: The study was to determine the mechanical properties of hypo-eutectic silumin AlSi12 modified with Sr or Al-Sr alloy slow or fast cooled and in the form of a strip or powder.
Design/methodology/approach: The experiment performed on EN AB-AlSi12 hypo-eutectic alloy. Aluminum and strontium was melted and next fast cooled to room temperature or cooled on a metal plate at rates about 200°C/s. This enabled to produce a different components, which were powdered immediately before adding to the alloy or used as a strip. The scope of this paper was to verify the cooling effect of Sr-Al modifiers and its form (powder or strip) on the microstructure and mechanical properties the AlSi12 alloy.
Findings: The use of fast cooled Al-Sr alloy in the modification process and/or powdered alloy contributed to a further increase mechanical properties AlSi12 alloy.
Research limitations/implications: The modification alloys with fast cooled powdered modifier are attractive for future research.
Practical implications: Widely presented books and research papers on the silumin treatment give not a lot of contents on the effect treatment fast cooled alloy in the form of a strip or powder.
Originality/value: The original value of the paper is comparison Sr and Al-Sr alloy modifiers slow and fast cooled and used as a powder or strip.

Study on homogeneity and repeatability of single-piece flow carburizing system

Madej A. (Lodz, Poland), Brewka A. (Swiebodzin, Poland), Wołowiec-Korecka E. (Lodz, Poalnd)

Purpose. The purpose was to demonstrate homogeneity and replicability of carburized layers obtained by a continuous single-piece flow method.
Design/methodology/approach. A series of 100 gears was carburized under low pressure atmosphere using the single-piece flow method. The microstructures of the obtained carbon layers were investigated. Hardness penetration pattern and carbon concentration profiles were tested.
Findings. The findings have shown the validity/correctness of microstructure of carburized layers obtained by the single-piece flow method. It has been proved that carbon layer in every gear is uniform, what confirms that each element is affected by the same process conditions and gears in the whole series can be precisely reproduced.
Research limitations/implications. The short-pulse low-pressure carburizing technology needs further investigation to fully understand its all mechanisms.
Practical implications. The single-piece flow method provides uniform and reproducible carburized layers with accuracy at about an order of magnitude exceeding the abilities of currently used thermo-

chemical furnaces. By applying the method it is possible to obtain uniform carburized case in every single gear from the whole series of elements subjected to the process. Appropriate configuration of process parameters and carbon-carrying mixture allows to meet high expectations of modern and future industry, what is crucial in exploiting carburized steel gears.
Originality/value. The adequacy of applying LPC single-piece flow method to demanding mass production has been verified. The statistical validity of research results of the whole manufactured series of gears is being performed for the first time.

1. 1.31

Carbon based coatings for applications in friction couples with bearing steel and aluminium alloy*

Makówka M. (Łódź, Poland), Wendler B. (Łódź, Poland)

In the paper the WC/a-C:H and (Si, Cr)C/a-C:H coatings deposited by means of magnetron sputtering were investigated. Tungsten and graphite targets or silicone, chromium and graphite targets were sputtered for deposition of WC/a-C:H and (Si,Cr)C/a-C:H coatings in Ar atmosphere, respectively. Hydrogenation of amorphous carbon matrix was obtained by introducing pure methane into vacuum chamber during deposition. Coatings were deposited onto bulk hardened and tempered HS Vanadis 23 steel. The coatings were investigated by means of SEM, EDS, in order to obtain thickness, surface morphology and chemical composition of coatings. Tribological properties of deposited coatings were elaborated by means of 'pin-on-disc' method in friction couple with 100Cr6 bearing steel and AlSi alloy. It was stated that (Si, Cr)C/a-C:H coatings have very good tribological properties in friction couple with bearing steel and AlSi alloy (friction coefficient <0.1). In case of WC/a-C:H coatings, good tribological properties were achieved in friction couple with bearing steel. When the counterbody was made for AlSi alloy, friction coefficient was significantly higher and obtained value >0.2. Both coatings WC/a-C:H and (Si,Cr)C/a-C:H have very low wear rate (in a range of 10^{-17} $m^3 \cdot N^{-1} \cdot m^{-1}$) in investigated friction couples.

1.32

Correlation between plasma parameters and properties of optical TiO2 thin films deposited by means of different magnetron sputtering methods*

Makówka M. (Lodz, Poland)

The aim of this work is to investigate the influence of experimental parameters on the characteristics of plasma induced by MF Magnetron Sputtering, Gas Impulse Magnetron Sputtering - GIMS (a newly developed method in Lodz University of Technology) and High Power Impulse Magnetron Sputtering – HIPPIMS or HPPMS. GIMS method is based on the impulse gas supply into the vacuum chamber (filed for patent protection in 2010-2012 in the form of 4 applications to the Polish Patent Office). Results of study of plasma parameters of different methods of plasma excitation (based on magnetron sputtering) are compared. The main characterized parameters of plasma are: plasma potential Vd, floating potential Vf, temperature of excitation and ionization Texc and Tes, plasma ionization degree βi, plasma density, temperatures of electrons and ions Te and Ti, stage of plasma component ionization. Moreover

parameters of discharge on magnetrons are under continuous investigation during deposition: changes of voltage and current. Spectrum of plasma in wide range from UV to infrared wavelength is monitored in function of time of plasma excitation. In case of GIMS method this parameters are highly related to the pressure of gas (argon, argon and oxygen or pure oxygen) in the vacuum chamber. This parameter is continuously measured using fast vacuum gauge and results are analyzed to calculate the pressure of plasma excitation and extinction.

1.63

Computer Aided Design in Maxillofacial Surgery*

Malara P. (Gliwice, Poland), Dobrzański L.B. (Gliwice, Poland)

Maxillofacial surgery is one of the most demanding medical disciplines due to highly complicated anatomy and the occurrence of many important organs on a very limited space. The use of state-of-the-art computer-assisted technologies allows for significant improvement of the process of surgical procedure preparation, planning of the incision lines and the manufacturing of necessary elements for efficient operation.

The predominant number of procedures in maxillofacial surgery are operations performed on bone tissue. They involve bone modelling, bone resection in cases of hypertrophy, osteosynthesis in fractures and reconstruction of post-traumatic and post-resection bone deficit. A separate group of procedures consists of orthognathic operations aimed at restoring proper three-dimensional relationships of the bone base to reconstruct normal bite conditions. During planning of these procedures, it is necessary to consider a large number of data to find the optimal position of the maxilla and the mandible, preparation of auxiliary elements that allow proper orientation in the three dimensions of the cut off bone fragments during the operation and the execution of individual joining elements that stabilize bone fragments in a new position.

In all the indications mentioned above, the implementation of technology of computer aided design and manufacturing to maxillofacial surgery is a great improvement. For the success of the whole procedure, it is extremely important to properly convert the data from Cone Beam Computed Tomography stored in DICOM format (ang. Digital Imaging and Communications in Medicine) in the form of slices defined by the resolution of the tomographs (usually from 100 to 200 micrometers) to three-dimensional stereolithography format (STL) used in software design and manufacturing. Before creating the three-dimensional model, the DICOM format image must be filtered in order to select the processing area of the bone where the implants should be placed. Filtration is carried out by analyzing the image histogram, which is a vector with the number of elements equal to the number of existing levels of brightness. Files saved in STL format describe the body as a triangular mesh with a predefined deviation, which should be less than the minimum precision of the milling machine used to produce the final product.

The use of CAD/CAM technology in maxillofacial surgery allows for virtual planning of complicated surgeries, preparation of auxiliary and fixation elements saving the operation time and creation of made-to-demand implants and endoprostheses that simplify the process of reconstruction of post-traumatic and post-resection bone deficit.

1.15

ZeroFlow gas nitriding and nitrocarburizing as a method of precise layer creation on machines, vehicles and tools parts with the minimal use of ammonia consumption and gas emission*

Małdziński L. (Poznan, Poland), Ostrowska K. (Poznan, Poland), Okoniewicz P. (Poznan, Poland), Kowalska J. (Poznan, Poland)

The paper describes a new method of gas nitriding and nitrocarburizing, designated ZeroFlow®, recently developed by Seco/Warwick Group and the Poznan University of Technology (Poland). The most important benefits relative to the process are highlighted. These include precise control in creating a layer's phase structure, thickness, and hardness; very low consumption of ammonia and emission of post-process gases to the environment; and a simple less expensive way of regulation and monitoring of the chemical composition. Selected industrial applications are discussed. In the last part of the paper, an detail analysis regarding the influence of ZeroFlow® gas nitriding parameters on the structure, hardness, and wear mechanism of aluminum profiles extrusion dies is presented. The nitrided layer thus created on the die has been verified under industrial conditions in a commercial plant and tests indicate significant increase in die service life.

1.4

Bio-based polyurethane applied as matrix of glass fibre reinforced composite

Miranda E. A. (São Paulo, Brazil), De Sousa Jr R.R. (São Paulo, Brazil), Batalha G.F. (São Paulo, Brazil), Dos Santos D. J. (São Paulo, Brazil)

Purpose: of this paper was to develop and to characterize the mechanical behaviour of a structural composite obtained using a bio-based polyurethane matrix reinforced with glass fibres. **Design/methodology/approach:** Castor oil and Kraft lignin-containing poliol was applied for bio-based polyurethane synthesis. Structural composite was obtained by reinforcing this renewable source bio-based polymer with glass fibres. Polyester resin composite was also obtained for comparison, following the same process and reinforcement conditions. Mechanical characterization was carried out through uniaxial tensile, flexural strength and Izod impact tests.
Findings: Bio-based polyurethane matrix composite was obtained and presented higher ultimate tensile strength (UTS) and impact resistance in comparison to polyester matrix composite. Research limitations/implications: Effects of Kraft lignin and glass fibre contents changing on mechanical properties might be investigated in future researches.
Practical implications: Revalorization of Kraft lignin. 50 million tons of lignin are produced worldwide every year as by-product of pulp and paper manufacturing. The most part of this Kraft lignin is currently burned for energy generation.
Originality/value: Results indicated the possibility of reusing this industrial wasted by-product at large scale as polymeric matrix for structural composite, in which high UTS and impact resistance are required. ¶

1.61.

New NDT methods for assessing the quality of polymer composites under production conditions

Nowacki J. (Szczecin, Poland), Sieczkiewicz N.(Szczecin, Poland)

Purpose Analysis of non-destructive testing systems polymer composite in terms of current solutions in the area of methodology and devices. Analysis of contemporary standards for non-destructive testing of polymer composites established by ASTM. Analysis of Flir ONE camera capabilities in non-destructive testing composite carbon-epoxy composites.

Design/methodology/approach The thermal imaging tests of the carbon-epoxy composite delamination were carried out using a thermal imaging camera and Flir One accessory for an iOS phone. The tests were performed on carbon-epoxy composite samples measuring 100x100mm. In order to simulate the delamination in a sample by the Resin Transfer Molding (RTM) method, a 30x30mm PTFE film was inserted between the reinforcement layers. The thickness of the sample with delamination was 2mm. Water was added to the selected sample sites. Samples were placed on a 50 ° C heated plate to record thermal images and thermal images combined with visual contours of samples with simulated defects. Area Calculator - SketchAndCalc Icalc, Inc. was used to describe the size and location of the defects.

Findings As a result of the tests, the use of the Flir One thermal imaging device in epoxy - carbon composite delamination tests has been demonstrated, and a methodology has been proposed to measure geometrical features of defects.

Research limitations/implications The description of welded joint structure and mechanical properties was based on welding toughened steels by using an innovative welding method and a filler that has been proposed.

Practical implications The development of thermal imaging studies of polymer composite delamination using the Flir One thermal imaging camera and accessory, with iOS, opens up the possibility of conducting a basic inspection of composite materials in production plants, and even for simplicity - also in small laboratories.

Originality/value In order to improve the quality of imaging of small items using the Flir One mobile camera, the use of cheap and readily available lenses used in laser optics has been tested positively.

1.21

Fatigue crack growth resistance of welded joints simulating the weld-repaired railway wheels metal

Ostash O.P. (Lviv, Ukraine), Kulyk V.V. (Lviv, Ukraine), Poznyakov V.D. (Lviv, Ukraine), Haivorons'kyi O.A. (Kyiv, Ukraine), Markashova L.I. (Kyiv, Ukraine), Vira V.V. (Lviv, Ukraine), Duriagina Z.A. (Lviv, Ukraine; Lublin, Poland) Tepla T.L. (Lviv, Ukraine)

Purpose: The aim of the paper is to study the structure and fatigue crack growth resistance characteristics of weld metal (WM), and heat affected zone (HAZ) under cyclic loadings for the development of railway wheels weld-repairing technology.

Design/methodology/approach: WM and HAZ of the welded joint were investigated. The welded joint of 65G steel (0.65 mass.% C; 0.19 Si; 0.91 Mn), which is a model material for high-strength railway wheels, was received by welding Sv-08HM wire per linear welding energy of 10 kJ/cm. Regimes of

welding were selected so that the cooling rate of the metal in the temperature range 500-600°C was 5°C/s. As a result, the bainite structure in WM and bainite-martensite one in HAZ are formed. To eliminate the residual stresses generated after the weld cooling, heat treatment was proposed: holding at 100°C for 2 hour after cooling under temperature below then that at the beginning of martensite transformation. Fracture resistance under cyclic loading was estimated by fatigue crack growth rates diagrams (da/dN vs. ΔK) according to standard method for compact tension samples testing. The microstructure and fracture surface were investigated using an optical, and electronic scanning and transmission microscope.

Findings: Microstructure parameters and fatigue crack growth resistance characteristics of WM and HAZ after the proposed heat treatment, and also residual stresses of the second kind and local strains in the bulk of bainite and martensite are obtained.

Research limitations/implications: Investigations were conducted on samples that simulate the structure and properties of real renovated railway wheels made of steel with high content (0.65%) of carbon.

Practical implications: Service durability and safety of weld-repaired railway wheels under high service loadings is increased.

Originality/value: HAZ is the most dangerous zone in terms of fatigue cracks initiation and propagation in elements repaired by surfacing method. The positive result on the proposed heat treatment influence is received since the fatigue crack growth resistance characteristics of HAZ metal with bainite-martensite structure raise to the level of weld metal.

1.3

Free vibration analysis of LGCP

Õunapuu E. (Tallinn, Estonia), Anton J. (Tallinn, Estonia), Eerme M. (Tallinn, Estonia), Väer K. (Tallinn, Estonia), Tšukrejev P. (Tallinn, Estonia)

Purpose: The aim of the study is to develop simple numerical simulation models for free vibration analysis of laminated glass composite pane (LGCP), also experimental validation of the proposed models.

Methodology: Two simulation models have been developed

Findings: finite element model (FEM) and Haar wavelet based model. Both averaged and layer wise plate theories were utilized. Here averaged (homogenized) material was used for preliminary analysis and layer wise theory for further study. Findings

Research implications: Experimentally validated simulation models for accurate describing the behavior of LGCP. Research limitations/implications

Practical implications: Certain complexities (restrictions) need to overcome are huge difference in material properties of the glass and plastic/viscoelastic interlayers. FFM analysis model is simpler to implement but the Haar wavelet based model developed is coded completely by authors and can be more easily adapted for considering different novel materials like fractional viscoelastic, etc. Practical implications

Originality: The results are validated against results of experimental study and good agreement has been observed. At the current stage of the study the linear elastic material model has been assumed for all layers. Future study planned cover incorporating viscoelastic material properties for interlayers and effect of residual stresses. Experimental study for determining viscoelastic material properties of the interlayer and residual stresses in glass layer is in progress. The experimental results obtained confirm

that in tempered glass tested the residual stresses are significant and should be considered in material model (in flow glass tested the residual stresses are relatively small). Originality/value

1.43

Crack resistance of tool steels corresponding with the chemical composition of their matrices

Pacyna J. (Kraków, Poland)

Purpose: of the presented investigations was showing that the crack resistance of tool steels depends on their hardenability and phase transformations occurring in the quenched matrix at tempering. The chemical composition of austenite decides on the steel hardenability while phase transformations after tempering can be influenced (apart from the chemical composition) by the heating method.
Design/methodology/approach: of investigations was based on the analysis of dilatograms and the achieved aim was to obtain the hard tool steel (app. 500 HV30) for hot works. Samples of a diameter of 10 mm (without a notch) made of this steel were not broken by the Charpy impact test of energy of 30 kGm.
Findings: of these investigations are practical. Grain boundaries of prior austenite should be protected against secondary precipitates, which constitute natural nuclei of diffusive structures. It is also possible to control phase transformations at tempering.
Research limitations/implications: constitute the availability of the adequate equipment for investigating the kinetics of phase transformations of undercooled austenite and the kinetics of phase transformations after tempering.
Practical implications: for the industry are such that the proposed tool steels of a high crack resistance contain molybdenum and nickel. Thus, these steels are very expensive.
Originality/value: of these investigations was confirmed in the industrial practice.

1.57

Possibilities of biocompatible material production using conform SPD technology

Palán J. (Dobřany, Czech Republic), Maleček L. (Dobřany, Czech Republic), Hodek J. (Dobřany, Czech Republic), Zemko M. (Dobřany, Czech Republic), Dzugan J. (Dobřany, Czech Republic)

Purpose: At present, materials research in the area of SPD (severe plastic deformation) processes is very intensive. Materials processed by these techniques show better mechanical properties and have finer grain when compared to the input feedstock. The refined microstructure may be ultrafine-grained or nanostructured, where the grain size becomes less than 100 nm. One of the materials used for such processes is CP (commercially pure) titanium of various grades, which is widely used for manufacturing dental implants. The article deals with one of the technologies available for the production of ultrafine-grained titanium: Conform technology. CP titanium processed by CONFORM technology exhibits improved mechanical properties and very favourable biocompatibility, due to its fine-grained structure. The article presents the current experience in the production of ultrafine CP titanium using this technology. The main objective of this article is describing the behaviour of CP titanium during forming in the Conform device and its subsequent use in dental implantology.

Design/methodology/approach: In the present study, commercially pure Grade 2 titanium was processed using the CONFORM machine. The numerical simulation of the process was done using FEM method with DEFORMTM software. The evaluation was performed by simple tensile testing and transmission electron microscopy. The first conclusions were derived from the determined mechanical properties and based on analogies in available publications on a similar topic.
Findings: This study confirmed that the SPD process improves mechanical properties and does not impair the ductility of the material. The CONFORM process enables the continuous production of ultrafine-grained or nanostructured materials.
Research limitations/implications: At the present work, the results show the possible way of continuous production of ultrafine-grained or nanostructured materials. Nevertheless, the further optimization is needed in order to improve the final quality of wires and stabilize the process. As these factors will be solved, the technology will be ready for the industry.
Practical implications: The article gives the practical information about the continuous production of ultrafine-grained pure titanium Grade 2 and the possibility of use this material for dental implants.
Originality/value: The present paper gives information about the influence of the CONFORM technology on final mechanical and structural properties with the emphasis on technological aspects.

1.20

Control of the weld quality using infrared sensors in a robotic welding process

Park M.-H. (Muan-gun, South Korea), Jin B.-J. (Muan-gun, South Korea), Yun T.-J. (Muan-gun, South Korea), Son J.-S. (Yeongam, South Korea), Kim I.-S. (Yeongam, South Korea), Kim C.-G. (Muan-gun, South Korea), Kim I.-S. (Muan-gun, South Korea)

Purpose: Since predicted model have widely been employed in industries and engineering, the role of predicted model has become more important for the increased demand for the automated and/or robotic welding systems where problem of a poor quality weld becomes apparent if the welding parameters are not controlled. Welding monitoring employed in the automated and/or robotic arc welding system must detect the changes in weld characteristics and produce the output that is in some way related to the change being detected. To be acceptable a weld quality must be positioned accurately with respect to the joints, have good appearance with sufficient penetration and reduce low porosity and inclusion content.
Design/methodology/approach: To achieve the objectives, two empirical models involving the use of a neural network algorithm in arc welding process with the help of a numerical analysis program MATLAB have been developed.
Findings: The results represented that welding quality was fully capable of quantifying and qualifying the welding faults.
Research limitations/implications: Welding parameters for the arc welding process should be well established and categorized for development of the robotic welding system. Furthermore, typical characteristics of welding quality are the bead geometry, composition, microstructure and appearance. However, an intelligent algorithm that predicts the optimal bead geometry and accomplishes the desired mechanical properties of the weldment in the robotic GMA (Gas Metal Arc) welding should be developed. The algorithm should also cover a wide range of material thicknesses and be applicable in all welding position. In addition, the proposed model for the automatic welding system must be available in the form of mathematical equations.

Practical implications: The neural network models to predict optimal welding parameters on the required bead reinforcement area in lab joint in the robotic GMA welding process have been developed. Experimental results have been employed to find the optimal algorithm to predict bead reinforcement area by BP and LM neural networks in lab joint in the robotic GMA welding. The developed neural network models are able to predict the optimal welding parameters on the desired bead reinforcement area and weld criteria, help the development of automatic control system and expert system and establish guidelines and criteria for the most effective joint design.
Originality/value: In this study, an intelligent model, which employed the neural network algorithms, one of AI (Artificial Intelligence) technologies has been developed to study the effects of welding parameters on bead reinforcement area and to predict the optimal bead reinforcement area for lab joint in the robotic GMA welding process. BP (Back Propagation) and LM (Levenberg-Marquardt) neural network algorithm have been used to develop the intelligent model.

1.51.

Ultrasonic vibrations as an impulse for glass transition in microforming of metallic glass

Presz W. (Warszawa, Poland), Kulik T.(Warszawa, Poland)

Purpose: The paper presents the idea of the utilisation of ultrasonic vibrations in a microforming at elevated temperature of a bulk metallic glasses as an impulse of additional energy for initiating a glass transition at lower than nominal transition temperature.
Methodology: The method of micro-upsetting at elevated temperature with non-uniform temperature distribution was used to determine the influence of ultrasonic vibration on the glass transition in a microforming process.
Findings: It is shown that applying ultrasonic vibrations on the tool could replace the part of the thermal energy needed for achieving by the metallic glass the super cooled liquid state necessary for the plastic forming of these materials.
Research implications: The results of research are limited to the analysis of two specimens only and their final state of deformation. Documenting the course of the deformation is planned – of side outline of the sample – with the camera and synchronizing it with the course of upsetting force, what diametrically would enhance possibilities of analysis. The FEM analysis gives the another and very important space to improvement. It is practically not possible to omit it, because of technically very difficult direct measurement of temperature distribution on the micro-sample.
Practical implications: Metallic glass is a modern material being able to be applied in the production of micro-parts for microsystem with the help of the microforming process in the state of the supercooled liquid. Metallic glass remains in this state at the relatively narrow range of temperature and time. Only few minutes are left for the forming process. After certain time crystallisation occurs and destroys the amorphous structure. Applying ultrasonic vibrations could be used as the tool which would provide energy for the proceeding "at the request" into the supercooled liquid state from the area of the temperature not yet threatening to the crystallization. It is also possible to imagine the situation in which the regional glass transition occurs because of a contact with the vibrating punch.

1.42

Single-frequency induction hardening of structural steel

Rokicki P. (Rzeszów, Poland), Bąk E. (Rzeszów, Poland), Mrówka-Nowotnik G. (Rzeszów, Poland), Nowotnik A. (Rzeszów, Poland)

Purpose: Current paper presents investigation of specimens after single frequency induction hardening process. The main aim is to compare microstructure of the material after the process conducted with different voltage on the induction coil. Moreover, two different steel grades are used for comparative reasons. As the final result it is desired to obtain sufficient parameters for the process in aim to obtain proper surface treatment of the material.
Design/methodology/approach: The objectives of the research are achieved by using single-frequency induction hardening device with varying voltage. Two different steel grades were treated with change of the induction voltage from 300 to 600 V.
Findings: In the outcomes of the study, the main conclusion is that there is an impact of the induction voltage in the hardening process on the microstructure of treated elements, both for 40H and 40HNMA steels.
Research limitations/implications: Obtained results will be used for much more complex investigation of the induction hardening process in future to introduce more exact parameters and double-frequency induction hardening process for complex geometries as gears.
Originality/value: The originality of the research is based on the specific process and the materials that are being submitted to the comparative analysis. Moreover, executed research will be a basis for more complex induction hardening processes in the future.

SILVER JUBILEE INTERNATIONAL SCIENTIFIC CONFERENCE AMME

1.62

A strategy for developing high performance functional eco-friendly polymer nanocomposites*

Thomas S. (Kottayam, India)

The talk will concentrate on various approaches being used to engineer materials at the nanoscale for various applications in future technologies. In particular, the case of clay, carbon nanostructures (e.g. nanotubes, graphene), metal oxides, bionanomaterials (cellulose, starch and chitin) will be used to highlight the challenges and progress. Several bio-degrdable polymer systems will be considered such as rubbers, thermoplastics, thermoetts and their blends for the fabrication of functional polymer nanocomposites. The interfacial activity of nanomaterials in compatibilising binary polymer blends will also be discussed. Various self-assembled architectures of hybrid nanostructures can be made using relatively simple processes. Some of these structures offer excellent opportunity to probe novel nanoscale behavior and can impart unusual macroscopic end properties. I will talk about various applications of these materials, taking into account their multifunctional properties. Some of the promising applications of clay, metal oxides, nano cellulose, chitin, carbon nanomaterials and their hybrids will be reviewed.

SILVER JUBILEE INTERNATIONAL SCIENTIFIC CONFERENCE AMME

1.4

Bio-based polyurethane applied as matrix of fiberglass reinforced composite

De Sousa Jr. R.R. (São Paulo, Brazil), Miranda E.A. (São Paulo, Brazil), Batalha G.F. (São Paulo, Brazil), dos Santos D.J. (São Paulo, Brazil)

Purpose: of this paper was to develop and to characterize the mechanical behaviour of a structural composite obtained from a bio-based polyurethane matrix reinforced with fiberglass.
Design/methodology/approach: Castor oil and Kraft lignin-containing polyol was applied for bio-based polyurethane synthesis. Structural composite was obtained by reinforcing this renewable source bio-based polymer with fiberglass mat. Polyester resin composite was also obtained for comparison, following the same process and reinforcement conditions. Mechanical characterization was carried out through uniaxial tensile, flexural strength, Izod impact tests and additionally scanning electron microscopy (MEV).
Findings: Bio-based polyurethane composite was obtained and presented higher ultimate tensile strength (UTS) and equivalent impact resistance in comparison to polyester matrix composite.
Research limitations/implications: Effects of Kraft lignin and fiberglass contents changing on mechanical properties might be investigated in future researches.
Practical implications: Revalorization of Kraft lignin. 50 million tons of lignin are produced worldwide every year as by-product of pulp and paper manufacturing. The most part of this Kraft lignin is currently burned for energy generation.
Originality/value: Results indicated the possibility of reusing this industrial wasted by-product at large scale as polymeric matrix for structural composite, in which high UTS and impact resistance are required.

1.16

Atom Dynamics and Structure of Glassy Alloys (Ni0.60Nb0.4)100-xZrx (x=0 to 30) by Neutron Spectroscopy and X-ray Photon Correlation Spectroscopy Studies*

Sarker S., (Reno, United States of America), Chandra D. (Reno, United States of America)

The demand for hydrogen is increasing due to mitigation of greenhouse gas emissions on the environment and led to the development of non-polluting hydrogen fuel cell use in automobiles. In coal gasification system, syngas is produced H2 and CO2 gasses by the water shift reaction [1]. We are persuing development of inexpensive membranes for ecomnical production of hydrogen form other gases. Currently, crystalline Pd/Pd-Ag membranes are used for this purpose, however, Pd is an expensive strategic metal. Thus, inexpensive Ni-Nb-Zr amorphous alloys are studied. Amorphous ribbons of (Ni0.60Nb0.40)100-xZrx fabricated by melt-spinning method exhibit high permeabilities of hydrogen between 200-400oC, however, the mechanism of permeation and the nature of the local atomic order are not fully understood. In this study, hydrogen vibrational density of states revealed by neutron vibrational spectroscopy (NVS) at NIST. NVS result displayed hydrogen position inside Zr4, Nb4 sides. The atom dynamics of amorphous membranes is determined by synchrotron x-ray photon correlation spectroscopy (XPCS) with and without hydrogen at ESRF. Nearest neighbour distance and short range order of these amorphous alloys are determined by Neutron Total scattering (HIPD). Atom probe tomography (APT) reveals Nb-rich (5-6 nm) and Zr-rich (~2 nm) clusters embedded in a Ni-rich matrix whose compositions deviates from the nominal overall composition of the membrane. Our DFT simulation reveals the icosahedra structure and cluster information which match results. To understand high-pressure permeation behavior Raman Spectroscopy measurement are used with diamond anvil cells at CIW. Altogether, these studies show the atom dynamics with and without hydrogen, local atomic structure of the amorphous ribbon and cluster formation inside the membranes.

2. 1.38

High strength steels and aluminium alloys in lightweight body manufacturing

Tisza M. (Miskolc, Hungary)

Purpose of this paper: The main objectives of this paper are to give an overview about the application of various kinds of high strength steels and aluminium alloys in the automotive industry to produce lightweight car body elements to achieve significant reductions in harmful emissions to provide more environmental friendly vehicles which simultaneously fulfils the increased safety requirements, too. In these respects, both high strength automotive steels (e.g. DP, TRIP, TWIP and HPF steels), as well as high strength aluminium alloys (e.g. AA6082, AA7075, etc.) are more and more widely applied in the vehicle manufacturing.
Design/methodology/approach: The contradiction between the increased strength and lower formability of these high strength metallic materials is one of the main issues in their application in the automotive industry. Therefore, in this paper primary focus will be placed on the formability properties of these materials, concerning first of all the limits of formability in various cold and hot forming conditions. To fully utilize the potentials of these materials in forming processes the numerical modelling of forming with FEM simulation is of utmost importance.
Findings: Recently in the automotive industry the Hot Press Forming of high strength boron-alloyed manganese steels become an industrially established process, while the Hot Forming and Quenching (HFQ) of artificially ageing high strength aluminium alloys now become the focus of scientific research. The paper will analyse the main process parameters and gives comparisons of automotive applications.
Research limitations/implications: There are still certain shortages of industrial applications, namely the limits of economic cycle times for economical mass production which needs further research activities in these fields.
Practical implications: Since both the materials mentioned above and the forming processes usually applied, furthermore the available benefits are extremely important for the automotive industry these results have significant practical involvement.
Originality/value: The applied research methods and the introduced new findings will show the originality of the paper.

1.45

The effect of welding defects to the tensile behaviour in corrosive environment of AISI 304L stainless steel joined with shielded metal electrode

Türkan M. (Denizli, Turkey, Izmir, Turkey), Karakaş Ö. (Denizli, Turkey)

Purpose: Determination of the tensile behavior of welded constructions made of austenitic stainless steel in corrosive environments is of great importance for the safer use of the construction. When austenitic stainless steels are welded together, welding defects can occur in some cases. And stainless steels are used in corrosive environments. Thus, we are aimed to investigate the effect of welding defects the tensile behavior in corrosive environment of AISI 304 L stainless steel joined with shielded metal electrode.

Design/methodology/approach: Hardness measurements and micro-macro structures examination were made before the corrosion test to characterize the structure of the weld zone. Corrosion tests were carried out in accordance with EN ISO 9227 by exposing the welded tensile specimens to salt spray for 24-96-240-480-720-1000 hours. After the salt spray test, tensile tests were performed. The fractured surfaces were examined following the tensile tests by scanning electron microscope (SEM).
Findings: A significant decrease in the tensile strength of the material was observed with the increase of the salt spraying period as a result of the tests. It is worth noting that corrosion products were occurred especially in the areas of welding defects.
Research limitations/implications: This study was performed on materials containing welding defects. In addition, the corrosive environment was provided by salt spraying. It should not be forgotten that the materials may behave differently in different corrosive environments.
Originality/value: While there are studies regarding effects of welding defects and corrosion individually, no study has been found in the literature which considers the effect of welding defects within corrosive environments on the material strength. Therefore, this study presents novel findings by considering both detrimental effects at the same time. The study shows significant decrease in strength of the material due to welding defects and corrosive environment.

1.2

Development of ice abrasive waterjet cutting technology

Valentinčič J. (Ljubljana, Slovenia), Lebar A. (Ljubljana, Slovenia), Sabotin I. (Ljubljana, Slovenia), Drešar P. (Ljubljana, Slovenia), Jerman M. (Ljubljana, Slovenia)

Purpose: Abrasive water jet (AWJ) cutting uses mineral abrasive to cut practically all materials. In ice abrasive water jet (IAWJ) cutting, the ice particles are used as abrasive. IAWJ is under development with the aim to bridge the gap in productivity between the abrasive water jet (AWJ) and water jet (WJ) cutting. It is clean and environmentally friendlier in comparison with AWJ, while its cutting efficiency could be better than WJ.
Design/methodology/approach: The main challenge is to provide very cold and thus hard ice particles in the cutting zone, thus cooling the water under high pressure is utilized. Further on, two approaches to obtain ice particles in the water are studied, namely generation of ice particles in the cutting head and generation of ice particles outside of the cutting head and adding them to the jet similar as in AWJ technology. In this process it is essential to monitor and control the temperature occurring in the system.
Findings: To have ice particles with suitable mechanical properties in the cutting process, the water have to be precooled, ice particles generated outside the cutting head and later added to the jet. The results show that, contrary to the common believe, the water temperature is not significantly changed when passing through the water nozzle.
Research limitations/implications: The presence of ice particles was only indirectly identified. In the future, a special high speed camera will be used to study the influence of process parameters on ice particle distribution.
Practical implications: IAWJ technology produces much less sludge (waste abrasive and removed workpiece material mixed with water) than AWJ technology which is beneficial in e.g. disintegration of nuclear power plants. IAWJ technology has also great potential in the food and medical industries for applications, where bacteria growth is not desired.
Originality/value: The paper presents the latest achievements of IAWJ technology.

1.6

Material characterization for laminated glass composite panel

Väer K. (Tallinn, Estonia), Anton J. (Tallinn, Estonia), Klauson A. (Tallinn, Estonia), Eerme M. (Tallinn, Estonia), Õunapuu E. (Tallinnnn, Estonia), Tšukrejev P. (Tallinn, Estonia)

Purpose: Laminated glass composite panel (LGCP) with at least one flexible plastic/viscoelastic interlayer is considered. The purpose of this paper is to determine the material properties of the constituents of LGCP required for accurate modelling of the laminated glass structures.

Design/methodology/approach: The proposed approach includes the following three type of tests: non-destructive tests for determining mechanical properties of the glass layers (based on wave propagation), mechanical tests and finite element simulations for determining properties of the interlayers, measuring residual stresses in glass layers using novel methods and equipment (non-destructive, wave propagation based).

Findings: Methodology and procedures for determining material properties of the LGCP.

Research limitations/implications: Due to fact that the shear moduli of the viscoelastic interlayers and glass skin layers differs up to thousands times, the direct application of the classical sandwich theory may lead to inaccurate results. The layer wise plate theory with viscoelastic interlayer should be applied. In the case of layer wise theory, the material properties should be determined for each layer (not averaged properties for laminate only).

Practical implications: The proposed approach allows to determine the properties of the LGCP components with high accuracy and form base for development of accurate plate model for modelling vibration, buckling and bending of the LGCP. The effect of the residual stresses is most commonly omitted in engineering applications. However, in the case of tempered glass the residual stresses are significant and have obviously impact on stress-strain behaviour of the laminated glass panel.

Originality/value: Study consists of valuable parts, i.e. determining residual stresses in glass performed in cooperation with private company GlasStress Ltd. Special software and measuring equipment are developed. Further LGCP interlayer mechanical properties are tested experimentally and using simulation tools for design optimization purposes.

1.65

The new carbon-rhenium nanomaterials

Wolany W. (Gliwice, Poland), Dobrzańska-Danikiewicz A.D. (Gliwice, Poland)

Purpose: The aim of this paper is to describe the structure of carbon-metal nanocomposites consisting of nanostructured rhenium permanently attached to carbon nanomaterials, in the form of single-walled (SWCNTs), double-walled (DWCNTs) or multi-walled carbon nanotubes (MWCNTs) or single-walled carbon nanohorns (SWCNHs), and also to present the electrical and catalytic properties of the selected nanocomposite materials.

Design/methodology/approach: Spectroscopic examinations were carried out to identify changes in the structure of carbon nanomaterials when fabricating nanocomposites from them. Such examinations specifically investigate the degree of defects of the structure of pristine, functionalised and rhenium-decorated carbon nanomaterials, and also allow to identify the chemical composition of the newly produced

nanocomposites. Microscopic examinations were also carried out with SEM and TEM of nanocomposites of the following types: MWCNTs-Re, SWCNTs/DWCNTs-Re, SWCNTs-Re, SWCNHs-Re.
Findings: A scientific achievement of this paper is that the structure and properties were described of the newly developed nanocomposite materials composed of nanostructured rhenium permanently attached to carbon nanomaterials created as a result of high-temperature reduction of a precursor of rhenium to metallic rhenium, deposited on the previously functionalised carbon nanomaterials in the form of nanoparticles or inside in the form of nanoparticles or nanowires whose size and dispersion depend on the technological process conditions.
Practical applications: Selected newly developed MWCNTs-Re nanocomposites have special electrical and catalytic properties. The measurement of electrical properties is discussed in the presence of H_2 and CO_2 in the atmosphere of synthetic air. A phenylacetylene (1-phenylopropyn) hydrogenation reaction was performed to check the catalytic properties of the developed materials.
Originally/value: Obtaining and manufacturing of newly developed MWCNTs-Re nanocomposites. It was concluded that, by selecting process conditions, one should consider, notably, functionalisation time and impregnation time of carbon nanomaterials in a rhenium precursor, and also the type of carbon material being a component of nanocomposite, as some of them are less resistant to intensive working in oxidisation substances and in ultrasounds.

SILVER JUBILEE INTERNATIONAL SCIENTIFIC CONFERENCE AMME

1.46

Dominant Role of the Columnar Structure in the Brass Ingots Continuous Casting

Wołczyński W. (Krakow, Poland), Kwapisiński P. (Lubin, Poland), Ivanova A.A. (Donetsk, Poland), Olejnik E. (Krakow, Poland)

Purpose The aim of this paper is to discuss the influence of both velocity of the brass ingot translation in the crystallizer and the crystallizer height onto the columnar structure formation. The columnar structure is responsible for the required hard particles motion in the brass ingots.
Design/methodology/approach The so-called mathematical modelling / predictions of the structural zones in the ingots, previously developed for the steel static ingots, is currently applied to determine some structural zones localization in the continuously cast brass ingot. Findings It is confirmed that the columnar structure zone is the largest one, among other zones, independently of the velocity of translation and height of the crystallizer. Moreover a single crystal situated axially in the ingots promotes the hard particles motion.
Research implications The present suggestion dealing with the dominant role of columnar structure in the hard particles pushing could be confirmed experimentally in the laboratory (Bridgman system) or in the semi-industrial scale.
Practical implications The current method of the mathematical predictions of some structural zones in the continuously cast brass ingot could be applied to the industrial practice to control the size / localization of both columnar structure zone and single crystal diameter.
Originality/value The original, recently developed method for the microstructure mathematical modelling is shown in details and applied to control the structural zones size in the continuously cast brass ingot. The method is dedicated to the KGHM – Polish Copper Company and other, similar companies. ¶

1.59

Methods of data mining for modelling of low-pressure heat treatment

Wołowiec-Korecka E. (Lodz, Poland)

Purpose. This paper addresses the methods of the modeling of thermal and thermochemical processes used in computer-aided design, optimization and control of processes of thermal and thermochemical treatment in terms of obtaining real-time results of the calculations, which allows for observation of how an item changes during its treatment to respond immediately and to determine the parameters of a corrective process should any irregularities be detected. The principal objective of the literature review was to develop a methodology for designing functional and effective processes for low-pressure thermal and thermochemical treatments using effective computation methods.

Design/methodology/approach. A detailed analysis was conducted regarding the modeling methods with low-pressure carburizing and low-pressure nitriding.

Findings. It was found the following criteria of methods selection of heat treatment modelling should be applied: data quality, data quantity, implementation speed, expected relationship complexity, economic and rational factors.

Practical implications. Computational support is particularly required in low-pressure thermochemical treatments due to its non-equilibrium nature and transient states in the course of the processes. In this case, the primary goal of the simulation is to predict the course of the process and the final properties of the product, thus ensuring the repeatability of the process results.

Originality/value. A synthetic presentation of modelling methods was done, in particular artificial intelligence methods; it also analyses the opportunities and threats associated with the methods.

INPO AUTHOR INDEX

AMME AUTHOR INDEX

INPO 2017 AMME 25 1988-2017

22nd – 25th October 2017
WISŁA, POLAND

International Scientific Congress INPO-AMME

10th Country-wide Scientific Conference on Surface Engineering INPO 2017

Silver Jubilee International Scientific Conference on Achievements in Mechanical and Materials Engineering AMME 2017

conference2017inpo@gmail.com www.inpo.wip.pcz.pl info@amme.pl www.amme.pl

Selected papers with the content relating to the lectures presented during INPO-AMME'2017 congress published in the subsequent issues of AMSE journal in 2017

INPO 2017 AMME 25 1988-2017

22nd – 25th October 2017
WISŁA, POLAND

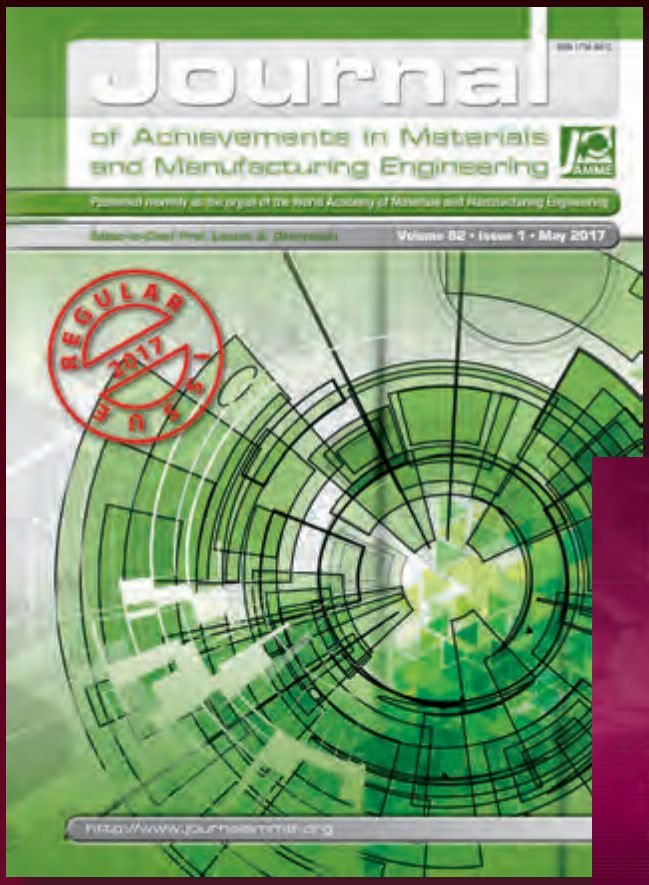
International Scientific Congress INPO-AMME

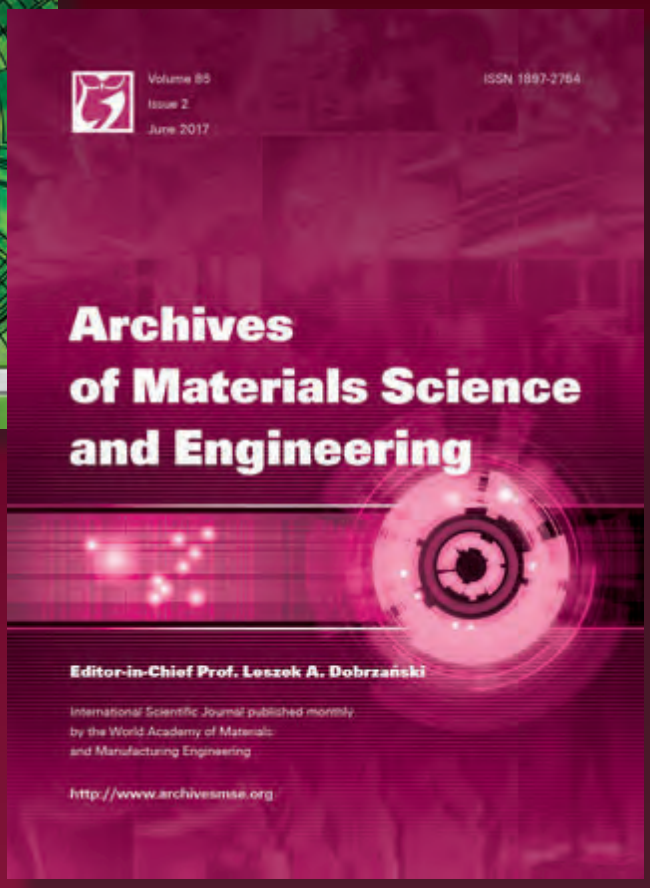
10th Country-wide Scientific Conference on Surface Engineering INPO 2017

Silver Jubilee International Scientific Conference on Achievements in Mechanical and Materials Engineering AMME 2017

conference2017inpo@gmail.com www.inpo.wip.pcz.pl info@amme.pl www.amme.pl

Selected papers with the content relating to the lectures presented during INPO-AMME'2017 congress published in the subsequent issues of JAMME journal in 2017





SELECTED SCIENTIFIC PAPERS

worked out on subjects corresponding to the presentations during the International Scientific Congress **INPO-AMME'2017** can be found in the consecutive issues of the Journal AMME and Archives MSE published in 2017

www.inpo.wip.pcz.pl

www.amme.pl