FUNKČNÉ MATERIÁLY / FUNCTIONAL MATERIALS

Kniha príspevkov / Book of abstracts

Conference focused on the exchange of the latest knowledge, especially in the field of functional engineering materials. The conference aims to create conditions for deepening existing and establishing new personal and professional contacts

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Institute of Materials and Machine Mechanics SAS

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& machine mechanics
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EDITORIAL

Funkčné materiály 2022 / Functional Materials 2022
Zborník / Book of Abstracts

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Zostavovatelia: Jaroslav Jerz, Alena Opálková Šišková

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Bratislava 2022

International Scientific Conference

Functional Materials 2022

Bratislava, October 25, 2022

Functional materials are those which possess particular native properties and functions of their own (e.g. ferroelectricity, piezoelectricity, magnetism or energy storage functions, etc.). The conference FM-2022 follows up on previous biennial conferences Structural Materials organized by Slovak Metal Science Society, which took place from 1997. The main goal is to start a new tradition and in even years to organize a conference focused on the exchange of the latest knowledge, especially in the field of functional engineering materials. The conference also aims to create conditions for deepening existing and establishing new personal and professional contacts.
The conference is focused on the following areas:

> functional materials (non-ferrous metal alloys, steels, cast irons, ceramics, polymers, composites, etc.)
> modification of material properties (thermal and thermochemical treatment, surface treatment, coating, etc.)
> structural analysis, physical properties
> production, recycling, sustainability, industrial applications, etc.

FINAL PROGRAM

8:30 – 9:00 AM	Registration
9:00 – 9:10 AM	Introduction
9:10 – 11:10 AM	**Keynote Lectures** Session Chair: J. Jerz **(KL-1) Watching catalytic reactions on metal and oxide nanostructures** Günther Rupprechter Institute of Materials Chemistry, TU Vienna, Austria **(KL-2) Multi-pulse femtosecond laser ablation of Au-coated Ni foil in various fluids: A way to produce hierarchical periodic surface structures and nanomaterials** Niusha Lasemi[1], Gerhard Liedl[2], Günther Rupprechter[1] [1] Institute of Materials Chemistry, TU Vienna, Austria [2] Institute of Production Engineering and Photonic Technologies, TU Vienna, Austria **(KL-3) Contribution to sustainability by recycling aluminum alloy chips** Sonja Jozić, Branimir Lela, Dražen Bajić Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split (FESB), Croatia **(KL-4) Investigation of fatigue damage of a railhead using an indentation tests, ultrasound inspection and microstructural observations** Stanisław Kucharski, Sławomir Mackiewicz, Tomasz Katz, Grzegorz Starzyński, Zbigniew Ranachowski, Przemysław Ranachowski, Stefania Woźniacka Institute of Fundamental Technological Research, PAS, Warsaw, Poland
11:10 – 11:40 AM	Tee/Coffee Break
11:40 AM – 1:00 PM	**Project Session** Session Chair: B. Lela **SHARE 4.0 – Create synergies in the region SK – AT by sharing best practices and awareness of innovative technologies to advance digitalized manufacturing** (www.projectshare40.com) Jaroslav Jerz, Institute of Materials & Machine Mechanics, SAS, Bratislava, Slovakia **FIT-4-NMP support for increased participation in Horizon Europe calls** (www.fit-4-nmp.eu) Karol Iždinský, Institute of Materials & Machine Mechanics, SAS, Bratislava, Slovakia **Keynote Lecture** Session Chair: P. Ranachowski **(KL-5) Overview of Austempered Ductile Iron investigation carried out on FESB in Split** Nikša Čatipović Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture, University of Split (FESB), Croatia
1:00 – 2:00 PM	Lunch Break & Lab Tour

2:00 – 2:40 PM	**Oral Lectures** Session Chair: N. Čatipović **(OL-1) Concentrating solar power and laser surface treatment of Ti and Ti composites** Jaroslav Kováčik[1], Štefan Emmer[2], José Rodriguez[3], Inmaculada Cañadas[3], Peter Šugár[4], Jana Šugárová[4], Barbora Bočáková[4] [1] Institute of Materials & Machine Mechanics, SAS, Bratislava, Slovakia [2] IVMA STU, s. r. o., Bratislava, Slovakia [3] La Plataforma Solar de Almería, Spain [4] Institute of Production Technologies, Faculty of Materials Science and Technology in Trnava, STU Bratislava, Slovakia **(OL-2) Effect of sample shape on compression behavior of AlSi PM aluminum foams** Jaroslav Kováčik[1], Jaroslav Jerz[1], Selim Burak Canturk[1,2], Liviu Marsavina[3], Emanoil Linul[4] [1] Institute of Materials & Machine Mechanics, SAS, Bratislava, Slovakia [2] Faculty of Materials Science and Technology in Trnava, STU Bratislava, Slovakia [3] Romanian Academy – Timişoara Branch, Timişoara, Romania [4] Polytechnic University of Timişoara, Timişoara, Romania
2:40 – 3:00 PM	**Poster Session** **(PS-1) Density evolution and microstructural characterization of sintered iron after different conditions of sintering process** Ľubomír Orovčík[1], Naďa Beronská[1], Jaroslav Jerz[1], Zuzana Gabalcová[2], Tomáš Dvorák[1], Jaroslav Kováčik[1], Martin Nosko[1] [1] Institute of Materials & Machine Mechanics, SAS, Bratislava, Slovakia [2] Faculty of Materials Science and Technology in Trnava, STU Bratislava, Slovakia **(PS-2) Microstructure investigation of additively manufactured (SLM, FDM) metals** Štefan Nagy[1], Zuzana Hájovská[1], Mohammad Sadegh Mohebbi[2], Veronika Nagy Trembošová[1,3] [1] Institute of Materials & Machine Mechanics, SAS, Bratislava, Slovakia [2] Airbus Endowed Chair for Integrative Simulation and Engineering of Materials and Processes (ISEMP), University of Bremen, Germany [3] Faculty of Materials Science and Technology in Trnava, STU Bratislava, Slovakia **(PS-3) Research of the use of dual laser beam and its influence on the resulting properties of welded joints of duplex steels** Lucia Kopčanová[1,2], Naďa Beronská[1], Martin Nosko[1] [1] Institute of Materials & Machine Mechanics, SAS, Bratislava, Slovakia [2] Faculty of Mechanical Engineering, Slovak University of Technology, Bratislava, Slovakia **(PS-4) Conversion of native oxide on Mg powders in CO_2 atmosphere** Veronika Nagy Trembošová[1,2], Štefan Nagy[1], Martin Nosko[1], Moara Marques de Castro[3], Peter Švec[3], Matej Štěpánek[1], Naďa Beronská[1] [1] Institute of Materials & Machine Mechanics, SAS, Bratislava, Slovakia [2] Faculty of Materials Science and Technology in Trnava, STU Bratislava, Slovakia [3] Centre for Advanced Materials Application, SAS, Bratislava, Slovakia
3:00 – 3:15 PM	Closing Remarks

Watching catalytic reactions on metal and oxide nanostructures

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ABSTRACT

Nanostructured metals are important functional materials for energy-relevant catalytic reactions. The oxidation of hydrogen to water by solid catalysts enables energy generation without combustion and without pollution, e.g., in fuel cells. For future developments of new green energy production technologies, it is important to monitor ongoing catalytic reactions by *in situ* microscopy of working catalyst surfaces. Two examples are presented, covering meso-scale Rhodium and a single Rh nanoparticle.

i) Using a *correlative microscopy* approach, H_2 oxidation on polycrystalline Rh foil was studied by scanning photoelectron microscopy (SPEM) and photoemission electron microscopy (PEEM), which allow local surface analysis and visualising the heterogeneity of ongoing reactions on a µm-scale. This revealed an anisotropy of surface oxidation, yielding an oxidation map. *In situ* PEEM imaging of ongoing H_2 oxidation directly compares the local reactivity of metallic and oxidised Rh, revealing a high transient activity of Rh surface oxide.

ii) Using the apex of a Rh-nanotip as model, *single particle catalysis* was studied on the nm-scale by field emission microscopy (FEM) as imaging tool. Novel effects were revealed, such as nanoscale multifrequential oscillations and limited interfacet coupling. Using ionized water as imaging species, the active sites on the metal nanotip were directly imaged by field ion microscopy (FIM).

These insights may stimulate new ways of metal catalyst design.

BIOGRAPHY

Prof. **Günther Rupprechter** received his Ph.D. in Physical Chemistry from the University of Innsbruck. After postdoctoral work at the University of California at Berkeley, the Lawrence Berkeley National Laboratory and the Fritz Haber Institute of the Max Planck Society in Berlin he accepted a Full Professorship in Surface and Interface Chemistry at Technische Universität Wien in 2005.

His research emphasis is on heterogeneous catalysis, *in situ (operando)* spectroscopy/microscopy on model and technological catalysts, applied to studies of the mechanisms and kinetics of processes relevant for energy and environment.

- Category: Keynote
- Web of Science ResearcherID: ABE-8023-2020
- ORCID: https://orcid.org/0000-0002-8040-1677
- Research Interest: Surface Science and Heterogeneous Catalysis

Multi-pulse femtosecond laser ablation of Au-coated Ni foil in various fluids: A way to produce hierarchical periodic surface structures and nanomaterials

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ABSTRACT

Femtosecond laser ablation in liquids can be used for surface engineering to generate laser-induced periodic surface structures (LIPSS) or for nanomaterial production. Both have a variety of applications in optics, electronics, catalysis and medicine. In fact, LIPSS is the preliminary process to generate nanoparticles. That´s why several monomodal and multimodal nanoparticles were detected while they were embedded or trapped on nanoripples. After applying several consecutive fs pulses on metals, the absorption of laser energy by surface electrons leads to the formation of hot and excited electron gas while the lattice system stays cold, as explained by the two-temperature model. Since the fs pulses are shorter than the electron-lattice relaxation time (10^{-10} to 10^{-12} s), a surface goes through a reorganization followed by hydrodynamic instabilities, phase transformations and formation of self-organized micro/nanostructures. However, the expected results can be affected by the ablation environment, thus the nature of the fluid plays an important role for the morphology of the laser-treated areas, type/frequency/orientation of hierarchical features, the composition of the ripples/crates/nanoparticles, crater width/depth/volume and specific ablation rate. For analyses of either LIPSS or craters, the highest resulting microstrain was measured for butanol. Also, LIPSS on butanol went through lattice deformation and increased cell volume. For NiAu nanoparticles, a lowest Stokes radius was observed in butanol. This can result from the formation of a thin graphite shell around the nanoparticles which prevents particles from further diffusion. Moreover, an imperfect graphite layer was detected by confocal Raman spectroscopy on LIPSS areas for butanol.

BIOGRAPHY

Dr. Niusha Lasemi has expertise in studying laser interaction with materials (e.g. metals, semiconductors, alloys, ceramics) in air and liquids, formation of laser-induced surface structures, nanomaterial production, analysis of ablated targets, nanoparticle characterization, hydrodynamic analysis and phase identification; and passion in finding new ways to modify the ablation efficiency to be applicable for catalysis.

- Category: Oral presentation
- ResearchGate: https://www.researchgate.net/profile/Niusha-Lasemi
- Research Interest: The scientific focus is on laser radiation-solid interaction from ultra-short to long-pulse regimes, particularly laser ablation in liquids, synthesis and electron microscopy-based characterization of defect-rich monometallic and bimetallic nanostructures, complemented by spectroscopy techniques and diffraction/scattering methods.

Contribution to sustainability by recycling aluminum alloy chips

Sonja Jozić[1], Branimir Lela[1] and Dražen Bajić[1]

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ABSTRACT

Aluminum's unique ability to be recycled an infinite number of times presents a definitive example of sustainability. It remains essentially unchanged no matter how many times it is processed and used. Therefore, it can be considered as a material with permanent characteristics, one that is not consumed, but used over and over again, without the loss of its essential properties. This lecture deals with the recycling of aluminum alloy waste with the emphasis on aluminum scraps of smaller dimensions such as chips obtained by different machining methods. The process of aluminum alloy chips recycling was presented, in which metal foams with open and closed cells were produced. Different types of aluminum alloys and different pore forming agents were investigated. The intention was to recycle the chips, without re-melting, i.e. in a solid or semi-solid state. This process is more energy efficient than the traditional approach and involves significantly lower carbon dioxide emissions, resulting from avoiding the re-melting stage, one feature which is typical for the conventional recycling process. Some of the most important properties such as mechanical and chemical properties were investigated. In the second part of the lecture, the machinability of produced metal foams was presented. The machining strategy as well as the applied machining parameters were examined. This research was conducted within the project "Recycling of aluminum alloys in solid and semisolid state" financed by the Croatian Science Foundation.

BIOGRAPHY

PhD Sonja Jozić is an associate professor at University of Split, Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture (FESB), Department of Mechanical Technologies, Split, Croatia. She received her PhD at the same institution in 2012 entitled: "Multiparameter hard milling modeling and optimization" under the supervision of professor Dražen Bajić. Her research interests are basic in the field of mechanical technologies (casting, machining) and computer aided manufacturing. She published 67 publications and attended several International Conferences and Workshops as invited lecturer. She is member of the scientific and organizing committee of International Conference of Mechanical Technologies and Structural Materials (MTSM). This year, she was appointed as head of the Chair of Technologies at FESB.

Investigation of fatigue damage of a railhead using an indentation tests, ultrasound inspection and microstructural observations

Stanisław Kucharski, Sławomir Mackiewicz, Tomasz Katz, Grzegorz Starzyński, Zbigniew Ranachowski, Przemysław Ranachowski, and Stefania Woźniacka
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ABSTRACT

The work presents an investigation of two regions of the steel railhead material R260. The first region was selected from a railhead section which was heavily exploited, while the other was a non-loaded section. In both regions the microstructure was investigated using optical microscopy and SEM images, the Brinell hardness was measured and spherical micro indentation tests were conducted. From the latter the modulus of elasticity, the indentation hardness and the plastic work in loading-unloading cycles were determined. The fatigue damage in various near-surface regions of the railhead was estimated on the basis of local deterioration of elastic modulus and the development of plastic work in cyclic indentation tests. The results indicate that there is a clear difference in hardness and fatigue damage between the used and the virgin regions or the railhead. The Brinell macro-hardness tests and ultrasonic tests were used to measure the properties of bulk material. These measurements indicate a moderate increase of Brinell hardness and a remarkable increase of elastic modulus with increasing distance from the center of railhead. This tendency was observed for both used and virgin side of railhead, therefore it may be attributed to the technological processes in rail manufacturing.

Keywords: fatigue damage, microindentation, Brinell hardness, ultrasonic measurements, railhead.

BIOGRAPHY

Przemysław Ranachowski, born in 1969, was graduated in chemistry from Warsaw University. Since 1997 he has been working at the Institute of Fundamental Technological Research, Polish Academy of Sciences (IPPT PAN). The subject of his research are the properties, parameters of the microstructure, operational durability and degradation effects in ceramic and composite materials as well as light alloys with a wide range of applications. In 2001 presented his dissertation entitled "The use of the acoustic emission method to study the dynamics of polymorphic transformations of inorganic compounds". In 2013 presented his habilitation thesis "Ageing processes in electrotechnical ceramic materials". He was co-author of about 50 papers in wide recognized journals and belongs to the experienced specialists in the field of microscopic and ultrasonic inspection of different kinds of materials.

- Category: oral presentation
- LinkedIn: www.linkedin.com/in/przemysław-ranachowski-52a77678/
- Research Interest: degradation processes in ceramic and composite material

Overview of Austempered Ductile Iron investigation carried out on Faculty of Electrical Engineering, Mechanical Engineering and Naval Architecture in Split

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ABSTRACT

When ductile iron is subjected to austempering heat treatment new material known as Austempered Ductile Iron - ADI is obtained, which has significantly better properties than ductile iron. ADI has a unique microstructure called ausferrite, a mixture of acicular ferrite and carbon-enriched stable austenite which exhibits twice the strength for a given level of ductility obtained by conventional heat treatment. The advantage of austempering heat treatment is savings in production. In addition to energy and financial advantages, austempering provides improved mechanical properties: increased ductility, impact fracture action, wear resistance and permanent dynamic strength. The application of ADI alloys in industry is very wide. It is based on excellent mechanical properties and economic profitability, and it is used in numerous fields (agriculture, excavators, general application industry, gears, construction, food industry). ADI research conducted at the FESB in Split is based on the influence of various heat treatment parameters on the microstructure and properties, from mechanical to anti-corrosive. The influence of copper content on the microstructure and properties was investigated. Research was conducted on the influence of the furnace protective atmosphere during austenitization on ADI properties. Also, the influence of salt bath agitation and the position of the samples within it during austempering was investigated. Research on the novel double tempering procedure has started, and the results obtained are extremely interesting. From most of the conducted research, certain mathematical models emerged that can be used for the ADI application in industry and for further research of this interesting material.

BIOGRAPHY

Dr. Čatipović was born and raised in Split. He graduated from FESB in 2012. He was a member of the FESB Racing Team. He went to Aachen for an internship, where he worked in the company "StreetScooter GmbH", which designs, engineers and produces electric vehicles. In 2013., he started as an assistant at FESB teaching and researching in the field of materials and tribology. He is the author of 24 papers, 7 of which were published in journals, and 17 were presented at international conferences. In 2013., he became a member of the "Croatian Society for Mechanical Technologies" and participates in the organization of the international conference "Mechanical Technologies and Structural Materials". From 2021. he is the president of the Organizing Committee. From 2020. is a member of the "Society of Mechanical Engineers Split". He was also member of the Quality Improvement Committee and Ethics Committee at FESB. Experimental part of dissertation was conducted in Bratislava at the "Institute for Materials and Mechanics of Machines". He actively participates in the popularization of science through newspaper articles, radio interviews and participation in the Science.

- Category: Oral presentation
- LinkedIn: http://hr.linkedin.com/in/niksacatipovic

- Skype: niksacatipovic
- Research Interest: Material science, Heat treatment, Mechanical properties, Microstructure, Corrosion resistance

Concentrating Solar Power and Laser surface treatment of Ti and Ti composites

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ABSTRACT

Titanium and its composites are widely used in implants. Besides mechanical properties also surface characteristics are very important in these biomaterials: surface topography, surface roughness, surface chemistry, surface energy, wettability, the thickness of surface layers and hardness.

Concentrated solar power was used to nitride titanium of commercial Grade 2 and powder metallurgical Ti prepared from hydrogenated dehydrogenated Ti powder via modified hot compaction method. The experiments were performed in SF40 (40kW horizontal solar furnace) at Plataforma Solar de Almeria (PSA), Spain. They were done under nitrogen atmosphere at different temperatures and dwell time. The concentrated solar power is an economical alternative to conventional techniques of gas nitriding in electric furnaces, plasma nitriding, CVD, PVD, or laser treatments. The solar process decreases the heating time to few minutes (up to 5 minutes at temperatures between 500 - 1000 °C), it is clean and non-CO_2 polluting high temperature process. The surface layers of TiN, Ti_2N were investigated using electron microscopy and RTG diffraction. The high hardness was achieved for all nitriding attempts with respect to hardness of the used titanium matrix.

Laser surface treatment is of great significance in modifying the surface morphology and surface and near-surface region microstructures. The influence of laser treatment parameters on the machined surface morphology, roughness and chemistry of PM titanium prepared by warm compaction are also analyzed in this study and discussed from the point of view of the application in dental implantology. The current advances of our research group in the application of laser-treated powder metallurgy of Ti-based materials are analyzed and discussed with respect to biomaterials applications.

ACKNOWLEDGMENT

Financial support by the Access to Research Infrastructures activity in the 7th Framework Programme of the EU (SFERA Grant Agreement n. 228296 and SFERA 2 Grant Agreement n. 312643) is gratefully acknowledged. We thank the Plataforma Solar de Almeria (PSA), Spain for providing access to its installations, the support of its scientific and technical staff, and the financial support of the SFERA-III project (Grant Agreement No 823802). This research was performed under the Slovak national project VEGA 2/0135/20.

BIOGRAPHY

Dr. Kováčik has his expertise in metal matrix composites, focused on physical and mechanical properties of copper – graphite materials. He deals also with powder metallurgical preparation of Ti and Ti composites via warm powder method and using of concentrated solar power for sintering of them and also for solar nitridation of Ti. He is also involved in investigation of metallic foams – measurement and modelling of mechanical and physical properties as well.

- Category: oral presentation
- LinkedIn: https://www.linkedin.com/in/jaroslav-kovacik-a5a1a410/
- Research Interest: composites, foams

Effect of Sample Shape on Compression Behavior of AlSi PM Aluminum Foams

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ABSTRACT

The paper deals with the effect of the sample shape on the uniaxial compression behavior of powder metallurgically prepared AlSi aluminum foams with surface skin. The combination of various geometry shapes of aluminum foams is important in the case of design and development of optimal impact energy absorbers and also seismic absorbers for building protection during earthquakes. Aluminum foam samples of the same density were prepared by a powder-metallurgical process from two brittle aluminum alloys: AlSi10 + 1% wt. TiH_2 and AlSi12Mg0.6 + 0.5 % wt. TiH_2. The samples were foamed in three different geometric shapes (cylinder, triangular prism and quadrilateral prism) with the same cross-sectional area. The samples contain surface skin. Uniaxial compression tests were performed parallel to the surface skin. From the obtained stress-strain curves compression strength, energy absorption at 50% strain and densification strain were determined.

AlSi12Mg0.6 + 0.4% wt. TiH_2 foam (0.71 $g\cdot cm^{-3}$) showed significant dependence of compression properties on sample shape: Compression strength and plateau strength of triangular and square prisms are significantly smaller. The same situation is for energy absorption at 50% strain. The cylinder compression properties are the best. AlSi10 + 1% wt. TiH_2 foam (0.69 $g\cdot cm^{-3}$) showed also significant dependence: Compression properties of triangular prism were significantly smaller. The square prism compression properties were the best. In this case the square prism has significant dense area in the foam core.

When different shapes are foamed from different powder metallurgical precursors different foams structures and different mechanical properties are obtained in compression. Only exception is densification strain which is probably independent on the sample shape.

ACKNOWLEDGMENT

Financial support by Slovak Academy of Sciences and Romanian Academy of Sciences under the Mobility project contract RA-SAS-22-01 (Project: Applications of metallic foams in intelligent panels and seismic absorbers).

BIOGRAPHY

Dr. Kováčik has her expertise in metal matrix composites, focused on physical and mechanical properties of copper – graphite materials. He deals also with powder metallurgical preparation of Ti and Ti composites via warm powder method and using of concentrated solar power for sintering of them and also for solar nitridation of Ti. He is also involved in investigation of metallic foams – measurement and modelling of mechanical and physical properties as well.

- Category: oral presentation
- LinkedIn: http://www.linkedin.com/in/jaroslav-kovacik-a5a1a410/
- Research Interest: composites, foams

Density evolution and microstructural characterization of sintered iron after different conditions of sintering process

Ľubomír Orovčík[1], Naďa Beronská[1], Jaroslav Jerz[1], Zuzana Gabalcová[2], Tomáš Dvorák[1], Jaroslav Kováčik[1], Martin Nosko[1]
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ABSTRACT
Material for high-performance applications produced by the powder metallurgy (PM) process, a pre-alloyed powder or powder mixture suitable for hardening/sintering is required. Pre-alloyed water atomized iron powders have become widely used in the PM industry. Alloying elements such as Cr, Ni, Cu, Mn are most often used in PM. Chromium (Cr) is widely used as an alloying element in PM mainly due to its high hardening ability, corrosion resistance, low cost, and easy recyclability.
Cr is generally sensitive to oxidation and water-atomized pre-alloyed iron powder during manufacturing. The barrier of Cr oxides on the surface affects the sintering of powder particles and the diffusion of elements such as Ni, which is added to the powder mixture to increase the dynamic properties. Other oxides to the powder particles reduce the mechanical properties. Therefore, our work is focused on the influence of sintering parameters on microstructural changes of Fe1.8% Cr + 2% Ni + 0.5% C alloy powder mixture. The powder mixtures were pressed under uniaxial pressure at 900 MPa and then sintered for 30 minutes at 1120, 1250, and 1350 °C. In the sintering process, the four atmospheres such as nitrogen (N_2), hydrogen (H_2), gas mixture (N_2 + 5% H_2), and (N_2 + 10% H_2), were used to reduce oxides in powder compacts, sinter powder particles, and distribute chemical elements into the microstructure of powder particles. The heating rate was set at 2 °C/min for better preheating the powder compacts and prolonging the oxide reduction time. The precipitation rate was set to 5 °C/min to obtain a soft microstructure formed by different amounts of austenite, ferrite, perlite, bainite and martensite.

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BIOGRAPHY
Dr. Orovčík has her expertise in scanning electron microscopy (SEM), focused on EDS,WDS and EBSD observation. He deals also with powder metallurgical preparation of Iron base components via different sintering parameters observed microstructural changes and mechanical properties. He is also involved in investigation of metallic foams during PhD. studies – preparation and measurement of mechanical and physical properties as well.

- Category: Poster presentation
- Research interest: Scanning electron microscopy, EBSD

Microstructure investigation of additively manufactured (SLM, FDM) metals

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ABSTRACT

Process parameters of additive manufacturing highly affect the microstructure of the material and its mechanical properties. In this study, we demonstrate two different additive manufacturing technologies for producing metal parts and the characteristic microstructures investigated with the help of light and electron microscopy (SEM, TEM). The development of additive manufacturing with Al-alloys has been slow, despite their widespread adoption in the industry owing to an excellent combination of low density and high strength-to-weight ratio. The current metallurgical understanding of microstructure and defect formation in Al-alloys during AM is necessary. Selective Laser Melting (SLM) technology uses a laser beam to build the metal component layer by layer with melting powder metal creating a typical molten pool microstructure. Scandium is the most effective known microalloying element strengthener in Al alloys. Nanosized Al_3Sc precipitates form during elevated temperature heat treatments, typically 200–400°C, and are very fine and uniformly distributed. Microscopic investigation from the microstructure down to the atomic structure of Al_3Sc nanoprecipitates is presented in this work using scanning and high-resolution transmission electron microscopy. In comparison, Fused Deposition Modeling (FDM) technology of metal uses highly filled polymer filament with metallic powders and requires sintering steps to prepare a dense metal part. Scanning electron microscopy was used to investigate the metal filament and the pre-sintering process of a 3D-printed sample. For the 316L filament, the production process till debinding is observed using SEM. Other highly filled polymer filaments (Cu, Al, Alumina) can also be additively manufactured with these processing steps.

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BIOGRAPHY

Ing. Stefan Nagy Ph.D. is currently a researcher at the Institute of Materials and Machine Mechanics of the Slovak Academy of Sciences. He completed both Engineering and Doctoral studies at the Faculty of Materials Technology, STU in the field of Advanced Materials and Material Design. The area of his expertise is metal matrix composite materials and electron microscopy (TEM, STEM, SEM).

- Category: Poster presentation
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Research of the use of dual laser beam and its influence on the resulting properties of welded joints of duplex steels

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ABSTRACT

Duplex stainless steels (DSS) are gaining in big attention from industry, thanks to their excellent mechanical properties and corrosion resistance, compared to conventional stainless steels. Their excellent mechanical properties result from the ideal 50/50 ratio of austenite (γ-phase) and ferrite (α-phase) phases represented the microstructure with their uniform distribution. Keeping this balanced ratio is the biggest challenge during DSS welding. All of the DSS solidify as delta ferrite and the duplex microstructure evolves under solid-state phase transformation during cooling. Using the laser beam welding technology could bring a number of advantages in contrast to conventional welding of DSS, e.g. a deeper penetration, narrow heat-affected zone (HAZ). On the other hand, the nature of ferrite to austenite transformation in fusion zone is strongly influenced by cooling rate, which is depended on heat input. Low heat input laser welds resulted in considerable variation in the ferrite/austenite balance as a result of high cooling rate. This problem could be solved by using a dual laser beam simultaneously distributed in a short distance with side-by-side or consecutive configuration. The second beam will repeatedly reheat the welded joint thus the cooling rate will slow down with austenite precipitation resulting from solid solution reactions during further cooling. However, when the cooling rate is too slow, undesired embrittling intermetallic phases may form in spite of the presence of the optimum ferrite content. The study of the energy distribution changes effect of the dual laser beam on the resulting structures of DSS welded joints will be further discussed.

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BIOGRAPHY

My name is Lucia Kopčanová. I am a PhD student working at the Institute of Materials & Machine Mechanics at Slovak Academy of Sciences in Bratislava pursuing my doctoral studies from Slovak University of Technology with dissertation thesis dedicated to the research of the use of dual laser beam and its influence on the resulting properties of welded joints of duplex steels. I´m working under the quidance of my supervisor Ing. Nada Beronska, PhD. My interests are in science and technology especially welding and additive technologies. In my free time I´m doing sport shooting and hunting.

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Conversion of native oxide on Mg powders in CO_2 atmosphere

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ABSTRACT

Either the automotive or aerospace application, the lightest structural metal offers significant opportunities for both. However, due to the continuous growth of its application also in biomedicine, the improvement of corrosion resistance of magnesium has received vast attention. The protective layer's design on magnesium particles in PM technology plays a crucial role in producing the compact made from powders with desirable corrosion and mechanical properties. Among various surface treatment methods, the hydration of the native MgO layer formed on the surface and further carbonation can be done without the need of thermal treatment.

Based on carbonate formation in nature, we present a simple method for conversion of native magnesium oxide to carbonate on the surface of magnesium powders. The current work devoted to examine the effect of gradual hydration of the pure magnesium powders in carbon dioxide atmosphere.

Detailed study of surface changes on pure magnesium powders shows that carbonation in the humid environment can enhance stability of magnesium powder and the native porous MgO can be transformed into a layer of carbonate. The effect of carbonation on corrosion and mechanical properties were further investigated on samples made from extruded powder. Microstructural modifications after extrusion were extensively studied by means of SEM, EBSD, S/TEM and EDS.

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BIOGRAPHY

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