# 19. KONFERENCA O MATERIALIH IN TEHNOLOGIJAH

**22.–23. november 2011, Portorož, Slovenija**

# 19th CONFERENCE ON MATERIALS AND TECHNOLOGY

**22–23 November 2011, Portorož, Slovenia**

# PROGRAM IN KNJIGA POVZETKOV

# PROGRAM AND BOOK OF ABSTRACTS

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**19. KONFERENCA O MATERIALIH IN TEHNOLOGIJAH /**
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**Program in knjiga povzetkov /** *Program and book of abstracts*

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## Predsednica konference – Chair: Monika Jenko

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**Legenda – Legend:**
**KM** Kovinski materiali – Metallic materials
**AM** Anorganski materiali – Inorganic materials
**P** Polimeri – Polymers
**VT** Vakuumska tehnika – Vacuum technique
**NN** Nanomateriali in nanotehnologije – Nanomaterials and nanotechnology
**RP** Raziskovalna politika – Research policy

**VP** Vabljena predavanja – Invited papers
**GP** Govorni prispevki – Oral
**MR** Mladi raziskovalci – Young scientists

# 19. KONFERENCA O MATERIALIH IN TEHNOLOGIJAH, 22. – 23. NOVEMBER 2011
# 19TH CONFERENCE ON MATERIALS AND TECHNOLOGY, 22–23 NOVEMBER, 2011
# PROGRAM – PROGRAM

| | TOREK – TUESDAY, 22. 11. 2011 | | | SREDA – WEDNESDAY, 23. 11. 2011 |
|---|---|---|---|---|
| 08:30 | ***Odprtje – Openning*** | | 8:30 | Kristina Žagar |
| 09:00 | Helmut Lachmund | | 8:45 | B. Poniku – P. Gselman |
| 09:20 | | | 9:05 | M. Hnidzil – G. Klančnik |
| 09:40 | David Nolan | | 9:25 | P. Borković – S. Iric |
| 10:00 | | | 9:45 | **Coffee Break** |
| 10:20 | **Coffee Break** | | 10:00 | T. Mauder – B. Žužek |
| 10:40 | Alojz Buhvald | | 10:20 | F. Kafexhiu – D. Pečko |
| 10:55 | Stanislav Jakelj | | 10:40 | M. Malešević – J. zavašnik |
| 11:10 | Bojan Senčič | | 11:00 | A. Bytyqi – M. Hočevar |
| 11:25 | Zlatko Čuš | | 11:20 | **Coffee Break** |
| 11:40 | Varužan Kevorkijan | | 11:35 | N. Pukšič – M. Soderžnik |
| 11:55 | Božidar Šarler | | 11:55 | A. Kupec – E. Švara Fabjan |
| 12:15 | **Coffee Break** | | 12:15 | M. Krivec – D. Primc |
| 12:30 | M. Godec | | | **12:35 – 14:00** |
| 12:45 | A. Legat | | | **Odmor za kosilo – Lunch** |
| 13:00 | B. Markoli | | 14:00 | S. Avdiaj |
| 13:15 | A. Šurca Vuk | | 14:10 | A. Ivekovič – A. Šestan |
| 13:30 | **13:30 – 15:00** | | 14:30 | D. Klement – K. Rade |
| | **Odmor za kosilo – Lunch** | | 14:50 | J. Koruza – A. Lenart |
| | **STEEL** | **NON-FEROUS MATERIALS** | 15:10 | M. Podlogar |
| 15:00 | B. Podgornik | K. T. Raić | 15:20 | **Coffee Break** |
| 15:15 | B. Bradaškja | M. Conradi | 15:40 | N. Čuk – I. A. Bocsan |
| 15:30 | S. Butković | D. Klobčar | 16:00 | P. Perdih – J. Krystek |
| 15:45 | S. Randjelović | D. Vojtech | 16:20 | H. Srbova – T. Šmigovec Ljubič |
| 16:00 | M. Bajt Leban | R. Keck | 16:40 | J. Bartošek – L. Klimes |
| 16:15 | M. Babič | Tadić | 17:00 | N. Brezavšček |
| 16:30 | K. Gryc | P. Novak | **17:30 – 19:00** | **Podelitev nagrad MR – Young Scientists Awards** |
| 16:45 | S. Senčič | M. Ubeyli | | **Cocktail Party** |
| 17:00 | **Coffee Break** | **Coffee Break** | | |
| | **MODELLING** | **NON-FEROUS MATERIALS** | | |
| 17:15 | P. Ternik | V. Gliha | | |
| 17:30 | M. Suban | R. Begić | | |
| 17:45 | M. Kovačič | J. Sobotova | | |
| 18:00 | F. Kavička | G. Lojen | | |
| 18:15 | L. Krajnc | D. Jenko | | |
| 18:30 | M. Tkadleckova | | | |
| 19:30 – 21:00 | **Posterska sekcija – Poster Session KM, AM, P, NN, VT, COCKTAIL PARTY** | | | |

# PROGRAM 19. KONFERENCE O MATERIALIH IN TEHNOLOGIJAH
# 19th CONFERENCE ON MATERIALS AND TECHNOLOGY: PROGRAM

| TOREK – TUESDAY 22. 11. 2011 | | |
|---|---|---|
| | **Predsedujoči – Chair: M. Godec** | |
| **8:30** | **ODPRTJE – OPENNING** | |
| **9:00** | Helmut Lachmund[1], Martina Maurischat[2]<br>[1]AG der DillingerHuttenwerke, Leiter Forschung & Entwicklung, D-66748 Dillingen/Saar, Germany<br>[2]Koordination Stahlwerke, Max Aicher GmbH & Co.KG, Teisenbergstrasse 7, D-83395 Freilassing, Germany<br>CLEAN STEELS | KM-VP |
| **9:40** | David Nolan<br>BlueScope Steel Limited, Old Port Road, PORT KEMBLA, NSW 2505, Australia<br>PROGRESS ON Al-Zn COATINGS ON SHEET STEEL PRODUCTS FOR THE BUILDING INDUSTRY | KM-VP |
| **10:20** | **Odmor – Break** | |
| | **Predsedujoči – Chair: M. Godec, A. Buhvald** | |
| **10:40** | Alojz Buhvald<br>Metal Ravne d.o.o., Koroška cesta 14, 2390 Ravne na Koroškem<br>SUPER ČISTA JEKLA – PRIHODNOST ZA PODJETJE METAL RAVNE | KM-VP |
| **10:55** | S. Jakelj[1], B. Bradaškja[1], B. Lešnik[1], M. Klinar[1], J. Novak[1], M. Kunšič[1], R. Robič[1], M. Fazarinc[2], G. Kugler[2]<br>[1]Acroni d.o.o., Cesta Borisa Kidriča 44, 4270 Jesenice, Slovenia, [2]Faculty of natural sciences and engineering, University of Ljubljana, Aškerčeva cesta 12, 1000Ljubljana, Slovenia<br>DEVELOPMENT OF MARTENSITIC STAINLESS STEEL FOR HEAVY PLATE PRODUCTION | KM-VP |
| **11:10** | Bojan Senčič[1], Vojteh Leskovšek[2]<br>[1]ŠTORE STEEL d.o.o., Železarska cesta 3, SI-3220 Štore, Slovenia, [2]Institute of metals and technology, Lepi pot 11, 1000 Ljubljana, Slovenia<br>SEGREGATIONS INFLUENCE ON FRACTURE TOUGHNESS $K_{Ic}$ OF HIGH STRENGTH SPRING STEEL | KM-VP |
| **11:25** | Zlatko Čuš<br>TALUM d.d. Kidričevo, Tovarniška c. 10, 2325 Kidričevo<br>SUSTAINABILITY OF THE EUROPEAN ALUMINIUM INDUSTRY | KM-VP |
| **11:40** | Varužan Kevorkijan[1], Srečo Davor Škapin[1], Irena Paulin[3], Uroš Kovačec[2], Monika Jenko[3]<br>Independent Researcher, Betnavska cesta 6, 2000 Maribor, Slovenia, Institute "Jožef Stefan", Jamova 39, 1000 Ljubljana, Slovenia, Institute of Metals and Technology, Lepi pot 11, 1000 Ljubljana, Slovenia, Impol LLT d.o.o., Partizanska 38, 2310 Slovenska Bistrica, Slovenia<br>EFFECT OF FOAMING AGENT AND ITS MORPHOLOGY ON THE FOAMING BEHAVIOUR, CELL-SIZE DISTRIBUTION AND MICROSTRUCTURE UNIFORMITY OF CLOSED-CELL ALUMINIUM FOAMS | KM-VP |
| **11:55** | Božidar Šarler[1,5], Igor Belič[2], Bogdan Filipič[3], Igor Grešovnik[1,5], Umut Hanoglu[1], Monika Jenko[2], Tadej Kodelja[5], Miha Kovačič[1,4], Agnieszka Zuzanna Lorbiecka[1], Miha Mlakar[3], Bojan Senčič[4,5], Tea Tušar[3], Robert Vertnik[1,4]<br>[1]Laboratory for Multiphase Processes, University of Nova Gorica, Vipavska 13, SI-5000 Nova Gorica, Slovenia, [2]IMT Ljubljana, Ljubljana, [3]Department of Intelligent Systems, Jožef Stefan Institute, Ljubljana, [4]Štore-Steel Technical Development, Štore, Slovenia, [5]Center of Excellence BIK, Solkan, Slovenia<br>SIMULATION AND OPTIMISATION OF CASTING, ROLLING AND HEAT TREATMENT PROCESSES FOR COMPETITIVE PRODUCTION OF TOPMOST STEEL | KM-VP |

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| **12:15** | **Odmor – Break** | |
| | **Predsedujoči – Chair: V. Leskovšek, B. Podgornik** | |
| **12:30** | Matjaž Godec<br>Institute of Metals and Technology, Lepi pot 11, 1000 Ljubljana, Slovenia<br>THE EBSD ANALYTICAL TECHNIQUE - A POWERFUL TOOL FOR METALLIC MATERIALS CHARACTERISATION | KM-GP |
| **12:45** | Bo Rosborga, Tadeja Kosec, Andrej Kranjc, Andraž Legat<br>Zavod za gradbeništvo Slovenije, Dimičeva 12, 1000 Ljubljana, Slovenia<br>CORROSION MONITORING OF COPPER EXPOSED TO BENTONITE UNDER OXIC CONDITIONS: THE FISRT STEP IN HIGH RADIONUCLEAR WASTE STORAGE | KM-GP |
| **13:00** | B. Markoli, T. Bončina, F. Zupanič<br>University of Ljubljana, Faculty of natural sciences and engineering, Slovenia<br>SYNTHESIS OF IN-SITU QUASICRYSTALLINE AL-MATRIX COMPOSITES | KM-GP |
| **13:15** | Angela Šurca Vuk, Metka Hajzeri, Marija Čolovič, Adolf Jesih, Boris Orel<br>National Institute of Chemistry, Hajdrihova 19, 1000 Ljubljana, Slovenia<br>ALKOXYSILYL FUNCTIONALISED IODIDE AND MESYLATE IONIC LIQUIDS | KM-GP |
| **13:30 – 15:00 ODMOR ZA KOSILO – LUNCH** | | |
| | **Session STEEL**<br>**Predsedujoči – Chair: M. Torkar, D. Steiner Petrovič** | |
| **15:00** | Bojan Podgornik, Vojteh Leskovšek<br>Institute of Metals and Technology, Lepi pot 11, 1000 Ljubljana<br>WEAR RESISTANCE OF FORMING TOOLS | KM-GP |
| **15:15** | B. Bradaškja[1], M. Fazarinc[2], G. Kuglar[2]<br>[1]Acroni d.o.o., Cesta Borisa Kidriča 44, 4270 Jesenice, Slovenia, [2]Faculty of natural science and engineering, University of Ljubljana, Aškarčeva 12, 1000 Ljubljana, Slovenia<br>STRAIN INDUCED PRECIPITATION OF NbC IN STEEL – A CLASS MODEL STUDY | KM-GP |
| **15:30** | Samir Butković[1], Mirsada Oruč[2], Emir Šarić[1], Muhamed Mehmedović[1], Boris Orel[1]<br>[1]University of Tuzla, Faculty of Mechanical Engineering, Univerzitetska 4, Tuzla, BiH<br>[2]University of Zenica, Institute of Metallurgy "Kemal Kapetanović" Zenica, Travnička cesta 7, 72000 Zenica, BiH<br>EFFECT OF SINTERING PARAMETERS ON DENSITY, MICROSTRUCTURE AND MECHANICAL PROPERTIES OF NIOBIUM MODIFIED HEAT RESISTANT STAINLESS STEEL GX40CrNiSi25-20 PRODUCED BY MIM TECHNOLOGY | KM-GP |
| **15:45** | S. Randjelović, M. Manić[1], M. Trajanović[1], M. Milutinović[2], D. Movrin[2]<br>[1]Faculty of Mechanical Engineering, University of Niš, Aleksandra Medveda 14, 18000 Niš, Serbia<br>[2]University of Novi Sad, Faculty of Technical Science, Trg Dositeja Obradovića 6, 21000 Novi Sad, Serbia<br>THE IMPACT OF THE DIE ANGLE ON TOOL LOADING IN THE PROCESS OF COLD EXTRUSION STEEL | KM-GP |
| **16:00** | Mirjam Bajt Leban, Tadeja Kosec, Andraž Legat<br>Slovenian National Building and Civil Engineering Institute, Dimičeva 12, SI-1000 Ljubljana, Slovenia<br>CORROSION OF GALVANIZD STEEL PIPES IN DRINKING WATER SYSTEM | KM-GP |
| **16:15** | Matej Babič<br>Emo-Orodjarna d.o.o., Bežigrajska cesta 10, 3000 Celje, Slovenija<br>COMPARISON FRACTAL STRUCTURES BETWEEN ROBOT LASER AND INDUCTIVE HARDENING | KM-GP |
| **16:30** | Karel Michalek, Libor Čamek, Karel Gryc, Markéta Tkadlečková, Tomáš Huczala, Vladimír Troszok, VSB-Tecchnical University of Ostrava; Trinecke zelezarny, Trinec<br>DESULPHURIZATION OF HIGH-ALLOY AND MIDDLE ALLOY STEEL UNDER CONDITIONS OF EAF BY MEANS OF SYNTHETIC SLAG BASED ON $CaO\text{-}Al_2O_3$ | KM-GP |

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| **16:45** | Miha Kovačič[1], Sandra Senčič[2]<br>[1]ŠTORE STEEL, [2]KOVA d.o.o., Slovenia<br>MODELING OF PM10 EMISSION NEAR THE STEEL PLANT AREA IN SLOVENIA WITH GENETIC PROGRAMMING | KM-GP |
| **17:00** | **ODMOR – BREAK** | |
| | **Session NON-FEROUS MATERIALS**<br>**Predsedujoči – Chair: Z. Čuš, A. Kocijan** | |
| **15:00** | Iva Milinković[1], Rebeka Rudolf[2], Karlo T. Raić[3], Zoran Aleksić[1], Vojkan Lazić[1], Aleksandar Todorović[1], Dragoslav Stamenković[1]<br>[1]University of Belgrade, School of Dentistry, Clinic for Prosthodontics, Belgrade, Serbia<br>[2]University of Maribor, Faculty of Mechanical Engineering, Maribor, Slovenia<br>[3]University of Belgrade, Faculty of Technology and Metallurgy, Belgrade, Serbia<br>ASPECTS OF TITANIUM IMPLANT SURFACE MODIFICATION ON MICRO AND NANO LEVELS | NN-GP |
| **15:15** | M. Conradi[1] , M. Zorko[2], I. Jerman[2], B. Orel[2], I. Verpoest[3]<br>[1]Institute of Metals and Technology, Lepi pot 11, SI-1000 Ljubljana, [2]Chemistry Institute, Hajdrihova 19, SI-1000 Ljubljana, [3]Department of Metallurgy and Materials, K. U. Leuven, Kasteelpark Arenberg 44, 3001 Heverlee, Belgium<br>PVC MODIFIED WITH WELL DISPERSED NANO SILICA SPHERES | P-GP |
| **15:30** | Damjan Klobčar[1], Janez Tušek[1], Ladislav Kosec[2]<br>[1]Faculty of mechanical engineering, SI-1000 Ljubljana, Slovenia, [2]Faculty of natural sciences and engineering, SI-1000 Ljubljana, Slovenia<br>FRICTION STIR WELDING OF AlMg4.5Mn ALLOY | KM-GP |
| **15:45** | D. Vojtěch, F. Průša<br>Department of Metals and Corrosion Engineering, Institute of Chemical Technology, Prague<br>APPLICATION OF POWER METALLURGY FOR PROCESSING OF ALUMINIUM SCRAPS WITH HIGH IRON CONTENTS | KM-GP |
| **16:00** | Rüdiger Keck<br>German Aerospace Center, Institute of Structures and Design, 70569 Stuttgart, Germany<br>VACUUM BASED MANUFACTURING OF HIGH-PERFORMANCE THERMOPLASTIC STRUCTURES | P-GP |
| **16:15** | Srdjan Tadić, Aleksandar Sedmak[1], Radica Prokić-Cvetković[2]<br>[1]Inovation Center, Faculty of Mechanical Engineering, Kraljice Marije 16, 11000 Beograd, Serbia<br>SUPERPLASTIC FLOW IN 7XXX ALUMINIUM PM ALLOY | KM-GP |
| **16:30** | P. Novak, L. Mejzlikova, A. Michalcova, J. Serak, D. Vojtech<br>Institute of Chemical Technology, Prague<br>REACTIVE SINTERING PRODUCTION OF INTERMETALLICS | KM-GP |
| **16:45** | Bertan Sarikan[1], Erhan Balci[1], Mustafa Übeylı[2], Necip CamuŞcu[1]<br>[1]TOBB University of Economics and Technology, Mechanical Engineering, Söğütözü Cad. No:43 06560 ANKARA, [2]Osmaniye Korkut Ata University, Mechanical Engineering, Karacaoğlan Yerleşkesi, 80000 OSMANİYE<br>AN INVESTIGATION ON THE AGING BEHAVIOR OF THE FUNCTIONALLY GRADIENT MATERIAL CONSISTING OF BORON CARBIDE AND ALUMINUM ALLOY | KM-GP |
| **17:00** | **ODMOR – BREAK** | |
| | **Session MODELLING**<br>**Predsedujoči – Chair: B. Šarler, I. Belič** | |
| **17:15** | Primož Ternik[1], Rebeka Rudolf[2,3], Zoran Žunič[4]<br>[1]Private Researcher, Bresterniška ulica 163, 2354 Bresternica, Slovenia, [2]University of Maribor, Faculty of Mechanical Engineering, Smetanova 17, 2000 Maribor, Slovenia, [3]Zlatarna Celje d.d., Kersnikova ul.19, 3000 Celje, [4]AVL-AST, Trg Leona Štuklja 5, 2000 Maribor, Slovenia<br>NUMERICAL STUDY OF HEAT TRANSFER ENHANCEMENT OF HOMOGENEOUS WATER-Au NANOFLUIDS UNDER NATURAL CONVECTION | NN-GP |

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|---|---|---|
| **17:30** | Robert Cvelbar, Marjan Suban, Borut Bundara<br>Institute of metal constructions, Mencingerjeva 7, 1001 Ljubljana, Slovenia<br>DIGITAL IMAGINING ANALYSIS OF MICROSTRUCTURES AS A TOOL TO IDENTIFY LOCAL PLASTIC DEFORMATION | KM-GP |
| **17:45** | Miha Kovačič[1], Božidar Šarler[2]<br>[1]ŠTORE STEEL d.o.o., Železarska cesta 3, SI-3220 Štore, [2]University of Nova Gorica, Vipavska 13, SI-5000, Slovenia<br>BATCH FILLING SCHEDULING AND GENETIC ALGORITHM | KM-GP |
| **18:00** | Frantisek Kavicka<br>Brno University of technology, Brno, Czech Republic<br>NUMERICAL AND EXPERIMENTAL INVESTIGATION OF TEMPERATURE FIELD OF SOLIDIFYING MASSIVE DUCTILE-CAST-IRON ROLLER | KM-GP |
| **18:15** | Luka Krajnc[1], Grega Klančnik[2], Primož Mrvar[2], Jožef Medved[2]<br>[1]Štore steel d.o.o., [2]Univerza v Ljubljani, Naravoslovnotehnična fakulteta<br>THERMODYNAMIC ANALYSIS OF NON-METALLIC INCLUSIONS FORMATION DURING THE C45 STEEL PRODUCTION | KM-GP |
| **18:30** | Tkadleckova Marketa[1], Gryc Karel[1], Machovcak Pavel[2], Michalek Karel[1], Socha Ladislav[1], Klus Petr[1], Kovac Marek[3]<br>[1]VSB-TU Ostrava, [2]VÍTKOVICE HEAVY MACHINERY a.s., [3]MECAS ESI s.r.o.<br>SETTING OF NUMERICAL SIMULATION OF FILLING AND SOLIDIFICATION OF HEAVY STEEL INGOT BASED ON REAL CASTING CONDITIONS | KM-GP |
| | **Session NON-FEROUS MATERIALS**<br>**Predsedujoči – Chair: V. Kevorkijan, M. Conradi** | |
| **17:15** | P. O. Maruschak[1], I. Konovalenko[1], V. Gliha[2], T. Vuherer, S. V. Panin<br>[1]TNTU, Ruska 56, 46001 Ternopil, Ukraine, [2]University of Maribor, Faculty of mechanical engineering, Slovenia<br>PHYSICAL REGULARITIES IN CRACKING OF NANOCOATINGS AND THE METHOD FOR AUTOMATED DETERMINATION OF CRACK NETWORK PARAMETERS | KM-GP |
| **17:30** | Razija Begić[1], Monika Jenko[2], Matjaž Godec[2], Črtomir Donik[2]<br>[1]Faculty of Engineering, University of Bihać, Irfana Ljubijankića bb., 77000 Bihać BiH<br>[2]Institute for Metals and Technology, Lepi pot 11, Ljubljana, Slovenija<br>CONTENT Cr AND Cr (VI) IN PARTICLES OF FUME FROM WELDING DEPENDING ON Cr CONTENT IN EXPERIMENTAL COATING Cr-Ni RUTILE ELECTRODE | KM-GP |
| **17:45** | Jana Sobotová[1], Peter Jurči[2], Petra Salabová[3], Otakar Prikner[3], Borivoj Šuštaršič[4], Darja Jenko[4]<br>[1]Czech Technical University in Prague, Faculty of Mechanical Engineering, Karlovo nám. 13, 121 35 Prague 2, Czech Republic, [2]Faculty of Material Sciences and Technolohy in Trnava, Paulínská 16, 917 24 Trnava, Slovakia, [3]Prikner – tepelné zpracování kovů, Martínkovice 279, 550 01, Czech Republic, [4]Institute of Metals and Technology, Lepi pot 11, 10000 Ljubljana, Slovenia<br>MICROSTRUCTUAL CHANGES IN SUB_ZERO PROCESSED VANADIS 6 P/M LEDEBURITIC TOOL STEEL | KM-GP |
| **18:00** | G. Lojen, T. Bončina, F. Zupanič<br>University of Maribor, Faculty of mechanical engineering, Slovenia<br>THERMAL STABILITY OF Al-Mn-Be MELT-SPUN RIBBONS | KM-GP |
| **18:15** | Darja Jenko[1], Irena Paulin[1], Varužan Kevorkijan[2], Srečo D. Škapin[3], Monika Jenko[1]<br>[1]Institute of Metals and Technology, Lepi pot 11, POB 431, SI-1000 Ljubljana, Slovenia<br>[2]Independent Researcher, Betnavska cesta 6, SI-2000 Maribor, Slovenia, [3]Institute "Jožef Stefan", Jamova 39, SI-1000 Ljubljana, Sloveni<br>CHARACTERIZATION OF CLOSED-CELL STRUCTURE OF ALUMINIUM FOAM USING TEM AND STEM | NN-GP |
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| **19:30 – 21:00** | **POSTERSKA SEKCIJA – POSTER SESSION**<br>**KM, AM, P, NN, VT**<br>**Cocktail Party** | |

| **SREDA – WEDNESDAY 23. 11. 2011** | | |
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| | **Predsedujoči – Chair: S. Pejovnik, M. Jenko** | |
| **8:30** | Kristina Žagar[1], Francisco Hernandez-Ramirez[2,3], Joan Daniel Prades[3], Joan Ramon Morante[2,3], Aleksander Rečnik[1], Miran Čeh[1]<br>[1]Jožef Stefan Institute, Jamova cesta 39, 1000 Ljubljana, Slovenia, [2]Catalonia Institute for Energy Research (IREC), Jardins de les Dones de Negre 1, 08930 Sant Adrià de Besòs, Barcelona, Spain, [3]University of Barcelona, Marti i Franquès 1, 08028 Barcelona, Spain<br>CHARACTERIZATION OF INDIVIDUAL $BaTiO_3$ NANORODS AND THEIR ASSESSMENT AS BUILDING-BLOCKS OF NEW CIRCUIT ARCHITECTURES | NN-GP |
| **8:45** | Besnik Poniku, Igor Belič, Monika Jenko<br>Institute of Metals and Technology, Lepi pot 11, 1000 Ljubljana, Slovenia<br>USING DIFFERENT PEAKS OF THE SAME ELEMENT IN THE QUANTIFICATION PROCESS OF AES SPECTRA | KM-MR |
| **8:55** | Peter Gselman[1], Peter Panjan[1], Darja Kek Merl[1], Miha Čekada[1], Tonica Bončina[2], Franc Zupanič[2]<br>[1]Jožef Stefan Institute, Jamova cesta 39, 1000 Ljubljana, Slovenia, [2]University of Maribor, Faculty of Mechanical Engineering, Smetanova 17, 2000 Maribor<br>CHARACTERIZATION OF DEFECTS IN PVD TiAlN HARD COATINGS | KM-MR |
| **9:05** | M. Raudensky[1], M. Hnizdil[1], S. H. Lee [2], S. Y. Kim[2], J. Y. Hwang[2]<br>[1]Brno University of Technology, Czech Republic, [2]POSCO, Korea<br>INFLUENCE OF WATER TEMPERATURE ON COOLING INTENSITY OF MIST NOZZLES IN CONTINUOUS CASTING | KM-MR |
| **9:15** | Grega Klančnik, Jožef Medved<br>University of Ljubljana, Faculty of Natural Science and Engineering<br>THERMODYNAMICS OF LIQUID Al-Sb-Zn ALLOYS | KM-MR |
| **9:25** | Predrag Borković, Borivoj Šuštaršič, Vojteh Leskovšek, Milan Malešević, Borut Žužek, Bojan Podgornik<br>Institute of metals and technology, Lepi pot 11, 1000 Ljubljana, Slovenia<br>FATIGUE LIFE BEHAVIOUR AND LIFETIME ASSESSMENT OF DOUBLE-LEAF SPRING USING FEM SOFTWARE | KM-MR |
| **9:35** | Ekrem Altuncu[1], Sedat Iriç[2], Fatıh Ustel[2]<br>[1]KOCAELİ UNİ. METAL-MACHİNE TECH., [2]SAKARYA UNİ. MACHİNE ENG.<br>WEAR RESISTANT INTERMETALLIC ARC SPRAY COATINGS | KM-MR |
| **9:45** | **ODMOR – BREAK** | |
| | **Predsedujoči – Chair: S. Pejovnik, M. Jenko** | |
| **10:00** | Tomas Mauder, Cenek Sandera, Josef Stetina<br>Brno University of Technology, Faculty of Mechanical Engineering<br>A FUZZY-BASED OPTIMAL CONTROL ALGORITHM FOR CONTINUOUS CASTING PROCESS | KM-MR |
| **10:10** | Borut Žužek, Monika Jenko, Matjaž Godec, Mitja Kmetič, Boris Arzenšek<br>Institute of metals and technology, Lepi pot 11, 1000 Ljubljana, Slovenia<br>ASSESSMENT OF RESIDUAL LIFE TIME FOR CREEP RESSISTANT STEELS AT THERMAL POWER PLANTS | KM-MR |
| **10:20** | Fevzi Kafexhiu, Jelena Vojvodič Tuma, Franc Vodopivec<br>Institute of Metals and Technology<br>THE MICROSTRUCTURE AND PROPERTIES IN WELD JOINTS OF CREEP-RESISTANT STEELS | KM-MR |

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| **10:30** | Darja Pečko[1], Kristina Žužek Rožman[1], Zoran Samardžija[1], Boris Pihlar[2], Spomenka Kobe[1]<br>[1]Jožef Stefan Institute, Ljubljana, Slovenia, [2]Faculty of Chemistry and Chemical Technology, University of Ljubljana, Slovenia<br>Fe-Pd BASED NANOSTRUCTURES SYNTHESIZED WITH THE ELECTRODEPOSITION METHOD | KM-MR |
| **10:40** | Milan Malešević, Jelena V. Tuma, Borivoj Šuštaršič<br>Institute of Metals and Technology, Lepi pot 11, 1000 Ljubljana, Slovenia<br>INVESTIGATIONS OF MECHANICAL PROPERTIES OF CF-8A STAINLESS STEEL | KM-MR |
| **10:50** | Janez Zavašnik, Nina Daneu, Aleksander Rečnik<br>"Jožef Stefan" Institute, Department for nanostructured materials<br>STACKING FAULTS AND TWIN BOUNDARIES IN PYRITE ($FeS_2$) | KM-MR |
| **11:00** | Arsim Bytyqi[1], Monika Jenko[2]<br>[1]ŠTORE STEEL d.o.o., Železarska cesta 3, SI-3220 Štore, Slovenia, [2]Institute of metals and technology, Lepi pot 11, 1000 Ljubljana, Slovenia<br>A HRAES DETERMINATION OF COMPLEX INCLUSIONS IN SPRING STEEL | KM-MR |
| **11:10** | Hočevar Matej[1], Matjaž Godec[1], Monika Jenko[1], Damjana Drobne[2], Sara Novak[2]<br>[1]Institute of metals and tehnology, Lepi pot 11, 1000 Ljubljana, Slovenia<br>[2]Biotechnical faculty, Department of Biology, Večna pot 111, 1000 Ljubljana, Slovenia<br>SURFACE ROUGHNESS AFFECTS ADHESION OF BACTERIA AND BIOFILMS FORMATION ON AUSTENIC STAINLESS STEEL (AISI 316L) | KM-MR |
| **11:20** | **ODMOR – BREAK** | |
| | **Predsedujoči – Chair: S. Pejovnik, M. Čeh** | |
| **11:35** | Nuša Pukšič, Monika Jenko<br>Institute of Metals and Technology, Lepi pot 11, SI-1000 Ljubljana, Slovenia<br>RECENT PROGRESS IN THE THEORY OF SURFACE EVOLUTION INDUCED BY ION IRRADIATION | NN-MR |
| **11:45** | Marko Soderžnik, Paul McGuiness, Kristina Žužek Rožman, Spomenka Kobe<br>Jožef Stefan Institute, Department for Nanostructured Materials<br>ELECTROPHORETIC DEPOSITION OF DyF3 ON Nd-Fe-B SINTERED MAGNETS | NN-MR |
| **11:55** | Alja Kupec,[1] Elena Tchernychova,[1,2] Barbara Malič[1,2], Marija Kosec[1]<br>[1]Jožef Stefan Institute, Jamova 39, Ljubljana, Slovenia, [2]Centre of ExcellenceSPACE.SI, Aškerčeva 12, Ljubljana, Slovenia<br>SOLUTION DERIVED LEAD-FREE $(K_{0,5}Na_{0,5})NbO_3$ THIN FILMS: COMPOSITIONAL AND STRUCTURAL STUDY | NN-MR |
| **12:05** | E. Švara Fabjan[1], A. Sever Škapin[1], L. Škrlep[1], M. Čeh[2], M. Gaberščček[3]<br>[1]Slovenian National Building and Civil Engineering Institute, Dimičeva 12, SI – 1000 Ljubljana Slovenia, [2]Jožef Stefan Institute, Jamova cesta 39, Ljubljana, Slovenia, [3]National Institute of Chemistry, Hajdrihova 19, Ljubljana, Slovenia<br>SURFACE MODIFICATION OF ORGANIC PIGMENTS FOR PROTECTION AGAINST PHOTOCATALYSIS | NN-MR |
| **12:15** | Matic Krivec[1], Ricardo A. Segundo[2], Adrian M. T. Silva[2], Goran Dražič[1]<br>[1]Jožef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenija, [2]FEUP-University of Porto, Rua Dr. Roberto Frias, 4200-465 Porto, Portugal<br>PHOTOCATALYTIC CHARACTERISATION OF RUTILE NANOPARTICLES PREPARED VIA LOW TEMPERATURE SYNTHESIS | NN-MR |
| **12:25** | Darinka Primc[1], Miha Drofenik [1,2], Darko Makovec[1]<br>[1]Department for Materials Synthesis, Jožef Stefan Institute, Jamova 39, SI-1000, Ljubljana, Slovenia, [2]Faculty for Chemistry and Chemical Engineering, University of Maribor, Smetanova 17, SI-2000, Maribor, Slovenia<br>NANOCOMPOSITES OF SPINEL ($\gamma$-$Fe_2O_3$) AND HEXAGONAL ($SrFe_{12}O_{19}$) FERRITES | NN-MR |

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| **12:35 – 14:00 ODMOR ZA KOSILO – LUNCH** | | |
| | **Predsedujoči – Chair: S. Pejovnik, D. Suvorov** | |
| **14:00** | Sefer Avdiaj[1], Janez Šetina[2]<br>[1]University of Prishtina, Faculty of Natural Sciences and Matehmatics, Mother Teresa av. 3, 1000 Kosova, [2]Institute of Metals and Technology, Lepi pot 11, 1000 Ljubljana, Slovenia<br>TESTING OF NON EVAPORABLE GETTER PUMP FOR EXTREMELY HIGH VACUUM CALIBRATION CHAMBER | VT-MR |
| **14:10** | Aljaž Ivekovič, Saša Novak, Goran Dražić<br>Jožef Stefan Institute, Slovenian Fusion Association<br>DENSIFICATION OF SiC-MATRIX IN SiC BASED COMPOSITES BY SITE-P PROCESS | AM-MR |
| **14:20** | Andreja Šestan, Damjan Vengust, Boštjan Jančar, Danilo Suvorov<br>Jožef Stefan Institute, Jamova 39, 1000 Ljubljana, Slovenia<br>DEGRADATION OF LAYERED SODUIM COBALTATE | AM-MR |
| **14:30** | Dejan Klement[1], Matjaž Spreitzer[1], Danilo Suvorov[1], Anton Meden[2]<br>[1]Advanced materials, Jozef Stefan Institute, Jamova cesta 39, 1001 Ljubljana, Slovenia, [2]Faculty of Chemistry and Chemical Technology, University of Ljubljana, Aškarčeva cesta 5, 1000 Ljubljana<br>INFLUENCE OF SYNTHESIS CONDITIONS ON THE STRUCTURAL AND ELECTRICAL PROPERTIES OF THE $Ag(Ta_xNb_{1-x})O_3$ CERAMIC | AM-MR |
| **14:40** | Katja Rade, Saša Novak, Goran Dražič, Spomenka Kobe<br>Department for nanostructured materials, Jožef Stefan Institute, Slovenia<br>ELECTROPHORETIC CO-DEPOSITION AND DENSIFICATION OF SiC WITH MgO FOR BIOMEDICAL APPLICATIONS | AM-MR |
| **14:50** | Jurij Koruza, Barbara Malič, Gregor Trefalt, Marija Kosec<br>Jožef Stefan Institute, Ljubljana, Slovenia<br>MICROSTRUCTURE DEVELOPMENT UPON TWO-STAGE SINTERING OF NANO-SODIUM NIOBATE | AM-MR |
| **15:00** | A. Lenart[1], Z. Samardžija[1,2], M. Godec[3], B. Mirtič[4], S. Šturm[1]<br>[1] Jožef Stefan Institute, Department for Nanostructured Materials, Jamova 39, 1000 Ljubljana, Slovenia, [2] Center of Excellence NAMASTE, Jamova 39, 1000 Ljubljana, Slovenia, [3] Institute of Metals and Technology, Department for Surface Engineering and Applied Surface Science, Lepi pot 11, 1000 Ljubljana, Slovenia, [4] University of Ljubljana, Faculty for Natural Sciences and Engineering, Department of Geology, Aškerčeva cesta 12, 1000 Ljubljana, Slovenia<br>EBSD AND TEM INVESTIGATIONS OF JAPANESE TWINS IN QUARTZ | AM-MR |
| **15:10** | Matejka Podlogar[1], Jacob J. Richardson[2], Damjan Vengust[3], Martin Strojnik[3], Nina Daneu[1], Aleksander Rečnik[1], Slavko Bernik[1]<br>[1]Department for Nanostructured Materials and Centre of Excellence NAMASTE, Jožef Stefan Institute, Jamova cesta 39, 1000 Ljubljana, Slovenia, [2]Materials Department, University of California, Santa Barbara, CA 93106, United States, [3]Department for Complex Matter, Jožef Stefan Institute, Jamova cesta 39, 1000 Ljubljana, Slovenia<br>SYNTHESIS AND CHARACTERIZATION OF UNDOPED AND Al-DOPED ZnO FILMS FROM AN AQUEOUS SOLUTION | AM-MR |

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| **15:30** | **ODMOR – BREAK** | |
| | **Predsedujoči – Chair: S. Pejovnik, E. Žagar** | |
| **15:50** | Nataša Čuk[1,2], Matjaž Kunaver[1,2], Sergej Medved[3]<br>[1]National Institute of Chemistry, Hajdrihova 19, SI-1000 Ljubljana, Slovenia, [2]Center of Excellence for Polymer Materials and Technologies, Tehnološki Park 24, SI-1000 Ljubljana, Slovenia, [3]University of Ljubljana, Biotechnical Faculty, Department of Wood Science and Technology, Rožna dolina C VIII/34, 1000 Ljubljana, Slovenia<br>THE PROPERTIES OF PARTICLEBOARDS MADE BY USING THE LIQUEFIED WOOD | P-MR |
| **16:00** | [1]Bocsan Iulia Andreea, [2]Conradi Marjetka, [2]Zorko Milena, [2]Jerman Ivan, [1]Hancu Liana, [1]Marian Borzan, [3]Maarten Fabre, [4]Jan Ivens<br>[1]Technical University of Cluj Napoca, Romania, [2]Institute of Metals and Technology, Ljubljana, [3]Lessius University College, Campus De Naye, Belgium, [4]Katolieke Universiteit Leuven, Department of Metallurgy and Materials Engineering, Belgium<br>SHAPE MEMORY POLYMERS FILLED WITH $SiO_2$ NANOPARTICLES | P-MR |
| **16:10** | Peter Perdih, Ema Žagar<br>Laboratory for Polymer Chemistry and Technology, National Institute of Chemistry, Hajdrihova 19, SI-1001 Ljubljana, Sloveni<br>THE SYNTHESIS OF THE POLYESTER DENDRIMERS | P-MR |
| **16:20** | Jan Krystek, Radek Kottor, Lukaš Bek<br>University of West Bohemia, Univerzitni 8, 30614 Plzen, Czech Republic<br>COMPARISON OF STRENGTH BEHAVIOUR OF UNIDIRECTIONAL HIGH MODULUS CARBON COMPOSITE AND HIGH STRENGTH CARBON COMPOSITE SUBJECTED TO BIAXIAL LOADING | P-MR |
| **16:30** | Hana Srbová, Tomáš Kroupa, Robert Zemčík<br>University of West Bohemia, Univerzitni 8, 30614, Pilsen, Czech Republic<br>IDENTIFICATION OF MATERIAL PARAMETERS OF UNIDIRECTIONAL FIBER COMPOSITE USING MICROMODEL | P-MR |
| **16:40** | Tina Šmigovec Ljubič, Majda Žigon, Ema Žagar<br>Laboratory for Polymer Chemistry and Technology, National Institute of Chemistry, Hajdrihova 19, SI-1000 Ljubljana, Slovenia<br>CHARACTERIZATION OF POLY(STYRENE–*block* – *t*-BUTYL METHACRYLATE) COPOLYMERS BY TWO-DIMENSIONAL CHROMATOGRAPHY | P-MR |
| **16:50** | Jan Bartošek, Tomáš Kroupa, Zemčík Robert, Petr Janda<br>University of West Bohemia, Univerzitni 8, 30614, Pilsen, Czech Republic<br>DETERMINATION OF COEFFICIENTS OF THERMAL EXPANSION OF WOVEN COMPOSITES USING DIGITAL IMAGE CORRELATION METHOD | P-MR |
| **17:00** | Lubomir Klimes[1], Pavel Charvat[1], Milan Ostry[2]<br>[1]Brno University of Technology, Faculty of Mechanical Engineering, [2]Brno University of Technology, Faculty of Civil Engineering<br>CHALLENGES IN COMPUTER MODELING OF PHASE CHANGE MATERIALS | P-MR |
| **17:10** | Neja Brezavšček[1], Anja Čusak[2], Ema Žagar[1,2]<br>[1]Laboratory for Polymer Chemistry and Technology, National Institute of Chemistry, Hajdrihova 19, 1000 Ljubljana, [2]CO EN-FIST, Dunajska cesta 156, 1000 Ljubljana<br>SINTHESYS OF DIFFERENT GENERATION POLYESTERAMIDE DENDRIMERS | P-MR |
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| **17:30** | **Podelitev nagrad MR – Young Scientists Awards**<br>Cocktail Party | |

# POSTERSKA SEKCIJA – POSTER SESSION
# TOREK – TUESDAY 22. 11. 2011 (19:30 – 21:00)

| KM – KOVINSKI MATERIALI / METALLIC MATERIALS | |
|---|---|
| KM-1 | Zdenek Adolf<br>VŠB-TU Ostrava, FMMI, 17. listopadu 15/2172,708 33 Ostrava, Czech Republic<br>EVOLUTION OF METALLOGRAPHIC PURITY OF STEEL IN LADLE FURNACE AND VACUUM CAISSON |
| KM-2 | Boštjan Arh, Franc Tehovnik<br>Institute of Metals and Technology, Lepi pot 11, 1000 Ljubljana<br>INFLUENCE OF THE ELECTROMAGNETIC STIRING OF THE MELT BY THE CONTINUOUS CASTING ON THE HOMOGENITY OF THE SOLIDIFIED STEEL |
| KM-3 | Boris Arzenšek[1], Franc Tehovnik[1], Borut Žužek[1], Boštjan Pirnar[2]<br>[1]Institute of Metals and Technology, Ljubljana, [2]ACRONI d.o.o. Jesenice<br>INFLUENCE OF PRECIPITATES ON HOT DEFORMATION ABILITIES OF DUPLEX STAINLESS STEELS |
| KM-4 | Matej Babič<br>Emo-Orodjarna d.o.o., Bežigrajska cesta 10, 3000 Celje, Slovenija<br>ROBOT LASER HARDENED MATERIALS GGG 60 AND GGG 70 AND FRACTAL DIMENSION |
| KM-5 | Matej Babič<br>Emo-Orodjarna d.o.o., Bežigrajska cesta 10, 3000 Celje, Slovenija<br>ROBOT LASER HARDENING WITH DIFFERENT ANGELS ON DIFFERENT MATERIALS |
| KM-6 | Martin Balcar[1], Ludvík Martínek[1], Pavel Fila[1], Jaroslav Novák[1], Jiří Bažan[2], Ladislav Socha[2], Danijela Anica Skobir Balantič[3], Matjaž Godec[3]<br>[1]ŽĎAS, a.s., Strojírenská 6, 591 71 Žďár nad Sázavou, Czech Republic<br>[2]VŠB - Technical University of Ostrava, 17. listopadu 15/2172, 708 33 Ostrava-Poruba, Czech Republic<br>[3]Institute of Metals and Technology, Lepi pot 11, 1000 Ljubjana, Slovenia<br>QUALITY OF SUPER CLEAN STEELS PRODUCED AT ŽĎAS, INC. |
| KM-7 | Jiri Bažan<br>VŠB – Technical University of Ostrava, FMME, 17. listopadu 15/2172, 708 33 Ostrava-Poruba, Czech Republic<br>WEAR OF REFRACTORY MATERIALS OF CERAMIC FILTERS OF DIFFERENT POROSITY AT CONTACT WITH HOT METAL |
| KM-8 | Pavol Beraxa, Lucia Domovcová, Ľudovít Parilák<br>ŽP VVC s.r.o., Kolkáreň 35, 97645, Podbrezová, Slovakia<br>IMPLEMENTATION OF THE CDV PROCESS FOR COLD FORMING TOOLS |
| KM-9 | Jure Bernetič[1], Iztok Tomažič[1], Goraz Kosec[1], Tomaž Vuherer[2], Karl Gotlih[2], Zijah Burzić[3], Borut Kosec[4], Matjaž Marčetič[1]<br>[1]ACRONI d.o.o., c. B. Kidrica 44, 4270 Jesenice, Slovenia, [2]University of Maribor, Faculty of Mechanical Engineering, Slovenia, [4]Military Technical Institute, Serbia, [3]University of Ljubljana, Faculty of Natural Sciences and Engineering, Aškerčeva cesta 12, Ljubljana, Slovenia<br>PRELIMINARY INVESTIGATION ON NEW GRADE OF ARMOUR STEEL – PROTAC 500 |
| KM-10 | Roman Celin, Dimitrij Kmetič<br>Institute of metals and technology, Lepi pot 11, 1000 Ljubljana<br>A CHARACTERIZATION OF GAS TURBINE INNER CASING MICROSTRUCTURE |
| KM-11 | Črtomir Donik, Aleksandra Kocijan, Irena Paulin, Monika Jenko<br>Institute of Metals and Technology, Lepi pot 11, 1000 Ljubljana<br>CORROSION CHARACTERISTICS OF FOAMED Al AND AlSi12 |

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| KM-12 | Karel Gryc[1], Karel Stránský[2], Karel Michalek[1], Winkler[3], Jan Morávka[1], Ladislav Socha[1], Markéta Tkadlečková[1], Jiří Bažan[1], Jana Dobrovská[1], Simona Zlá[1]<br>[1]VŠB-TUO, [2]VUT, [3]VOP, [4]MMV<br>STUDY OF HIGH-TEMPERATURE INTERACTION BETWEEN SYNTHETIC SLAGS AND STEEL |
| KM-13 | A. Gurbuza[1], N. Onarb[1], I. Ozdemirc[1], A. C. Karaoglanli[2], E. Celika[3]<br>[1]Metallurgical and Materials Engineering Department., Dokuz Eylul University, 35160 Izmir, Turkey, [2]Textile Engineering Department, Pamukkale University, 20020 Denizli, Turkey, [3]Metallurgical and Materials Engineering Department, Bartin University, 74100 Bartin, Turkey<br>STRUCTURAL, THERMAL AND MAGNETIC PROPERTIES OF Mn, Cu OR Co AND X (X=Sr AND Ni) SUBSTITUTED-BARIUM FERRITE POWDERS PREPARED BY SOL-GEL METHOD |
| KM-14 | Štefan Hozjan[1], Jelena Vojvodič Tuma[2], Aleksandra Kocijan[2], Monika Jenko[2], Franc Vodopivec[2]<br>[1]Nafta Strojna, Mlinska ulica 5, 9220 Lendava, Slovenia, [2]Inštitut za kovinske material in tehnologije, Lepi pot 11, 1000 Ljubljana<br>THE PHENOMENA OF SPECIFIC DAMAGES AT THE BOTTOM PLATES OF AN ABOVEGROUND FUEL STORAGE TANKS COMPOSED OF STRUCTURAL STEELS |
| KM-15 | Primož Jan[1,2], Jure Bernetič[1], Gorazd Kosec[1], Matjaž Marčetič[1], Zijah Burzić[3], Jasmin Huskić[1], Robert Robič[1], Grega Stare[1,2], Borut Kosec[2]<br>[1] ACRONI d.o.o., C. B. Kidriča 44, 4270 Jesenice, Slovenia, [2] University of Ljubljana, Faculty of Natural Sciences and Engineering, Aškerčeva cesta 12, Ljubljana, Slovenia, [3] Military Technical Institute, Ratka Resanovića 1, 11030 Belgrade, Serbia<br>HEAT TREATMENT OF HIGH STRENGTH WEAR RESISTANT FLAT STEEL PLATES |
| KM-16 | Pustějovská, P., Jursová, S.<br>[1]Technical University of Ostrava. Ostrava, Czech Republic<br>RELATION BETWEEN THE INJECTION OF LIGNITE TAR AND OTHER SIGNIFICANT PARAMETRES |
| KM-17 | Abdullah Cahit Karaoglanli[1], Garip Erdogan[2], Fatih Ustel[2], Ahmet Turk[2]<br>[1]Bartin University, [2]Sakarya University<br>STUDY OF MICROSTRUCTURAL AND OXIDATION BEHAVIOR OF YSZ AND YSZ/$AL_2O_3$ TBCS WITH HVOF BOND COATINGS |
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# 19. KONFERENCA O MATERIALIH IN TEHNOLOGIJAH

22.–23. november 2011, Kongresni center GH Bernardin, Portorož, Slovenija

# 19th CONFERENCE ON MATERIALS AND TECHNOLOGY

22–23 November 2011, Congress Centre GH Bernardin, Portorož, Slovenia

# KNJIGA POVZETKOV

# BOOK OF ABSTRACTS

KM

# DEVELOPMENT OF MARTENSITIC STAINLESS STEEL FOR HEAVY PLATE PRODUCTION

S. Jakelj[1], B. Bradaškja[1], B. Lešnik[1], M. Klinar[1], J. Novak[1], M. Kunšič[1], R. Robič[1], M. Fazarinc[2], G. Kugler[2]
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Development of martensitic stainless steel grade 410.
On the basis of interesting inquiries, especially from big American market, the decision to tackle the demanding developmental project.
Martensitic stainless steel of 410 group is excelled by its high hardness, strength and low toughness.
The process of producing this steel grade, from mould to casting, rolling to the last heat treatment of heavy plates is very demanding.
The grade is produced in thicknesses from 8 up to 65 mm.
The development of technological process of this martensitic stainless steel is based upon our own research and development knowledge.

KM

# SEGREGATIONS INFLUENCE ON FRACTURE TOUGHNESS $K_{Ic}$ OF HIGH STRENGTH SPRING STEEL

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Manufacturer of spring steel must provide a technical description of steel, which includes beside the chemical composition also the basic mechanical, physical and technological properties of steel. Among technological properties an information concerning the heat treatment is very important for the manufacturer of springs.

Charpy-V notch (CVN) impact-test values are used in toughness specifications for spring steels, even though the fracturing energy is not directly related to the spring design.

It is surprising that there is no demand for fracture toughness $K_{Ic}$ value (the plain-strain stress-intensity factor at the onset of unstable crack growth) in delivery conditions for spring steel producers. To the spring designer $K_{Ic}$ values are more useful than CVN values, because the design calculations for springs from high strength steels should also take into account the strength and the toughness of materials to prevent rapid and brittle fracture.

An investigation was conducted to determine whether standardized fracture toughness testing (ASTM E399-90), which is difficult to perform reliably for hard and low ductility materials, could be replaced with a non-standard testing method using circumferentially notched and fatigue-precracked tensile specimens. The results of this innovative approach of investigation have shown that using the proposed method it was possible to draw, for the normally used range of working hardness, combined tempering diagrams (Rockwell-C hardness – Fracture toughness $K_{Ic}$ – Tempering temperature) for the vacuum-heat-treated high strength spring steel grade 51CrV4.

The main objective of our work was creating of tempering diagrams for the investigated high strength spring steel 51CrV4. Using tempering diagrams, we wanted to confirm the suitability of the investigated steel to produce high strength springs (required tensile strength between 1500 and 1800 MPa) when properly performed heat treatment.

In accordance with the plan of experiments heat treatment was carried out on the basis of the trial preliminary research and modeling results. This was followed by measurements of mechanical properties and analysis of fractured surfaces and the microstructure of $K_{Ic}$ samples.

Based on measurements of mechanical properties beside classic tempering diagram:

- Tensile strength $R_m$-Yield stress $R_{p0.2}$-Elongation $A_5$(%)-Necking Z(%)-Tempering temperature following tempering diagrams for spring steel 51CrV4 for selected austenitizing temperature were created:
- Hardness HRc – fracture toughness $K_{Ic}$ – Tempering temperature,
- Hardness HRc – Impact toughness Charpy-V – Tempering temperature.

According to tempering diagrams we can conclude that the investigated spring steel 51CrV4 is suitable for production of high strength springs (the required tensile strength is between 1500 and 1800 MPa) when proper heat treatment is performed.

Fractographic and metallographic analyses of the $K_{Ic}$ -test specimens used shows in steel the presence of segregations. Therefore, we focused on examining the impact of segregations on the fracture toughness $K_{Ic}$. By use of optical microscope and electron microscope (SEM + EDS) we have determined the number and the width of the positive segregations bands and the matrix bands just under the fractured surface of $K_{Ic}$-test specimens.

We found out that the width of the positive segregations bands and the matrix bands between samples varies considerably. We have also discovered that the number and the width of segregations bands influence significantly the fracture toughness $K_{Ic}$ due to the presence of bainite in matrix bands.

Keywords: fracture toughness, segregations, high strength spring steel, vacuum heat treatment, tempering diagrams, microstructure.

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# SUSTAINABILITY OF THE EUROPEAN ALUMINIUM INDUSTRY

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Aluminum is one of the best performing and most sustainable materials, thanks to its unique properties including recyclability and industry is ready to support this statement with quantitative and qualitative evidence. Today, thousands of products can be made safer, lighter, more energy efficient and fully recyclable thanks to aluminum: from cars, trains or aircrafts to cookware, packaging and electrical conductors.

Almost three-quarters of all aluminum ever manufactured (700 million tones) is still in use thanks to its long life cycle and excellent recyclability. Life cycle time is 10-20 years in transportation and 50–80 years in buildings. Aluminum can be recycled infinitely without of loss of quality and has impressive recycling rates: over 90 % in transport and building applications and more than 55 % in packaging, with some countries exceeding 90 % for beverage cans. Also, aluminum recycling saves up to 95 % of the energy used in the primary production.

The variety of applications for aluminum has grown apace and will continue to contribute to sustainable development and energy efficiency in Europe. This is clearly visible from historical and actual aluminum production trends in Europe and World, presented in this article.

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# EFFECT OF FOAMING AGENT AND ITS MORPHOLOGY ON THE FOAMING BEHAVIOUR, CELL-SIZE DISTRIBUTION AND MICROSTRUCTURE UNIFORMITY OF CLOSED-CELL ALUMINIUM FOAMS

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A quantitative evaluation of the microstructure of aluminium foams and, particularly, their quantitative comparison is a very demanding and complex issue. In this work, the cell-size distribution (CSD) was proposed as the most efficient approach.
Because a mutual correlation between the cell-size distribution (CSD) and the aluminium-foam processing parameters has not yet been established, the purpose was to investigate the interdependence of the applied processing parameters on the cell-size distribution and the density of the aluminium foams. The foams were made by the powder metallurgy (P/M) route, by applying titanium hydride and dolomite powders of five different average particle sizes as the foaming agents.
The average size of the pores and the pore size distribution were estimated by analysing optical and scanning electron micrographs of as-polished foam bars by applying the point-counting method and image-analysis software.
The uniformity of the cell-size distribution in foamed samples with closed cells was studied as a function of the particle size distribution of the foaming agents, the average particle size of the applied AlSi12 powders, the concentration of foaming agents, the foaming temperature and the foaming time.
Generally, samples foamed with the dolomite foaming agent had a more uniform cell-size distribution and a lower average bubble size. The most uniform cell-size distribution was achieved in the foam samples foamed with the minimum amount (0.5 wt. %) of dolomite powder grades having the lowest average particle size and a narrow particle size distribution. In contrast, in samples made from coarser and less-uniform grades of foaming agents, the cell size distribution was more comprehensive, with a significantly higher fraction of large bubbles. In addition, longer foaming times and higher foaming temperatures also led to foam samples with a less-uniform microstructure.
Based on experimental findings and theoretical considerations of the aluminium foams' microstructure development, the preconditions for stable bubble growth into a homogeneous and uniform foam structure were modelled and compared with the experimentally determined values.

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# SIMULATION AND OPTIMISATION OF CASTING, ROLLING AND HEAT TREATMENT PROCESSES FOR COMPETITIVE PRODUCTION OF TOPMOST STEEL

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An overview of research and development towards establishing a multiscale numerical model of the production chain of steel semiproducts is presented. Process steps of continuous casting, hot rolling and heat treatment are considered. The final goal of the modelling is the prediction of the product properties as a function of the process parameters of each process step. This is achieved by the coupled physical models of relations between the process parameters and the product macrostructure, microstructure and the product properties. The physical modelling of the microstructure evolution is complemented, replaced or tuned by the artificial intelligence methods. The process is optimised through minimization of two weighted objective functions: the macroscopic one, taking into account the factors such as process productivity, usage of the machines and use of energy and cooling agents, and the microscopic one, taking into account the product properties as a function of the microstructure. Experimental validation of the models is described. Several simulation and optimisation examples, associated with the production chain in Štore Steel company are shown.

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# THE EBSD ANALYTICAL TECHNIQUE - A POWERFUL TOOL FOR METALLIC MATERIALS CHARACTERISATION

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Electron backscatter diffraction is a scanning electron microscopy based microstructural-crystallographic technique used to examine the crystallographic orientation of many materials. Main applications of EBSD method are orientations distributions, phase identification, strain and deformation, general microstructure and interface parameters. The EBSD characterisation of textures in electrical steels, phase analysis of carbides in tool steels and phase orientation relationship studies in duplex stainless steel were shown and the results demonstrate that EBSD is a powerful tool particularly when the technique is combined with EDS measurements.

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# CORROSION MONITORING OF COPPER EXPOSED TO BENTONITE UNDER OXIC CONDITIONS: THE FISRT STEP IN HIGH RADIONUCLEAR WASTE STORAGE

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Corrosion rate of pure copper has been followed by thin electrical resistance (ER) sensors placed in a test package containing an oxic bentonite/saline groundwater environment at room temperature for a period of more than three years. Potential measurements have verified oxic conditions in the test package. A series of electrochemical impedance spectroscopy (EIS) measurements has also been performed on the ER sensors and results from one of the sensors are presented here. The impedance spectra for copper in the oxic bentonite/saline groundwater environment change considerably with time of exposure. The impedance is increased over the whole frequency range. Different methods have been applied to estimate the corrosion rate from both, EIS and electrical resistance measurement data. The measurements on sensors have revealed decreasing but measurable corrosion rates all through the exposure period. After three years exposure the estimated corrosion rate from the EIS measurements falls in the range 0.4–0.7 micro m/year, which is somewhat lower than the value of 1.0 micro m/year obtained from the ER measurements. Gravimetric data from six years exposure in the Äspö Hard Rock Laboratory showed an average corrosion rate of 0.5 micro m/year. The corrosion modes of copper exposed to bentonite have been studied by optical, confocal and Raman spectroscopy.

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# SYNTHESIS OF IN-SITU QUASICRYSTALLINE AL-MATRIX COMPOSITES

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The fabrication of ex-situ and in-situ composites are processes that differ from each other where ex-situ composites usually suffer from defects e.g. porosity and insufficient adhesion between reinforcing component and matrix material. The in-situ composites are usually free of such defects because the reinforcing component forms and grows from within using the matrix material as a substrate to grow on and from. This is very often with metal matrix composites where the fabrication process involves the synthesis of the composite beginning with the melt. Provided the composition and the cooling rates are favourable the quasicrystalline (QC) phases will form and grow in such systems. The QC phases can appear as primary phase and/or within structures. Namely, very high symmetry is linked to the icosahedral QC phase (i-phase). Such phase doesn't have the tendency to grow in a plate-like or needle-like morphology. It grows in an equiaxed form as faceted pentagonal dodecahedrons or branched dendrites. This can considerably increase the ductility. Furthermore, the high symmetry of the i-phase ensures many possible orientations for planar matching with another crystalline phase e.g. matrix. The quasiperiodicity ensures an epitaxy with periodic planes of many possible spacings at the interface. The high symmetry of the i-phase ensures that epitaxy is produced on nearly all interfaces in bulk. Slight misorientations across interfaces are accommodated by dislocations. Thus the structural properties of QC phases make them very compatible with the matrix regarding the ability to deform and hence very interesting for structural applications. In our work the Al-Mn-Be alloys with additions of Cu were synthesized using vacuum-induction melting under Ar. These alloys were cast applying three different cooling rates to explore the possibilities of fabrication of metal matrix composites reinforced with suitably sized QC particles by means of reliable and cost effective process techniques (e.g. casting).

KM

# ALKOXYSILYL FUNCTIONALISED IODIDE AND MESYLATE IONIC LIQUIDS

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Ionic liquids are important as electrolytes for various applications like lithium rechargeable batteries, dye-sensitised photoelectrochemical cells and electrochromic (EC) devices. To avoid application of liquid electrolytes, different polymerisable ionic liquids have already been synthesised, for example with different polymerisable groups (acryl, vinyl…) that are positioned either on anions or cations. Similarly, also alkoxysilyl-functionalised ionic liquids can be synthesised, which during processes of hydrolysis (solvolysis) and condensation lead to electrolytes with a quasi solid-state consistency. In our laboratory we synthesised a series of alkoxysilyl-functionalised ionic liquids with iodide or mesylate anions, the former being used as redox I3-/I- electrolytes for hybrid EC devices and the latter for preparation of lithium ion conductive electrolytes for battery-type of EC devices. It was found that bis end-capped ionic liquids, due to the presence of alkoxysilyl groups at both ends of the precursor, guarantee the formation of compact 3D sol-gel network, but unfortunately the conductivity of such electrolytes dropped significantly during condensation. The solution was found in addition of a non-reactive alkyl or poly(glycol) functionalised ionic liquid as co-solvent. Different combinations of ionic liquids, their properties and application will be presented. The research leading to these results has received funding from the European Community's Seventh Framework Programme (grant agreement n° 200431, INNOSHADE) and Centre of Excellence Low Carbon Technologies (Contract n° 3211-09-000641).

KM

# WEAR RESISTANCE OF FORMING TOOLS

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Manufacturing of parts is confronted with ever-increasing demands on higher strength and hardness of the work material as well as higher productivity, which put increased requirements on wear and fatigue resistance of the tools. At the same time the quality requirements are high and will continue to grow in the future, together with demands on tool efficiency and productivity. However, in competitive environment only increased production at maintained product quality and reduced environment pollution can be successful because this directly influences the profitability. The life and performance of forming tools and dies is limited because of a number of reasons, such as thermal fatigue cracking, erosion, corrosion, local adherence of the formed material to the tool surface (soldering/galling), and gross fracture. Beside that the surface finish of the formed part is a critical quality parameter in many forming operations. A smooth surface often results in marketing advantages, as well as improved performance. The major obstacles to generation of superior quality and smooth surfaces are tool wear and surface roughness increase, but above all adhesion of work material to the tool surface. Soldering and galling are also the dominant cause for tool failure in sheet metal forming and forging processes. Tool wear and adhesion of work material cause aesthetic problems for the work-peace and generates high contact pressure and unstable friction conditions, being very unfavorable for the forming process. The main focus on improving wear resistance and tribological properties of forming tools has been on developing tool steels with improved fracture toughness and modifying lubricants for better retention and permeability at the tool/work-peace contact area. Nevertheless, wear and galling can successfully be hindered also by modification of the tool surface. One way of modifying the surface to improve wear resistance of the tools, is thermo-chemical surface treatment, i.e. hardening, nitriding, deep cryogenic treatment, etc. In the last couple of years also hard coatings (i.e. TiN, TiAlN, CrN, etc.) have started to compete successfully with the traditional thermo-chemical treatments. However, although hard and corrosion-resistant coatings are frequently used to protect and enhance the lifetime of cutting tools, the majority of the industrial forming tools is still uncoated. Beside a complex shape of forming tools, which makes them difficult to coat, commercial hard coatings have a relatively high coefficient of friction and sticking tendency in contact with the work materials. Furthermore, as compared to high speed steels, cemented carbide and ceramic materials used in cutting tool applications, tool steels have a lower load-carrying capacity. However, in the last decade a lot of new and modified coating deposition techniques as well as hard low-friction coatings with exceptional anti-wear properties have been developed. Especially carbon-based coatings were found to give very promising results. But, in order to fully exploit properties of hard coatings, coated surface must also be able to sustain the applied load, which can be achieved through duplex treatment, a combination of thermo-chemical treatment of the substrate and subsequent deposition of a hard wear-resistant coating. Especially, the combination of plasma nitriding and Physical Vapor Deposited (PVD) hard coating has been found to give very good mechanical and tribological properties of contact surfaces. Another way of improve tribological properties of forming tools, being coated or uncoated is to optimise their surface roughness and topography. Investigations on surface topography show that this has a great influence on the tribological behaviour of contacting surfaces, thus playing an important role in the process of improving tribological properties of forming tools. This paper reviews various surface engineering techniques aimed and used to improve wear resistance and anti-sticking properties of forming tools, and considers reasons behind the selection. Furthermore, benefits of applying surface engineering on forming tools is presented on various examples, from sheet-metal forming to fine blanking and forging.

KM

# STRAIN INDUCED PRECIPITATION OF NbC IN STEEL – A CLASS MODEL STUDY

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Strain induced precipitation is very important phenomenon that influences the properties of steels during their thermo-mechanical processing. In this contribution the model for prediction of strain induced precipitation is proposed. It is based on a mean-field concept and enables prediction of evolution of precipitates size distribution. The accelerated diffusion along dislocations is taken into account using effective diffusion coefficient that depends on dislocation density. At the precipitate/matrix interface local equilibrium is assumed, which is calculated with the use of experimental equation for solubility product, taking into account Gibbs-Thomson effect. The parametric study and comparison with previous models found in literature was made and discussed.

KM

# EFFECT OF SINTERING PARAMETERS ON DENSITY, MICROSTRUCTURE AND MECHANICAL PROPERTIES OF NIOBIUM MODIFIED HEAT RESISTANT STAINLESS STEEL GX40CrNiSi25-20 PRODUCED BY MIM TECHNOLOGY

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Properties of heat resistant stainless steel parts produced by metal injection molding (MIM) process are mostly dependent on sintering parameters. In this regard, effect of sintering parameters on densification, microstructure, hardness and tensile properties of niobium modified heat resistant stainless steel GX40CrNiSi25-20 was investigated in this paper. Prepared feedstock was injection molded to produce tensile test specimens (ISO 2740). Debinding of injection molded parts was performed by catalytic debinding method, while removing of residual binder was done by thermal debinding process. Sintering was performed at temperatures 1200 °C and 1310 °C, in argon (Ar), hydrogen ($H_2$) and nitrogen ($N_2$) atmospheres. Sintering times between 3 h and 6 h were used in this study. It was found that sintering in nitrogen atmosphere causes strengthening of material and reduction of ductility. Mechanical properties were also enhanced by a higher sintering temperature (1310 °C), due to positive effects from pore rounding and increased density. Prolonged sintering time caused changes in grain size, but had little effect on the sintered density. Faster sintering and improved ductility was observed on samples sintered in hydrogen and argon atmospheres.

KM

# THE IMPACT OF THE DIE ANGLE ON TOOL LOADING IN THE PROCESS OF COLD EXTRUSION STEEL

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This paper presents an analysis of tool loading in the technology of cold forward extrusion of steel. In the process of plastic deformation it is necessary to know the contact stress as a prerequisite for more accurate analysis of stress and strain on the internal structure of the continuum. That way, accurate boundary conditions on contact surfaces are obtained for achieved conditions of deformation, which represent the starting values for generating numerical approximations of the plasticity parameter changes within the deformable volume. In the process of forward extrusion of steel, workpiece material is exposed to all-round pressure during the entire process. Due to the high surface pressure at the head of the punch and solid walls of the die, the material flows in the direction of opening the exchangeable conical surfaces of the die. During the extrusion process, the greatest resistance occurs in the direction of the axis displacement, i.e. the head punch, while the walls of tools suffer considerably smaller loads but which has crucial importance on the accuracy and quality of the finished part.

KM

## CORROSION OF GALVANIZED STEEL PIPES IN DRINKING WATER SYSTEM

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Objective of the research was an estimation of corrosion damage of a relatively new drinking water system in one of Slovenian hospitals, and assessment of causes for the severe damage. Water drinking system was made from galvanized steel pipes. Most accessories, fittings and valves, were made from brass. It was found that stagnant water caused the initial corrosion after pressure testing of the drinking water system at commissioning. Moreover, Legionella prevention led to severe corrosion due to frequent chemical and thermal disinfection of the system. Corrosion tests (potentiodynamic polarization and gravimetrical testing of coupons) were performed in order to investigate corrosion susceptibility of materials in system to different disinfection methods. FTIR analysis was performed in order to investigate biofilm formation in cold and warm water systems. Corrosion products were examined by SEM/EDS analysis. EDS analysis proved a presence of copper in the system as an evidence of galvanic corrosion. In addition, metallographic examination of pipe cross-sections was also performed. Investigation has shown that materials used in this particular drinking water system were highly susceptible to the thermal and chlorine desinfection. Corrosion caused by desinfection was mostly uniform; however, corrosion due to galvanic couples in the systems manifested as pitting corrosion. It was observed that heat affected zone of pipe seams presented the most corrosion susceptible sites. Corrosion progressed almost through entire cross-section of the pipes and therefore perforation was expected to happen any time.

KM

# COMPARISON FRACTAL STRUCTURES BETWEEN ROBOT LASER AND INDUCTIVE HARDENING

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Laser hardening is a metal surface treatment process complementary to conventional ame and induction hardening processes. A high-power laser beam is used to heat a metal surface rapidly and selectively to produce hardened case depths of up to 1,5mm with the hardness of the martensitic micro-structure providing improved properties such as wear resistance and increased strength. Induction hardening is a form of heat treatment in which a metal part is heated by induction heating and then quenched. Fractal patterns are observed in computational mechanics of elastic-plastic transitions. We compared the fractal structure of robot laser hardened and inductive hardened of four different materials of DIN standard GGG 60, GGG 70, GGG 60L and GGG70L. We find which method of hardening give us better result. We graphical compare fractal structure and hardness.

KM

## DESULPHURIZATION OF HIGH-ALLOY AND MIDDLE ALLOY STEEL UNDER CONDITIONS OF EAF BY MEANS OF SYNTHETIC SLAG BASED ON $CaO\text{-}Al_2O_3$

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The article deals with the findings and results of experimental heat performed at the Electric Steel Plant of TŘINECKÉ ŽELEZÁRNY, a.s. (Czech Republic). The aim was to verify the possibilities of deep desulfurization of steel in the 10-ton basic electric arc furnace under conditions of heat in the reduction stage. Experimental procedures with the use of industrially produced synthetic slag were applied in the production of high-alloy chrome steels and middle-alloy tool steels whose desulphurization is, in terms of thermodynamics, more difficult than chrome-nickel steel desulphurization. With the use of designed technological procedures it was possible to achieve low contents of sulphur in steel, below 0,003 wt.%. Achieving these contents depends on a suitable slag composition, in particular of its basicity and $CaO/Al_2O_3$ ratio. The analysis of results has shown that a critical factor that significantly affects the final content of sulphur and thus the efficiency of desulphurisation of steel, is clearly considered to be the content of FeO in the reduction slag. The higher MgO content in slag (up to 25 wt.%) had no significant influence on the results of steel desulphurization.

KM

# MODELING OF PM10 EMISSION NEAR THE STEEL PLANT AREA IN SLOVENIA WITH GENETIC PROGRAMMING

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To implement sound air quality policies, Regulatory Agencies require tools to evaluate outcomes and costs associated to different emission reduction strategies. Applicability of such tools could be also uncertain. It is also known that source-receptor models cannot be implemented through deterministic modeling. The article presents the attempt of PM10 emission modeling close to steel plant area in Slovenia with genetic programming method. The daily PM10 concentrations, daily rolling mill and steel plant production, meteorological data (wind speed and direction – hourly average, air temperature – hourly average and rainfall – daily average), weekday and month number were used for modeling from a 1-year monitoring campaign. The genetic programming modeling results show good agreement with measured daily PM10 concentrations.

KM

# ASPECTS OF TITANIUM IMPLANT SURFACE MODIFICATION ON MICRO AND NANO LEVELS

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Shape and chemical composition, as well as the macro and microtopography of the implant surface have been studied widely as major factors that influence implant osseointegration positively. Titanium and titanium alloys have been used widely over the past 20 years as biomedical materials in orthopaedic and dental surgeries due to their high mechanical properties, corrosion resistance, no cell toxicity, and very poor inflammatory response in peri-implant tissue, which is proving their high biocompatibility. Their favourable biological performance is attributed to a thin native oxide film, which forms spontaneously on the titanium surface.

It is well established that surface roughness plays an important role in implant fixation. Accordingly, some authors have indicated the existence of an optimal range of surface roughness (Wennerberg 1998).

The titanium surface can be either chemically or physically modified, or both, in order to improve biomaterial-tissue integration.

Different treatments are used to modify the titanium surface. Hydroxyapatite coatings, preceded or not by acid etching, are used to create a rough, potentially bioactive surface (de Groot et al. 1998; Barrere et al. 2002; Sena et al. 2002). Oxide blasting treatments, either with or without chemical etching, (Wennerberg 1998; Yerokhin et al. 2000; Diniz et al. 2002) are used to develop rough surfaces.Thick oxide films obtained by anodic (Sul et al. 2001; Sena et al. 2003) or thermal oxidation (Velten et al. 2002) have been used currently to accelerate the osseointegration process.

Therefore, the ideal microtopography of the surface is still unknown, because it is very difficult to associate surface properties with clinical results.

As more accurate knowledge is required, several Ti surfaces have been modified on the micro and nano level. In this respect, the appropriate overview of our results will be given.

P

# PVC MODIFIED WITH WELL DISPERSED NANO SILICA SPHERES

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Poly(vinyl chloride), PVC-based composites were prepared by blending PVC with various weight ratios of submicron (i.e. 600 nm) and nano-$SiO_2$ spherical particles (i.e. 30 nm), which were initially treated with different surfactants: $IO_7T_7(OH)_3$ (trisilanol isooctyl polyhedral oligomeric silsesquioxane), $IB_7T_7(OH)_3$ (trisilanol isobutyl polyhedral oligomeric silsesquioxane) and DMOAP (N,N-dimethyl-n-octadecyl1-3-aminopropyl-trimethoxysilyl chloride). The degree of dispersion and interfacial compatibility of surface treated $SiO_2$ particles in PVC matrix was characterized with SEM. The best dispersion of surface modified particles and their compatibility with the PVC matrix was obtained for the silica particles (1% wt) treated with $IO_7T_7(OH)_3$, exhibiting a highly ordered 3D silica (600 nm and 30 nm)/PVC organic-inorganic composites layers. The main interest of this study was the investigation of the composites' mechanical and optical properties, which will be presented and discussed in details.

KM

# FRICTION STIR WELDING OF AlMg4.5Mn ALLOY

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A study of weldability of 4 mm thick aluminium alloy (AlMg4.5Mn) plates using friction stir welding was done. A plan of experiments was prepared based on abilities of universal milling machine, where tool rotation speed varied from 200 – 1250 rev/min, welding speed from 71 – 450 mm/min and the tool tilt angle was held constant at 2°. A factor feed per revolution (FPR) was introduced to get the better insight into the friction stirring process. From the welds samples for microstructure analysis, Vickers micro-hardness measurement and special miniature tensile testing samples were prepared. The microstructure was prepared for observation on a light microscope under the polarised light source. A set of optimal welding parameters were determined, at which a quality welds can be made with weld tensile strength equal to the base material.

KM

# APPLICATION OF POWER METALLURGY FOR PROCESSING OF ALUMINIUM SCRAPS WITH HIGH IRON CONTENTS

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Aluminum alloys show relatively high strength to weight ratio and good corrosion resistance. It makes them attractive materials for automotive and aerospace industry. In recycling of aluminum, various grades of Al-containing scrap are processed. The main impurity in the scrap is iron whose contents can exceed several wt. %. Unfortunately, iron strongly negatively influences mechanical properties of Al alloys, therefore, its content in most of commercial alloys is minimized. High-iron Al-based alloys can not be processed by classical ingot or casting metallurgy, because resulting materials would be extremely brittle with very low tensile strength and fracture toughness due to the presence of coarse and needle like Fe-Al or Fe-Si-Al intermetallic phases. In the present work we show that powder metallurgy is a way suitable for direct processing of Al-based alloys or scraps containing even 10 wt. % Fe. The alloys can be processed by gas or centrifugal atomization, followed by pressing and sintering or hot extrusion. We show that resulting materials exhibit good combination of strength and plasticity. Moreover, high iron contents are responsible for excellent thermal stability of new alloys.

P

# VACUUM BASED MANUFACTURING OF HIGH-PERFORMANCE THERMOPLASTIC STRUCTURES

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The application of fiber reinforced composites in aircraft structures is traditionally based on thermoset matrix materials. As the percentage of composite parts based on thermoplastic matrix materials is increasing, cost effective manufacturing techniques for large aircraft structures become more and more necessary. This paper shows various out-of-autoclave techniques for manufacturing fiber reinforced thermoplastic parts, such as the vaccum consolidation process, which allows to combine forming and welding in one step. As smart joining technologies are the key technologies for low cost fabrication of large aircraft structures, several verying technologies will be presented. By design and fabrication of a generic tail rudder for a jet-fighter aircraft, it is demonstrated that thermoplastic composites structures based on carbon fiber reinforced PEEK prepreg have a potential cost saving of more than 25 %, compared with the use of traditional carbon fiber reinforced epoxy prepreg. The demonstrator tail structure was based on load cases and laminate construction for an existing composite structure, and was developed in a copperative programme between EADS-MAS, Ottobrunn, and the DLR, Institute of Structures and Design, Stuttgart. In a second project, the application of composites within impact endangered areas had been examined in co-operation with DLR and EADS. A new advanced thermoplastic composite slat concept, based on the aerodynamic shape of an aluminium A340 outer slat, had been developed with the aim of minimizing weight and manufacturing costs. The verification of the impact performance for high performance thermoplastic materials had been demonstrated as well as the possibility of manufacturing skins of complex geometry using out-of-autoclave manufacturing methods. Several generic and two full scale thermoplastic demonstrators were manufactured using endless fibre reinforced UD CF-PEEK.

KM

# SUPERPLASTIC FLOW IN 7XXX ALUMINIUM PM ALLOY

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Tensile tests were conducted on a superplastic aluminum 7xxx alloy in the temperature range 490–530 °C and strain-rates $10^{-5}$ to $10^{-1}$ $s^{-1}$. The objective of the paper was to examine the possible rate controlling mechanisms that govern superplastic deformation. The values of strain-rate sensitivity, activation energy and microstructural observations indicate that deformation is rate- controlled by lattice diffusion. Comparing with theoretical models, deformation mechanism for superplastic flow is ascribed to grain boundary sliding accommodated by dislocation slip. However, at low stresses, deformation behavior is attributed to the existence of threshold stress which strongly depends on temperature. The origin of threshold stress is discussed in terms of dislocation interaction with grain-boundary particles.

KM

## REACTIVE SINTERING PRODUCTION OF INTERMETALLICS

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Intermetallic phases offer a large variety of interesting properties as high-temperature oxidation resistance, creep resistance, special magnetic properties, shape memory or the ability to store hydrogen reversibly. However, the practical utilization of this group of materials is very limited due to problematic production. Casting is commonly applied to produce many of these materials, even though there are strong limitations of this technology as high melting points and poor casting properties. Powder metallurgy involving the reactive sintering of compressed mixtures of elemental powders is one of the promising alternative production routes. In this work, the preparation of several technically important intermetallics was tested. Aluminide- and silicide-based high temperature materials and NiTi shape memory alloys were successfully produced by this technique.

KM

AN INVESTIGATION ON THE AGING BEHAVIOR OF THE FUNCTIONALLY GRADIENT MATERIAL CONSISTING OF BORON CARBIDE AND ALUMINUM ALLOY

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In the current study, the effect of different temperatures on the aging behavior of a functionally gradient material was investigated to see the variation of hardness with respect to aging time. To do this, the Functionally Gradient Material (FGM) specimens, containing boron carbide and aluminum alloy, were produced via hot pressing. Three different layers were used in the FGM samples. And then, macro and micro examinations were carried out to observe interface between layers, porosity, grain size and probable cracks in these samples. After that, the specimens were solutionized at 590 °C for 20 minutes. Next, the artificial aging at 100 °C, 120 °C and 150 °C for 96 h was applied to the FGM specimens. During the aging treatment, the Brinell hardness measurements were taken on the samples every 30 minutes. Moreover, three-point bending tests were also carried out to clarify the influence of aging treatment on the strength of the FGM. Experimental results indicated that the highest hardness values were reached at 120 °C for the aging period of 48–65 h. And also, the aged specimens exhibited higher bending strength compared to solutionized ones.

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NN

# NUMERICAL STUDY OF HEAT TRANSFER ENHANCEMENT OF HOMOGENEOUS WATER-Au NANOFLUIDS UNDER NATURAL CONVECTION

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Numerical analysis is performed to examine the heat transfer enhancement of colloidal dispersions of Au nanoparticles in water (Au nanofluids). The analysis uses a two-dimensional enclosure under natural convection heat transfer conditions and considers a range of Rayleigh numbers. The enclosure was subjected to a constant and uniform temperature at the left thick wall, generating a natural convection flow. The thicknesses of the other boundaries are assumed to be zero. The right wall is kept at a low constant temperature, while the horizontal walls are assumed to be adiabatic. The study has been carried out for the Rayleigh number in the range $10^3 \leq Ra\ 10^5$, and for the Au nanoparticlesž volume fraction range $0 \leq \varphi \leq 0{,}1$.

The governing equations of such a flow are solved with the standard finite-volume method and the hydrodynamic and thermal fields are coupled together using the Boussinesq approximation. Grid refinement study is performed in order to obtain the mesh independent and to assess the numerical accuracy of the numerical results, while the numerical approach is validated with comparison of the present results with the results of other author authors.

Highly accurate numerical results are presented in the form of streamlines, isotherms, average Nusselt number and heat transfer enhancement. The results obtained from numerical modelling indicate clearly that the average Nusselt number is an increasing function of both, Rayleigh number and volume fraction of Au nanoparticles. The results also indicate that heat transfer enhancement is possible using nanofluids in comparison to conventional fluids, resulting in the compactness of many industrial devices. However, low Rayleigh numbers show more enhancement compared to high Rayleigh numbers.

KM

# DIGITAL IMAGINING ANALYSIS OF MICROSTRUCTURES AS A TOOL TO IDENTIFY LOCAL PLASTIC DEFORMATION

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This paper presents a methodology to detect plastic deformation on micro level. The analysis based on statistical data describing the morphological and crystallographic textures of a sample microstructure, obtained from an optical microscopy using digital imaging analysis. Important parameters necessary to describe a microstructure were identified as grain size and grain orientation distributions. Change in weighted product of these two parameters, grain size as area of grain and grain orientation as moment of inertia of grain can represent a measure to identify plastic deformation on small area. Demonstration of applicability was performed on a real object as part of failure analysis of ruptured pipe in thermal power plant boiler. Presented analysis leads to the fast identification of the local plastic deformation and in a case of periodical analysis of the same sample can even be used as a measure to identify creeping.

KM

# BATCH FILLING SCHEDULING AND GENETIC ALGORITHM

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Štore Steel ltd faces a problem of production of a huge amount (approximately 1400) of different steel compositions in a relatively small quantities (approximately 15 tons). This production is performed in batches of predetermined quantities (50–53 tons). The purpose of this paper is to present the methodology for optimizing the production of predetermined steel grades in predetermined quantities before a customer's set deadline in such a way as to reduce the non-planned and ordered quantities with the date before the deadline and minimize the number of batches. The genetic algorithm method was used for the optimization. The results of the research have been used in practice since 2006 with reducing the non-planned and ordered quantities from 17.17 % up to 10.12 %.

KM

# NUMERICAL AND EXPERIMENTAL INVESTIGATION OF TEMPERATURE FIELD OF SOLIDIFYING MASSIVE DUCTILE-CAST-IRON ROLLER

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The quality of the working rollers used for rolling rails of different profiles is determined by the chemical and structural composition of the material of the rollers and the production technology The requirements of the quality cannot be ensured without perfect knowledge of the course of solidification, cooling and heat treatment of the cast rollers as well as the kinetics of the temperature field of the casting and mould. The solidification and cooling of ductile-cast-iron roller in metal and non-metal mold is a very complicated problem of heat and mass transfer with a phase and structural changes described by the Fourier equation. An original application of ANSYS simulated the forming of the temperature field of the entire system comprising the casting, the mold and ambient. The simulation of the release of the latent heats of phase or structural changes is carried out by introducing the thermodynamic enthalpy function. In the experimental investigation of temperature field, an original methodology for the measurement of the distribution of temperatures and heat flows in the roller-mould system had been developed and verified in the operation. In the design of the original procedure, there were a number of problems connected with the great size of the roller and mould, uneven dilatation of the solidifying roller and mould, the installation and insulation of the thermocouples, the wiring of the thermocouple system, etc. The findings regarding the kinetics of the temperature field of the roller and mould, obtained from experimental research, were used for determining the boundary conditions and for the verification of the numerical simulation program. The calculation of the temperature field focused on the analysis of the effect of the mould separator on the course of solidification of the roller. The results of the mathematical modelling indicate that the distribution of temperatures and the solidification in the vertical direction is significantly uneven – this has an effect on the internal quality of the casting.

KM

# THERMODYNAMIC ANALYSIS OF NON-METALLIC INCLUSIONS FORMATION DURING THE C45 STEEL PRODUCTION

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C45 steel belongs to carbon steels and it is used in normalized and tempered state for heavy stressed parts in automobile industry. Nowadays a major problem in steelmaking are non-metallic inclusions, which can form at different steps of steelmaking process and are detrimental for mechanical properties of steel. With this diploma work we have tried to determine at which steps of steelmaking process non-metallic inclusions are formed. Samples were taken from three different steps of steelmaking process, from electric arc furnace, from ladle furnace and from tundish. A chemical analysis was made on the samples. The results were used for thermodynamic simulation with Thermo-Calc. Other samples were prepared from another simultaneously taken probe and were partly subject to differential scanning calorimetry (DSC) and partly metalographicaly prepared and pictures were taken with light microscope, from which a phase composition was calculated. Non-metallic inclusions in our samples were analyzed with EDS – pictures were taken and point and mapping analysis were made on them. We have found out that in our C45 steel sample, spinel ($MgO \cdot Al_2O_3$) and aluminate ($Al_2O_3$) inclusion can be found at the end of the ladle furnace treatment. In the tundish sample only small aluminate and spinel inclusions and a lot of MnS inclusions were found.

KM

# SETTING OF NUMERICAL SIMULATION OF FILLING AND SOLIDIFICATION OF HEAVY STEEL INGOT BASED ON REAL CASTING CONDITIONS

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The paper devotes to new experiences with setting of numerical simulation of filling and solidification of 90-ton heavy steel ingot in the simulation program ProCAST. The aim of numerical modelling realized under conditions of the Department of Metallurgy at VSB-TU Ostrava is the verification and optimization of production technology of heavy steel ingots produced in VÍTKOVICE HEAVY MACHINERY a.s. Input parameters of computation were determined by the real conditions of casting of 90-ton steel ingot. The ingot geometry was created in CAD system SolidWorks. Before the computational grid generation of finite elements in module Visual-Mesh, the geometry was subjected to analysis of the topology. Material properties of the individual components of ingot casting system were defined by Computherm calculating module, by selecting materials from its own database of ProCast. Also the thermodynamic properties were determined using datasheets of refractory materials of manufacturer and finally checked by calculating of the equations generally used to determine liquidus and solidus temperatures, density and enthalpy etc. Boundary conditions and heat transfer were defined. In parallel with the numerical simulation, the operational experimental casting of 90-ton ingot was carried out. To obtain more complete information about the temperature fields of the ingot casting system and obtaining of data about the values of heat flow, the process of filling and solidification was monitored using thermal imaging cameras. The conclusion summarizes the main knowledge of the primary results of the computation and presents a direction of further research.

KM

# PHYSICAL REGULARITIES IN CRACKING OF NANOCOATINGS AND THE METHOD FOR AUTOMATED DETERMINATION OF CRACK NETWORK PARAMETERS

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The regularities and spatial distribution of multiple cracking of a nanocoating are investigated. It is found out that in the zones of cracking the relaxation of stresses, which accumulate in the coating, takes place; moreover, the intensity of its failure is determined by the structural level of defect accumulation. A new algorithm for digital identification of the elements of a network of cracks in a nanocoating is proposed, and its adequacy is checked.

KM

# CONTENT Cr AND Cr (VI) IN PARTICLES OF FUME FROM WELDING DEPENDING ON Cr CONTENT IN EXPERIMENTAL COATING Cr-Ni RUTILE ELECTRODE

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In the process of welding SMAW process, generated by the welding fumes harmful to human health and the environment, welding fume is a mixture of gaseous and solid phases, which are to a greater or lesser extent, generate the majority of the electric arc welding processes. The researches related to the particles that constitute the solid phase welding fumes. By changing the chemical composition of the electrode and its components (coating and core) can affect the chemical composition of particles of welding fumes. The largest amount of welding fumes are generated from the coating electrodes in value about 80% and is therefore the focus of research was the influence of chemical composition of electrode compresses the chemical composition of welding fumes particles, and this paper presents research results obtained for the content of Cr and Cr(VI) oxide particles in welding fumes. In experimental purposes was made six variants of commercial electrodes E 23 12 2 LR 12 welding chamber, collecting particles of welding fumes and chemical analysis of particles were carried out according to standard EN15011. In addition to satisfying the characteristics of the experimental welding electrodes should generate welding fumes particles which contain the lowest percentage content of Cr and Cr(VI) oxide.

KM

# MICROSTRUCTUAL CHANGES IN SUB_ZERO PROCESSED VANADIS 6 P/M LEDEBURITIC TOOL STEEL

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Specimens made from P/M Vanadis 6 cold work steel were austenitized, quenched and tempered at various combinations of parameters. For selected sets of samples, also sub-zero period, performed at the temperatures of -90 °C and -196 °C, respectively, and different processing dwell times was included between quenching and tempering. The microstructure has been investigated as a function of austenitizing temperature, parameters of sub-zero processing and tempering, using the light microscopy, transmission electron microscopy (TEM) high resolution transmission electron microscopy (HRTEM) and X-ray diffraction. It has been found that as-quenched microstructure is composed of martensite, retained austenite and carbides. Sub-zero processing reduced the amount of retained austenite and led to an increase of tetragonality of the martensitic lattice. As a result, the hardness of the material was higher by 2 HRC before tempering. HRTEM observations revealed a lot of nano-particles in the microstructure after sub-zero processing. Tempering of the material induced different behaviour of the no-sub-zero and sub-zero processed steel. Generally, the no-sub-zero processed steel had higher hardness than that sub-zero processed. We assume that it is: firstly the occurrence of high number of nano-particles and secondly lower portion of retained austenite that make a worsening of secondary hardenability of the material. It seems to be logical because the secondary hardenability can be considered as a complex effect of tempering of the martensite (hardness decrease), transformation of retained austenite to the martensite (hardness increase) and carbides precipitation (hardness increase). Based on the facts that the sub-zero processed steel contained lower retained austenite portion and great number of nano-precipitates, we expect it's lower capability to manifest the secondary hardening effect.

KM

## THERMAL STABILITY OF Al-Mn-Be MELT-SPUN RIBBONS

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As other kinds of fine dispersed small particles also the icosahedral quasicrystals (IQCs) have a distinct strengthening effect, which can be utilised to enhance mechanical properties of aluminium alloys. In Al–Mn–Be alloys IQCs can form already at moderate cooling rates, which can be realised at some conventional casting processes like mould casting or injection casting, but in this case also crystalline intermetallic phases are present and the mechanical properties are inferior to those of two-phase (Al-matrix + IQC) alloys. Two-phase microstructures are feasible with rapid solidification techniques, e.g. melt spinning. Further processing often involves technologies (consolidation, extrusion...) which include influence of heat. In order to preserve the strengthening effect of metastable IQC-particles, the alloy must not be overheated. In the present research the Al-Mn-Be alloy was melt-spun on a free jet melt spinner. Subsequently the thermal stability of IQCs was explored by annealing the ribbons for 24 hours at different temperatures. The samples were examined in as-cast and heat treated condition by SEM-FIB, TEM (bright field and electron diffraction), XRD and DSC. It was found, that in the as-cast condition the ribbons had two-phase microstructure, consisting of Al-matrix and fine dispersed IQCs. During annealing at temperatures up to 400 °C decomposition of IQCs did not start and the phase composition remained unchanged. Annealing at 500 °C and higher temperatures caused decomposition of IQCs, and afterwards only crystalline intermetallic phases Al6Mn and Be4AlMn could be found in the Al-matrix.

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# CHARACTERIZATION OF CLOSED-CELL STRUCTURE OF ALUMINIUM FOAM USING TEM AND STEM

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Aluminium foams with closed-cell structure, one of the lightest engineered materials, are manufactured with different foaming agents that are gas releasing substances. Closed-cell structure has high impact energy absorption which is a very important mechanical property in military and car industry.
The specimen of closed-cell structure of aluminium foam was manufactured from air-atomized Al powder (purity of 99.7 %, particle size $D_{50}$ of 106 μm) and mass fraction of 1 % $TiH_2$ (purity of 98 %, particle size $D_{50}$ of 14 μm) as a foaming agent. Both powders were mixed in a turbular mixer for 1 hour, isostatically cold-pressed and sintered in air at 750 °C for 5 min and 20 s. Thin foil specimen of sintered aluminium foam was prepared by means of argon ion-slicing with JEOL EM-09100IS Ion Slicer and further analyzed by TEM (Jeol JEM-2100) at 200 kV using conventional transmission electron microscopy (CTEM), high-resolution TEM (HRTEM), energy dispersive X-ray spectroscopy (EDXS, Jeol JED-2300 Series), electron diffraction and scanning transmission electron microscopy (STEM) with bright- (BF) and dark-field (DF) detectors, and EDXS mapping.
The study focused on the analysis of cell walls. Detailed characterization of the microstructure was performed on thin section specimens and electron diffraction method was used to carry out the microstructure–crystallographic analysis of the phases. At least two oxide layers with different ratios of aluminium and oxygen appeared at the interface aluminium-pore. The thickness of both the layers was around 1–2 μm.

NN

# CHARACTERIZATION OF INDIVIDUAL $BaTiO_3$ NANORODS AND THEIR ASSESSMENT AS BUILDING-BLOCKS OF NEW CIRCUIT ARCHITECTURES

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One-dimensional $BaTiO_3$ nanostructures in the form of nanorods are a potential candidate for energy-harvester systems and sensors. In order to explore possible potential applications of $BaTiO_3$ nanostructures, we report on the template-assisted growth and the structural characterization of $BaTiO_3$ nanorods, the prototyping of functional devices based on them, and the preliminary assessment of their electrical performances.

For the electrophoretic deposition method of a stoichiometric $BaTiO_3$ sol into the anodic aluminium oxide (AAO) template, a potential of 30 V was applied between the AAO/Al working electrode and counter electrode. Afterwards samples were annealed at 700 °C for 1 h with subsequent template removal. Resulting $BaTiO_3$ nanorods were characterized by electron microscopy techniques. To study electrical properties, $BaTiO_3$ nanorod devices were fabricated by focused ion beam nanolithography techniques using $[(CH_3)_3CH_3C_5H_4Pt]$ injector to deposit platinum.

Obtained $BaTiO_3$ nanorods had diameters ranging from 150 to 200 nm, with an average length of 10-25 μm. The $BaTiO_3$ nanorods were always polycrystalline and composed of well-crystallized nanosized $BaTiO_3$ grains with a pseudo-cubic structure and grain sizes ranging from 20 to 50 nm. A high-temperature hexagonal $BaTiO_3$ polymorph, that was observed as intergrowth of more or less ordered sequences of (111) twins with the perovskite matrix, was present as a minor phase. Its formation was triggered by reduction of $Ti^{4+}$ to $Ti^{3+}$ as a consequence of the local reducing environment, due to the decomposition of the organic precursors during the annealing process. For the electrical characterization the prototype device was formed by integration of individual $BaTiO_3$ nanorod into simple circuit architecture. Four-probe electrical measurements performed on individual $BaTiO_3$ nanorods revealed the resistivity values between 10 and 100 ohm·cm, which corresponds to typical values for oxygen-deficient $BaTiO_3$. The measurements of electrical resistivity of single nanorods in varying humidity environment showed reproducible response, thus demonstrating that $BaTiO_3$ nanorods can be integrated in more complex circuit architectures with functional capacities of a humidity nano-sensor.

KM

# USING DIFFERENT PEAKS OF THE SAME ELEMENT IN THE QUANTIFICATION PROCESS OF AES SPECTRA

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Often when measuring spectra in Auger electron spectroscopy, elements with more than one Auger peak close to each other may be present in the sample. These peaks appear as a result of more than one transition occurring in the atoms of a certain type of element.
These transitions have different probabilities of occurring, i.e. they have different cross sections. In our work we wanted to compare the results of compositional determination, given in at %, when quantification is done using different peaks of the same element. Since we aim in the long run to automate the processing of the Auger spectra, which includes peak recognition and quantification, it is important for us to decide which peaks we should use in such a process. We believe that this work will provide some answers.

KM

# CHARACTERIZATION OF DEFECTS IN PVD TiAlN HARD COATINGS

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Hard coatings play a continuously increasing role in the field of tribology as well as in the field of decorative applications. In both areas, they are often exposed to corrosive environments. While hard coatings possess inherently high corrosion resistance, hard coating–substrate systems may suffer from a severe corrosion attack due to the defects in the coating structure resulting from the PVD-typical film morphology. Morphology consists of macro and micro defects. On sites where the defects reach the substrate, pitting corrosion can take place. In contrast to a huge number of investigations on the morphology, structure and properties of hard coatings, only a limited number of studies tried to solve the question regarding the formation of a defect at a specific location, and whether it such a defect causes pitting corrosion. Thus this topic remains very important for further investigations from scientific and technological reasons, and it was our main goal to make a contribution to answering this question by microstructural characterization and 3D-reconstruction of defects. A PVD TiAlN hard coating was prepared on D2 tool steel substrates by sputtering using unbalanced magnetron sources. The growth defects incorporated into the coating were studied after deposition and corrosion experiments. We used several methods: light microscopy (LM) for general overview of the layer, scanning electron microscopy (SEM) for 2D-characterization and scanning electron microscopy with focused ion beam (SEM-FIB) with serial cross sections over the defect for 3D-characterization. It was found by analysing several sites that defects often form on foreign external particles attached to the substrate, and between large carbide inclusions in steel. The growth defects formed on the latter sites represent preferential places for pitting corrosion.

KM

# INFLUENCE OF WATER TEMPERATURE ON COOLING INTENSITY OF MIST NOZZLES IN CONTINUOUS CASTING

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Small mist nozzles used in continuous casting were tested for heat transfer intensity. These nozzles are used in secondary cooling area of a steel slab casting machine. Impact pressure distribution was measured first. Laboratory measurements of cooling intensity (heat transfer coefficient distribution) were conducted with a variable water temperature. A temperature range from 20 °C to 80 °C was used in the tests.

Surprisingly, a high influence of water temperature was found. The major effect is a shift of the Leidenfrost temperature to low temperatures. Changing of the water temperature from 20 °C to 80 °C caused a change of Leidenfrost temperature of 130 °C. This can be significant and can change the cooling character in continuous casting machine. Interesting is an increase of the cooling intensity with a growing water temperature in a high temperature region (above Leidenfrost temperature). The difference is small about 30 $W/m^2K$.

Surprisingly high differences in Leidenfrost temperature were found for an intensive cooling where a difference of only 20 °C in the coolant temperature makes a difference of about 100 °C in Leidenfrost temperature.

The results of the experiments performed with elevated water temperature showed a high sensitivity of the cooling intensity to this parameter. The decreasing effect of the cooling intensity with the water temperature is more important for spray cooling of high intensities.

KM

# THERMODYNAMICS OF LIQUID Al-Sb-Zn ALLOYS

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Measurements and modeling of thermodynamic properties of liquid and solid alloys are important for optimization of the existing phase diagrams. For the calculation of the phase diagrams the CALPHAD method was used with the SSOL4 thermodynamic database. In Al-Sb-Zn ternary system no experimental thermodynamic integral mixing data exists, to our best knowledge. Based on the Calvet type micro-calorimeter and thermodynamic analysis method developed by Oelsen, the mixing properties were obtained in the near binary Al-Zn and Sb-Zn system. For the modeling part of liquid phase, the determination of excess Gibbs energy was done with the Redlich-Kister formulation on several models at 1350 K: general solution model, Toop model and Muggianu et al. The experimentally determined mixing enthalpies at 1080 K were compared with the calculations done using SSOL4 database and General solution model. Rather good agreement was found between modeling and experimental part.

KM

## FATIGUE LIFE BEHAVIOUR AND LIFETIME ASSESSMENT OF DOUBLE-LEAF SPRING USING FEM SOFTWARE

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The lifetime assessment of any component by performing classical fatigue tests on real geometry is very expensive and time consuming task. For that reason, many efforts have been made to produce a computer software which will be able to replace these conventional fatigue testings. Although, there are some dissimilarities between these two testing methods, we are free to use such computer tool to decrease the testing time. Finite Element Method (FEM) is one of the most frequently used methods for component designing as well as for fatigue assessment. This assessment consists of: stresses, loads and strength behavior of the material component. As a input value for the material properties S/N curves were defined which are based on test results. Fatigue tests on notched as well as unnotched specimens under compression-tension loading were carried out in order to obtain the S/N curves of investigated spring steel. Two groups of specimens were prepared: longitudinal and perpendicular relative to the rolling direction, both with two different tempering temperature.
The results of the performed investigation showed a clear difference between the fatigue strength of specimens with two outmost segregation orientations as well as specimens with two different tempering temperatures. Also, other influences such as residual stresses due to shoot peening and machining, surface roughness, metallurgical variables can affect the fatigue strength of material. All these effects will be taken into account in further investigation using a FEM software.

KM

# WEAR RESISTANT INTERMETALLIC ARC SPRAY COATINGS

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Arc spraying is a commonly used coating technique in which single or dual wires of either similar or dissimilar materials are melted, atomized, and subsequently deposited on a pretreated surface to build up a metallic coating. The preparation of intermetallic alloys using two dissimilar wires is rather difficult because of the different melting points of the wires. In this study, an arc-sprayed Cu-Al composite coating obtained by using a twin-wire arc-spraying system with the Al and Cu wires fed synchronously was investigated. These intermetallic coatings are discussed and their coating characteristics, antiwear properties, and corrosion resistance performance are compared to those of pure Cu- and Al-sprayed coatings.

KM

# A FUZZY-BASED OPTIMAL CONTROL ALGORITHM FOR CONTINUOUS CASTING PROCESS

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Nowadays continuous casting is used for providing almost one hundred percent of liquid steel into an intermediate shape. A wide range of steel grades is continuously cast with high-quality achievements, because steel with poor structure and many defects is not acceptable for the final customers. The solidifying slab, during its pass through the caster, is subjected to variable thermal conditions and mechanical loading, both of which contribute to the material stresses and strains, the main sources of the defects. Many serious defects might be eliminated by simulation, optimization and subsequent control of the casting process. This paper describes an algorithm for obtaining such control parameters which ensure high production rate and high quality of products as well. The main idea of the algorithm is to keep surface and core temperatures in the specific ranges corresponding with ductility of steel. The core of the algorithm is our original two-dimensional numerical model designed for simulation of temperature field on real caster geometry. The phase and structural changes, during the process of solidification, are modeled by enthalpy computed from the chemical composition of the steel by using solidification analysis package IDS. The optimization part is performed by our fuzzy-regulation algorithm which provides a robust way for dealing with instability of the thermomechanical processes. The factors for controlling the cast process are casting speed and cooling intensities in the secondary cooling zone. Their proper setting is crucial for achieving high-quality products in short time and therefore for economical price.

KM

# ASSESSMENT OF RESIDUAL LIFE TIME FOR CREEP RESSISTANT STEELS AT THERMAL POWER PLANTS

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Steels used in thermal power plants are exposed to elevated temperatures and high pressures, what causes the change in microstructure and thermo-mechanical properties. With aim to determine the properties of steels after certain period of operation, thermo-mechanical investigations and microstructure characterization were made and results of this investigation serve for remaining life-time assessment of steels. From economic and technological point of view these is very important information. Creep is one of the major mechanisms which causes deformation and degradation of steels at elevated temperatures. Creep can occur in local areas due to increased load (short-term overheating, reducing the pipe wall thickness), or due to microstructural degradation during prolonged operation of the steel at elevated temperatures. This is the reason for the reduction of mechanical properties of steel, especially resistance to deformation by creep. Microstructure degradation of the steels (spheroidisation of carbides in pearlite, formation of nitride and carbide precipitations in ferrite, carbide grains on grain boundaries, growth of carbide grains, micro pores and micro cracks formation) can be defined by microstructural investigations on metallographic samples or replicas. Microstructures and the assessment of their conditions of some steels used in Slovenian thermal power plants (15Mo3 10CrMo910, 13CrMo44, X20CrMoV121, GS21CrMoV511) after a long operation are presented.

KM

# THE MICROSTRUCTURE AND PROPERTIES IN WELD JOINTS OF CREEP-RESISTANT STEELS

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Research on high chromium ferritic materials for high temperature power plant components generally concentrates on the properties of the parent steel. Weldments, however, are often the weak link, leading to premature failures and associated forced outages and high maintenance spend. Clearly, consideration of the creep performance of weld metals and associated heat-affected zones (HAZs) in these materials is important. Despite this, relevant weldment creep rupture data are not commonly available, and weldment creep rupture "strength reduction factors" are not always known. This seminar provides comment on the available information on parent materials, and highlights the need for the assessment of the creep performance of weldments. Strategies for increasing HAZ creep rupture strength are reviewed, and some available weldment data are considered. Less conventional welding processes (GTA/TIG variants and EB welding) appear to provide improved creep performance of weldments. They therefore merit further study, and should be considered for welding the new steel grades, particularly in supercritical and ultra-supercritical applications.

KM

# Fe-Pd BASED NANOSTRUCTURES SYNTHESIZED WITH THE ELECTRODEPOSITION METHOD

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Nanostructures, with an ordered L10 structure, such as Fe50Pd50 based nanostructures, have attracted a lot of attention, due to the high uniaxial anisotropy, which makes them a promising material for magnetic data storage applications. In this study equiatomic thin films and nanowires were successfully synthesized using the electrodeposition method from the citrate based bath. 1. Thin films: The electrodeposition process was analyzed using cyclic voltammetry measurements. The citrate and ammonia were used as complexing agents. The deposition of palladium was found to start at potential –0.6 V measured against SSCE and was followed by a two step reduction of iron at potentials –0.9 V and at –1.0V. From the potential lower than –0.8 V there is a co-deposition of hydrogen observed, which is catalyzed by palladium and contributes to the surface roughness. Fe50Pd50 thin films with the thickness of 200 nm were deposited at –1.2 V and then annealed in forming gas (Ar + 7% $H_2$) at 400 °C, 500 °C and 600 °C for 1h. The highest coercivity was found 870 Oe for thin films annealed at 400 °C due to the ordering into the L10 structure observed with the XRD. 2.Nanowires: FePd-based nanowires were prepared via template-assisted electrodeposition method into self-assembled anodic alumina templates with the pore diameter 200 nm and pore length 60 μm. In this process the diffusion is slow and kinetics is very fast, therefore the deposition at constant potential leads to formation of dendrite like structures. To increase the diffusion rate the concentration of metal ions was increased up to 3 times and the dendrites-like structures were successfully avoided. However, the nanowires were still not completely homogenous and fully dense. To improve the homogeneity pulse plating method was used. We have investigated the number of pulses, the applied potential – $E_{on}$, and $E_{off}$ and the time $t_{on}$ and $t_{off}$. With this method fully dense and homogeneous nanowires of different stoichiometries were synthesised.

KM

## INVESTIGATIONS OF MECHANICAL PROPERTIES OF CF-8A STAINLESS STEEL

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We investigated the mechanical properties of CF-8A cast stainless steel before and after different periods of ageing. This is low-carbon Cr-Ni-based austenitic stainless steel with some amount of delta ferrite in the structure. This material can also be called duplex, because of its two-phase (austenite-ferrite) microstructure. It is used in thermo-energetic installations. Long-term exposure to high temperatures causes material degradation, thermal embrittlement, decrease of toughness and eventually cracks. Three different alloys were made, with different delta ferrite contents, 3.3, 13.3 and 28 vol.% of delta ferrite in the structure. Alloys were aged for one year on two different ageing temperatures, 290 °C and 350 °C. Mechanical tests which are performed were tensile test, Vickers hardness test and Charpy impact toughness test. The goal was to determine the influence of delta ferrite content, time and temperature of ageing on mechanical properties of the CF-8A steel after long-term exposure to high temperatures. On the basis of results obtained here it will be possible to understand more clearly under what conditions and when thermal embrittlement of the vital parts in power plants occurs.

KM

## STACKING FAULTS AND TWIN BOUNDARIES IN PYRITE ($FeS_2$)

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Pyrite ($FeS_2$) crystalizes in face-centred cubic structure, which can be derived from rock-salt structure if anions are replaced by $S_2$ doublets with their axes oriented equally along the 111 cube directions. The coordination polyhedra around Fe atoms are distorted octahedra, sharing common corners. Each S atom is thus coordinated by three Fe and one S atom in a distorted tetrahedral configuration. Pyrite is dimorphous with marcasite, an orthorhombic iron sulphide, with linear chains of edge-sharing octahedra running parallel to the orthorhombic c-axis. In the present study we used natural twinned crystals of pyrite from Katarina Mountain near Ljubljana (central Slovenia). (001) cross-sections were cut from the central parts of the crystals, mounted in brass ring, thinned and ion milled for TEM observations. The most common type of planar defects are stacking faults laying in {010} planes and twin boundaries extending in 110 and 010 planes. In order to solve the structure of the observed planar faults atomic models were constructed based on the translational conditions measured from experimental HRTEM images and crystal chemistry principles that must be obeyed in this structure type. Using experimental imaging conditions HRTEM images were simulated and correlated with the experimental images. {010} stacking faults were interpreted as a monolayer of marcasite structure in pyrite matrix. For {110} twin boundaries we prepared two different structure models with experimentally observed translational state between the two blocks of the twin, however with different local atomic arrangement. To resolve the local atomic structure of {110} twin boundaries atomic resolution HAADF-STEM and suitable analytical methods will be employed in future work.

KM

# HRAES DETERMINATION OF COMPLEX INCLUSIONS IN SPRING STEEL

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In order to determine the characterization of inclusion in steel in terms of size, shape, and chemical composition in spring steel (51CrV4) auger analysis were performed using a high resolution scanning auger electron microscope and auger electron spectroscopy. In complex inclusions the presence of aluminum, magnesium sulphur, calcium, and titanium was detected. Inclusions were present in variety of morphologies which depends on their crystallographic structure, the growth conditions and the presence of impurities.

KM

# SURFACE ROUGHNESS AFFECTS ADHESION OF BACTERIA AND BIOFILMS FORMATION ON AUSTENIC STAINLESS STEEL (AISI 316L)

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Stainless steel is most commonly used material for construction of vessels, pipes, valves, medical and food processing equipment. The presence of bacteria on the surface is enhancing corrosion of material and presents chronic source of microbial contamination in food and medical industries. Bacterial adhesion to material is governed by physicochemical interactions. The aim of our research is to examine the effect of surface roughness and topography of austenitic stainless steel (AISI 316L) on adhesion of bacteria. By using different grinding papers we created surface finishes corresponding to different roughness (Ra) values. The surface morphology of the samples was analysed by atomic force microscope (AFM), scanning electron microscope (SEM) and contact profilometer. Then we tested adhesion of bacteria (Escherichia coli (Exb-V1)) to different surfaces. Based on the literature data conflict results about roughness and adhesion are reported, which indicates that also surface topography plays a role in bacterial adhesion. We hypothesized that surface roughness ranging from 0.05 μm to 0.5 μm and furrows of similar size as bacteria or smaller will affect bacterial adhesion. So far, it was shown that the bacteria prefer cracks and scratches over smooth surfaces to attach.

NN

# RECENT PROGRESS IN THE THEORY OF SURFACE EVOLUTION INDUCED BY ION IRRADIATION

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A detailed knowledge of surface evolution during ion sputtering is important for further progress in a number of applications in industry and laboratory. The theory of ion sputtering was built starting with energy deposition in the bulk material after ion impact leading to sputtering when enough energy is deposited at the surface. This was followed by the dependence of the sputtering yield on the local curvature of the surface and the influence of diffusion on the surface evolution. The theory is reasonably successful, but mainly for amorphous substrates. With the increasing number of experiments and a detailed study of the theory over the years it became increasingly clear that the general model of ion-beam sputtering reached a limit. A new outlook was needed and material redistribution induced by ion-beam sputtering has recently replaced the energy dissipation as the foundation for the theory of sputtering.

NN

## ELECTROPHORETIC DEPOSITION OF DyF3 ON Nd-Fe-B SINTERED MAGNETS

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The increased use of Nd-Fe-B magnets in the motors of electric vehicles is hampered by their relatively poor high-temperature performance. In such automotive applications it is necessary for the magnets to operate for long periods at temperatures up to 150 °C. With any rare-earth transition-metal magnet there are basically two possibilities when it comes to developing coercivity at high temperatures: either we improve the intrinsic temperature dependence of the materials, or we develop sufficient coercivity at room temperature so that enough coercivity remains when the magnet is exposed to high temperatures. Unfortunately, the intrinsic properties of Nd-Fe-B are very difficult to change; however, the addition of heavy rare earths such as Dy and Tb in place of the Nd can make substantial improvements to the coercivity, as a result of an increased magnetocrystalline anisotropy field (HA), relatively easily. Of course, the disadvantage of adding heavy rare earths is that they couple anti-ferromagnetically with the Fe in the RE2Fe14B lattice, leading to much reduced levels of saturation. In a novel process to enhance the coercivity we have electrophoretically deposited DyF3 powder onto the surface of an as-sintered Nd-Fe-B magnet as the initial step in the grain-boundary diffusion process. After a conventional heat treatment at 850 and 500 °C the coercivities were better than in the case of simple dipping after a typical 10 hours. The electrophoretic deposition (EPD) process is quick, reliable, easily controllable in terms thickness and can be used to deposit the rare-earth fluoride powder on the surface of complex and irregularly shaped magnets. Since the amount of deposited powder can be tailored to maximise the coercivity while minimising the quantity of expensive heavy rare earth there is no wasted powder, making the process more environmentally friendly and potentially cheaper than conventional dipping.

NN

# SOLUTION DERIVED LEAD-FREE $(K_{0,5}Na_{0,5})NbO_3$ THIN FILMS: COMPOSITIONAL AND STRUCTURAL STUDY

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$(K_{0,5}Na_{0,5})NbO_3$ or KNN is a promising lead free piezoelectric material which could replace lead based perovskites. The major problem encountered during processing of KNN thin films is volatilisation of alkali compounds, which hinders the control over the composition and contributes to a major reduction of its functional properties. In Chemical Solution Deposition of thin films, the alkali losses can be compensated by adding alkali excess to the starting solution. Based on the reports in the literature, the alkali excess may not be needed or it ranges up to 10 % to as much as 20 %, depending on the synthesis, deposition and further heating conditions. The composition of the alkali excess varies from either Na-rich or Na- and K- in equal fractions.

The aim of our work was to find the optimal type and amount of alkali excess that would compensate the expected alkali losses. We deposited the KNN thin films from alkoxide based solutions with different Na/K/Nb ratios: 0.6/0.5/1, 0.55/0.5/1, 0.5/0.5/1, 0.5/0.55/1 and 0.5/0.6/1.

Upon heating at 750 °C all films crystallize in pure perovskite phase. The grain size in the films prepared from the stoichiometric and 5 mole % alkali excess solutions is about 50 nm while it is about 200 nm in the films prepared from the 10 mole % excess solutions. The about 250 nm thick film prepared from the solution with 5 mole % potassium excess has the chemical composition closest to the stoichiometric composition and the room temperature values of dielectric permittivity, dielectric losses, remnant polarization and coercive field at 1 kHz are 610, 0.015, 8 $\mu C/cm^2$ and 80 kV/cm, respectively.

NN

# SURFACE MODIFICATION OF ORGANIC PIGMENTS FOR PROTECTION AGAINST PHOTOCATALYSIS

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Organic pigments in the surface protection paints offer much wider range of nuances and more profound intensities, but unfortunately, they are incompatible with photocatalytically active materials that can provide the so-called self-cleaning effect. Photocatalysis is based on the use of photocatalysts which, under UV radiation, cause degradation of the nearby organic substances. Namely, the highly reactive photocatalytically-generated species do not only degrade the organic dirt (the primary target of self-cleaning surfaces) but also the nearby organic pigments inside the paint.

The aim of our work was to protect organic pigments against photocatalytic degradation by encapsulation of each individual pigment particle with a transparent nanofilm. As model organic pigment ß – copper phtalo cyanine was selected whereas the encapsulation material was silica. A sol gel reaction with potassium water glass as a precursor was used. The synthesis was optimized by varying appropriate parameters such as temperature (from room temperature to 70 °C) and pH (from pH 8 to pH 10). The films around pigment particles were observed by field emission scanning electron microscopy (FESEM) and transmission electron microscopy (TEM). A fast method for determination of effectiveness of protection against photocatalysis was developed. It was based on the measurement of colour characteristics of a mixture of encapsulated pigment particles and nanoparticles of $TiO_2$ before and after UV radiation. The results showed that the best protection was achieved in the case of pH 8 and the temperature of 70 °C.

KM

# PHOTOCATALYTIC CHARACTERISATION OF RUTILE NANOPARTICLES PREPARED VIA LOW TEMPERATURE SYNTHESIS

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Titanium oxide ($TiO_2$) is a semiconductor which is widely used because of its various application possibilities: self-cleaning and self-sterilizing surfaces, water and air purification devices, anti-fogging mirrors and photovoltaics. $TiO_2$ can be found in three crystal modifications: anatase, rutile and brookite. Eeach phase has its own physical and chemical properties and therefore different functionalities. Photocatalysis has been extensively studied on anatase and rutile nanoparticles. Anatase has higher band gap (3,2 eV) than rutile (3,0 eV), which means that it can activate only in a UV-spectrum whereas rutile activates in the visible one. Nevertheless, anatase has overall better photocatalytic activity in the solar spectrum due to the other properties that have a key role in this process. The first one is the particle size: anatase is the most stable phase for particles below 11 nm, whereas rutile for particles above 35 nm. Photocatalytic activity increases with higher specific surface areas of photocatalysts. Another important photocatalytic factor is the surface hydroxylation of the photocatalyst: if the surface is highly hydroxylated, the substrate can easily get into contact with the photocatalyst and undergo the oxidation reaction. The surface of rutile has lower concentration of hydroxyl groups in comparison to anatase due to higher synthesis temperature (usually above 600 °C). The basic idea is to improve photocatalytic properties of rutile nanoparticles, which could contribute to higher photocatalytic activation in the visible spectrum in comparison to anatase particles. In the present work rutile particles were synthesized with the use of a peroxotitanium complex as a precursor at low temperature and without an additional calcination step. Particles were investigated with different characterization techniques: X-ray diffraction (XRD), UV-Vis spectrophotometry, Fourier transform infrared spectroscopy (FT-IR) and Transmission electron microscopy (TEM). The photocatalytic activity of the samples was measured with the oxidation of caffeine in the presence of UV-Vis illumination.

NN

# NANOCOMPOSITES OF SPINEL ($\gamma$-$Fe_2O_3$) AND HEXAGONAL ($SrFe_{12}O_{19}$) FERRITES

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Magnetic nanoparticles have attracted a lot of attention because of their potential use in different modern medical applications, including contrast enhancement in magnetic resonance imaging, as the active constituents of drug-delivery platforms, and as mediators for magnetic hyperthermia.

For applications in magnetic hyperthermia today, the spinel ferrites magnetite ($Fe_3O_4$) and maghemite ($\gamma$-$Fe_2O_3$) are almost exclusively used as the magnetic-core material. Although their biocompatibility is well established, their magnetic properties cannot be simply adjusted to meet the demands of applications in magnetic hyperthermia. Hexagonal ferrites ($SrFe_{12}O_{19}$, $BaFe_{12}O_{19}$) are believed to exhibit greater heating capacities, but only when a large external AC field is applied. One possible solution to the problem is to prepare core-shell nanocomposite, where the exchange coupling of different magnetic phases – soft-magnetic spinel ferrite and hard-magnetic hexaferrite – would enable adjusting the magnetic properties demanded for magnetic fluid hyperthermia.

The aim of our study was first to develop a strategy for the heterogeneous nucleation of spinel iron oxide on the hexaferrite core nanoparticles by applying the simple precipitation in order to develop a procedure to synthesize nanocomposite particles based on the intergrowth of Sr hexaferrite ($SrFe_{12}O_{19}$) and maghemite ($\gamma$-$Fe_2O_3$).

First, the ultrafine Sr-hexaferrite nanoparticles were hydrothermally synthesized in the presence of oleic acid and subsequently dispersed in hexane to form a stable, non-polar suspension. To prepare them in aqueous suspensions, the adsorbed oleic acid was exchanged with citric acid in a ligand-exchange reaction. The ultrafine Sr-hexaferrite nanoparticles in the form of a stable aqueous suspension were then used as the core nanoparticles for the heterogeneous nucleation of iron oxide in the second step.

The nanocomposite's structures were characterized using high-resolution transmission electron microscopy (HREM) and X-ray diffractometry (XRD). The magnetic properties of the synthesized nanocomposites were measured using a vibrating-sample magnetometer (VSM).

VT

# TESTING OF NON EVAPORABLE GETTER PUMP FOR EXTREMELY HIGH VACUUM CALIBRATION CHAMBER

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In a dynamically pumped vacuum system under the conditions of the molecular flow regime, the equilibrium pressure in the system is proportional to the total gas flow (sum of outgassing. leaks and process gases), and inversely proportional to the available pumping speed. In dynamic expansion calibration systems the known gas flow is injected into the calibration chamber and continuously pumped through an orifice of known conductance. Pumping speed through the orifice is deliberately limited to few tens L/s to retain as close as possible a Maxwellian distribution of gas molecules. It has been accepted on the basis of consensus that the area of the opening in the orifice shall be less than 1/1000 of the inner surface area of the calibration chamber. In such conditions it is possible to calculate calibration pressure in the calibration chamber. In well outgassed »baked« stainless steel vacuum systems the dominant remaining outgassing component is hydrogen, which is generated by diffusion of dissolved hydrogen atoms from the bulk toward surface, where two hydrogen atoms recombine and desorb into vacuum. Our Extremely High Vacuum (XHV) calibration chamber utilizes a Non Evaporable Getter Pumps (NEGP) to reduce hydrogen partial pressure caused by outgassing. NEGP has two remarkable characteristics, one is a large pumping speed for active gases, especially for hydrogen at ambient temperature, and the second is zero pumping speed for inert gases. We have tested two possible configurations of connections of NEGP to XHV calibration chamber. In the first case the NEGP was connected to the chamber via an all metal valve. In this case the effective pumping speed of the NEGP was limited by the conductance of housing and the valve and was was not high enough to reach XHV in the calibration chamber. For this reason we investigated also another possibility where we mounted the NEGP directly in the chamber. With this configuration the pumping speed of the getter pump was increased 20 times, which was sufficient to reach XHV.

AM

# DENSIFICATION OF SiC-MATRIX IN SiC BASED COMPOSITES BY SITE-P PROCESS

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Fabrication of the continuous SiC-fibre reinforced SiC-ceramics for fusion applications represents a major challenge for material science, since the material to be used in the first wall of the future reactor has to meet several highly demanding requirements. Beside the appropriate mechanical properties and stability at the operating temperature, closed porosity and low neutron activation, one of the main issues remained is sufficient thermal conductivity. Recently we introduced the "SITE" process as an optional way that comprises ceramic slip-infiltration in SiC-fibre perform, followed by moderate-temperature densification of SiC-based matrix using transient eutectoid. It was found, however, that the thermal conductivity of the resulting material would allow use in flow channel inserts, but it was too low for the structural applications. Therefore, as another alternative we have introduced a novel route, where a pre-ceramic polymer is introduced into the green ceramic body after electrophoretic infiltration with SiC powder suspension. In the next step, the infiltrated part is thermally treated to pyrolyse the polymer precursor and crystallise the newly formed SiC at moderate temperatures, i.e. 1600 °C. The resulting matrix material is relatively pure ß-SiC with high crystallinity. The feasibility of the process to produce a dense SiC-based composite was tested firstly on SiC matrix material. The effect of densification on the mechanical properties and thermal conductivity of the matrix was evaluated.

AM

# DEGRADATION OF LAYERED SODUIM COBALTATE

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During the last decade it has been realized that some semiconducting oxides are promising candidates for thermoelements in thermoelectric modules. One of the highest zT values, 1.2 at 800 K, was measured for $NaCo_2O_4$ single crystal. This oxide exhibits a hexagonal layered structure with edge-sharing 2D triangular $CoO_2$ sheets and Na ions among them, which results in properties close to electron crystal – phonon glass. The performance of ceramics based on $Na_xCo_2O_4$ is, however, considerably lower compared to single crystal and furthermore the literature reports on the properties that differ for an order of magnitude, which calls for systematic investigation of chemistry of this compound. We investigated the degradation under high-temperature and ambient conditions of polycrystalline $Na_xCo_2O_4$ prepared by solid-state and sol-gel synthesis by applying thermogravimetry (TG), scanning electron microscopy (SEM), energy dispersive X-ray spectroscopy (EDS) and powder X-ray diffraction (XRD).

AM

# INFLUENCE OF SYNTHESIS CONDITIONS ON THE STRUCTURAL AND ELECTRICAL PROPERTIES OF THE $Ag(Ta_xNb_{1-x})O_3$ CERAMIC

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$Ag(Nb_{1-x}Ta_x)O_3$ ceramics exhibit microwave dielectric properties suitable for various electronic components, such as resonators, filters, capacitors, etc. However, during the preparation of the ceramics the oxidation and reduction processes of Ag cause problems related to matrix decomposition and densification and have not been successfully solved so far. The aim of our work was thus to investigate the influence of the sintering temperature and different atmosphere on the densification, decomposition of the matrix, and the homogeneity of the components with respect to their dielectric properties in the microwave-frequency region. The materials were prepared by solid-state reaction and analyzed using an X-ray powder-diffraction method, scanning electron microscopy, coupled with energy-dispersive X-ray spectroscopy, and optical microscopy. The densities of the ceramic bodies were determined via Archimedes' method. At low sintering temperatures (1040–1080 °C) the secondary phases related to the heterogeneous distribution of the Nb and Ta were detected in addition to the matrix phase. At sintering temperatures between 1120 and 1200 °C the homogeneity of the components improved due to the higher diffusion rates, but on the other hand $Ag(Nb_{0.5}Ta_{0.5})O_3$ partially decomposed into $Ag_2(Nb,Ta)_4O_{11}$, $Ag_8(Nb_{0.5}Ta_{0.5})_{26}O_{69}$ and Ag. Consequently, sintering in air did not result in a single-phase $Ag(Nb_{0.5}Ta_{0.5})O_3$ ceramic. We observed that sintering in pure oxygen under increased pressure retarded the decomposition process according to Le Chatelier's principle and as a result we were able to synthesize almost single-phase ceramics with a high density. Nevertheless, sample sintered at 1080 °C in air exhibited optimal dielectric properties; i.e., $\varepsilon$ 440, Q×f 622 GHz, and $\tau$f -16 ppm/K. In our contribution we will also describe how the Nb and Ta distributions in the $Ag(Nb_{0.5}Ta_{0.5})O_3$ material influence the temperature coefficient of the resonant frequency.

KM

# ELECTROPHORETIC CO-DEPOSITION AND DENSIFICATION OF SiC WITH MgO FOR BIOMEDICAL APPLICATIONS

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Silicon carbide is due to its excellent properties arising from its covalent structure a very promising material for various applications. However, the covalent character of the bond is also the reason for challenging densification and so normally sintering additives containing $Al_2O_3$ and $Y_2O_3$ are used. Bulk SiC as a potential biomaterial has not yet been thoroughly investigated, but there is an increasing interest for using non-oxide ceramics for orthopaedic applications. $Al_2O_3$ should therefore, because of the reported neurotoxicity of aluminium, be avoided. In our work we have focused on electrophoretic co-deposition of SiC and MgO which was used as a replacement of $Al_2O_3$. EPD of SiC has been generally widely investigated while EPD of SiC with sintering additives has not yet been seriously taken into account since every additional component strongly affects the properties of the suspension. Due to solubility in water MgO was introduced into SiC suspension in ethanol while polyethyleneimine was proven to be an effective deflocculant. EPD was performed at 60 or 300 V and parameters of the suspension were modified in such way that highest green density was obtained. Densities after sintering in open air increased from 1.9 g/cm$^3$ (green part) to 2.3 g/cm$^3$. SEM and TEM analyses revealed that the samples are composed of SiC grains embedded in $SiO_2$ matrix, while XRD confirmed that even though the sintering caused a partial oxidation and the appearance of an amorphous phase, the prevailing crystalline phase is still ß SiC. In the presence of MgO, $SiO_2$ also appears in the crystalline form as crystoballite. We have also performed analysis of elements dissolved from the sample in 0.9 % NaCl solution; it was proven that some silicon and magnesium (both body friendly elements) ions are released after 10 days of soaking.

AM

# MICROSTRUCTURE DEVELOPMENT UPON TWO-STAGE SINTERING OF NANO-SODIUM NIOBATE

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Alkaline niobate based perovskites, such as $K_{0.5}Na_{0.5}NbO_3$, are environment-friendly lead-free piezoelectrics and could replace the widely used lead-based ceramics. Even though these materials are of considerable technological importance, the problems in obtaining high densities and fine-grained microstructure are still reported. In order to better understand their sintering behaviour, we focused on sodium niobate ($NaNbO_3$) as one of the end members of the most studied solid solutions with piezoelectric properties comparable to $Pb(Zr,Ti)O_3$ based ceramics. Sodium niobate ceramics, with the relative density over 95 %, were prepared from the submicron powder with the median size of 240 nm upon sintering at 1350 °C in air atmosphere. Exaggerated grain growth, with the grains exceeding several tens of microns, was observed already after 15 minutes and was attributed to the extremely high velocity of grain boundaries. In addition, high temperatures, required to obtain high densities of the powder compacts, lead to volatilization of the alkali component and subsequently to occurrence of secondary phases. In order to prepare the sodium niobate ceramics with a fine-grained microstructure, while maintaining a high density, we applied a top-down approach to obtain sodium niobate nanopowders with the average grain size of 80 nm. The powders were subsequently compacted and sintered using the two-stage sintering technique introduced by Chen and Wang which has been successfully implemented in other ceramic systems. By optimizing the conditions of the first and the second sintering stage we managed to prepare sodium niobate ceramics with relative densities over 95 % and an average grain size of around 1 μm. The sintering temperature was decreased for more than 200 °C, which also contributed to reduced alkali losses during sintering. In addition, the development of microstructure elements, such as porosity and grain size, was followed.

AM

# EBSD AND TEM INVESTIGATIONS OF JAPANESE TWINS IN QUARTZ

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Low-temperature quartz ($SiO_2$) frequently forms twins that influence the morphology of crystals. Among them, Japanese twins are only rarely found in nature. They are classified as contact twins with the composition plane of {1122} and an angle of 84.33° between both twin individuals. This study combines electron backscatter diffraction (EBSD) in a scanning electron microscope (SEM) with transmission electron microscopy (TEM) in order to reveal the cause of its nucleation, based on the obtained structural information.

Observations showed that the twin junction consists of two units, which correspond to different growth stages. In its interior crystal exhibits ~100 μm flat twin junction, a so-called twin boundary, whereas closer to the surface it becomes irregular with no distinct crystallographic relations. EBSD across the twin boundary confirmed the rotation of the unit cell by ~84°, which matches with the known theoretical angle for Japanese twins. In addition, TEM results showed that this crystallographically defined coherent twin boundary can only be found in the first 400 μm of the crystal, where it is attached to the bedrock. High-resolution TEM showed that the crystal lattice does not contain any evident defects or inclusions near the twin boundary, while spatially resolved EDX analyses confirmed no compositional changes across the twin boundary.

From these studies it can be concluded that the formation of Japanese twins can be divided into nucleation, earlier and subsequent growth stage. The twin formation is believed to be initiated in the nucleation stage, which also determines the morphology of the crystal. In the earlier growth stage incoherent twin boundary develops. The subsequent growth continues in the same direction with a less crystallographically defined interface, which results in the formation of the general interface between both sides of the twinned quartz and consequently random intergrowth.

AM

# SYNTHESIS AND CHARACTERIZATION OF UNDOPED AND Al-DOPED ZnO FILMS FROM AN AQUEOUS SOLUTION

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Zinc oxide (ZnO) is known as a material with many useful properties and is already successfully used for different applications. Optically transparent and electrically conductive ZnO films have potential to replace indium tin oxide (ITO) films, which is nowadays widely used in liquid crystal and plasma displays, touch panels, organic light-emitting diodes, gas sensors, anti-static and anti-reflection coatings, solar cells, etc. The methods to prepare low-dimensional ZnO structures are usually different solid-vapour deposition methods, but in recent years solution-based synthesis methods are being increasingly developed because of the advantages in cost, easier transformation to large-scale production and the reduced pollution effects.

Low-temperature aqueous synthesis of undoped and Al-doped ZnO films involves three steps. In the first step, 0.5 M Zn-acetate ethanol solution was deposited on high-temperature glass slides using a spin-coater at room temperature. In the second step of the synthesis, the transformation from deposited Zn-acetate to ZnO thin film was performed with a heat treatment at 600 °C. Such ZnO thin films with thickness of 90 nm on glass were used as seed layer in the third step of synthesis, growth from nuclei to the thicker ZnO film on the glass substrate. Growth of smooth ZnO film occurs in an autoclave from a 0.026 M Zn-nitrate aqueous solution and pH of 10.9, which was raised with ammonium hydroxide. Na-citrate was added as a crystal morphology-controlling agent; it slows down the growth rate in the [0001] direction. Doped films were prepared by additions of Al-nitrate. The ZnO films were observed by a scanning electron microscope (SEM) and a transmission electron microscope (TEM). The phases and the preferred growth direction were identified using x-ray diffraction. The optical properties were studied using UV-Vis-NIR spectrometer and the electrical characteristics of ZnO films were determined using 4-points current-voltage characteristic at room temperature.

P

# THE PROPERTIES OF PARTICLEBOARDS MADE BY USING THE LIQUEFIED WOOD

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Wood is one of the most spread natural materials. It can be converted to many useful industrial chemicals, but nowadays, it can also be liquefied using different polyhydric alcohols and acid catalysts. Wood is composed mainly of cellulose, hemicellulose and lignin and during liquefaction these components are decomposed. The final product has lots of free hydroxyl groups and can therefore be used to prepare an adhesive for gluing the wood and wood composites. Almost 60 % of the wood composites represent particleboards.

The aim of our research was to determine some properties of particleboards made by using liquefied wood in the adhesive mixture. Liquefied wood was added to melamine-formaldehyde resin and then three-layer particleboards were manufactured. We investigated the impact of two different catalysts and examined the influence of two pressing conditions on the properties of the particleboards. We measured physical and mechanical properties of particleboards and determined gelation times for different adhesive mixtures depending on the temperature and the type of the catalyst.

Results showed that gelation time decreased with temperature and was shorter when ammonium formate was used. Produced particleboards satisfied the EN standards requirements. The optimal properties were obtained at 3 minutes press time and 180 °C press temperature using ammonium formate. Also, low formaldehyde content was achieved and that is extremely important in the provision of better quality of life.

With liquefaction of wood and application of liquefied wood in particleboard production we can increase wood biomass exploitation. From renewable resources we are able to produce new materials that can be a great alternative to the raw materials, originating from crude oil.

P

# SHAPE MEMORY POLYMERS FILLED WITH $SiO_2$ NANOPARTICLES

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In this paper we discuss the behaviour of mechanical and thermal properties of Shape Memory Polymer Composites (SMPC) filled with $SiO_2$ nanoparticles. A series of SMPC samples were prepared using a commercially provided Shape Memory Polymer (SMP) filled with different mass fractions of 600 nm and 30 nm $SiO_2$ particles. The mechanical properties of the SMPC were determined by performing three point bending (3PB) and Izod impact testing and the thermomechanical and thermal behavior were investigated using differential scanning calorimetry (DSC) and dynamic mechanical analysis (DMA). The results showed that SMPC filled with $SiO_2$ nanoparticles have the same mechanical properties as the pure SMP, however the thermal and thermomechanical properties were significantly affected by filling SMPC with $SiO_2$ nanoparticles.

P

# THE SYNTHESIS OF THE POLYESTER DENDRIMERS

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Dendrimers are highly branched polymers of defined structure, high functionality and uniform molar mass distribution. The properties of dendrimers (solution and solid state properties) are significantly different from those of their linear counterparts of the comparable molar mass. Dendrimers with hydrophobic repeat units in the interior and the hydrophilic functional groups at the periphery (or *vice versa*) exhibit micelle-type behaviour and can encapsulate guest-molecules. On the other hand, molecules can be also covalently attached to the functional groups at dendrimer's periphery.

These unique macromolecules are applicable in various fields, e.g., catalysis, biomedicine, light-harvesting systems, etc. The synthesis of dendrimers is a stepwise procedure which involves many deprotecting, coupling and purification steps. There are two general strategies for the synthesis of dendritic structures, i.e., divergent and convergent approach. When using divergent approach, one starts synthesis at the core moiety, whereas when applying convergent approach, the dendritic structure is being built at the periphery.

In our work we used a modified divergent synthetic strategy for the preparation of the fourth generation polyester tridendron dendrimer with 1,1,1-tris(hydroxymethyl)propane as a core moiety and an adduct of 2,2-bis(hydroxymethyl)propionic acid and glycolic acid as a monomer building block. The second generation dendrons were coupled to the core moiety to afford the second generation dendrimer. Then, in the final coupling reaction, the second generation dendrons were coupled to the deprotected dendrimer of the second generation to prepare the fourth generation dendrimer.

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# COMPARISON OF STRENGTH BEHAVIOUR OF UNIDIRECTIONAL HIGH MODULUS CARBON COMPOSITE AND HIGH STRENGTH CARBON COMPOSITE SUBJECTED TO BIAXIAL LOADING

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Firstly, selected stiffness and strength parameters of two kinds of composites were identified subjected to uniaxial loading: a tension and a compression. The composites had high modulus carbon (HMC) fibres and high strength carbon (HSC) fibres. Epoxy resin was used in both cases. Then, the strength analysis of the composites subjected to biaxial loading was performed. Composite specimens were loaded in two perpendicular directions. The specimens were exposed to the combination of the tension in the fibre direction and the localized compression in the transverse direction. The dependence of the tensile strength in the fibre direction on the level of compression in the transverse direction was investigated. Comparison of the dependences of the high modulus and the high strenght composites was carried out.

P

# IDENTIFICATION OF MATERIAL PARAMETERS OF UNIDIRECTIONAL FIBER COMPOSITE USING MICROMODEL

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The work is focused on the identification of material parameters of unidirectional carbon-epoxy longfiber reinforced composite. A model of representative volume element is created in MSC.Marc. Fibers are considered as elastic transversely isotropic material and matrix is considered as elasto-plastic isotropic material. Simple tensile tests using thin strips with various fiber orientations were performed and force-displacement diagrams were obtained. The representative volume element is loaded in the same directions and up to the same level of loadings as the experimental samples. Square of difference between the numerical and experimental results is minimized within the identification process. Identified parameters are Young's modulus of fibers in axis direction and three shape parameters of matrix work-hardening function. The identification process is performed using Optislang optimization software and Matlab.

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# CHARACTERIZATION OF POLY(STYRENE–*block* – *t*-BUTYL METHACRYLATE) COPOLYMERS BY TWO-DIMENSIONAL CHROMATOGRAPHY

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The separation of three poly(styrene–*block*–*t*-butyl methacrylate) copolymers (PS–*b*–P*t*BMA), consisting of polystyrene blocks of the same molar mass and *t*-butyl methacrylate blocks of different molar masses was performed by using fully automated two-dimensional liquid chromatography that separates polymers by chemical composition in the first dimension and by molar mass in the second dimension. Elution of block copolymers in the first dimension was investigated by gradient liquid chromatography and liquid chromatography at critical conditions (LCCC) on the reversed phase and normal phase columns, respectively. In the second dimension high speed size exclusion chromatography was used. By the gradient liquid chromatography on the reversed phase column C18 using gradient acetonitrile and THF, as non-solvent/solvent comibantion, partial separation of the block copolymers was achieved according to the block length of P*t*BMA. Since the length of the P*t*BMA block in two copolymers was rather small as compared to that of the PS block and since the difference in P*t*BMA block's length in these two copolymers was rather small, as was confirmed by SEC-MALLS (size exclusion chromatography coupled with multi angle laser light scattering detector) and NMR, they coeluted, while the third block copolymer with much longer P*t*BMA block was baseline separated from the other two copolymers.

P

# DETERMINATION OF COEFFICIENTS OF THERMAL EXPANSION OF WOVEN COMPOSITES USING DIGITAL IMAGE CORRELATION METHOD

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Coefficients of thermal expansion of woven composites are determined in this study. Composites consist of glass, carbon or aramid fibers and epoxy matrix are investigated. Furthermore, specimens with plain and quasi-unidirectional weaves are studied. The values of coefficients of thermal expansion are determined in temperature range from 20 °C to 125 °C using specimens with various weave orientations. The dilatation of specimens is measured using two-dimensional digital image correlation method. The method is used for its simplicity. Fundamentals of the method are described in the paper. The precision and the usefulness of the method for this type of measurement are discussed.

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# CHALLENGES IN COMPUTER MODELING OF PHASE CHANGE MATERIALS

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Phase Change Materials (PCMs) are a well established category of materials with many possible applications ranging from the stabilization of temperature to the heat or cold storage. The main principle of PCMs is the utilization of latent heat of phase change for the energy storage. Though many pure chemical elements can be used as PCMs, a PCM very often consists of a number of substances. The main reason for creating the PCM as mixtures of various sub-stances is to achieve a desirable melting temperature for a particular application. However, these mixed PCMs require accurate and reliable methods for the determination of physical properties, since for numerical modeling the thermal properties of materials and their proper determination represent a significant issue that considerably affects the accuracy and credibility of numerical simulations and their outcomes. The thermal properties of PCMs are usually obtained by the Differential Scanning Calorimetry (DSC) method based on the temperature and heat measurement of desired and reference materials. There exist several approaches how the materials comprising phase changes can be modeled. In the paper, the main attention is aimed at the enthalpy approach and the effective heat capacity method. Both the techniques, which utilize results from a particular DSC measurement, allow treating with the latent heat, thereby the desired heat or cold storage may efficiently be simulated. The presented methods were implemented with using the results of DSC measurements in order to simulate the solar air collector with a PCM. The obtained results are presented and discussed. The paper also concerns with problems of uncertainty of material properties and their impact on numerical simulations.

P

# SINTHESYS OF DIFFERENT GENERATION POLYESTERAMIDE DENDRIMERS

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Dendrimers are monodisperse and highly branched macromolecules which are applicable in various biomedical fields, including drug delivery. Aliphatic polyesteramide dendrimers from the first to the fourth generation were syntesized using a mixture of convergent and divergent approaches to improve water-solubility of poorly soluble low molar-mass drugs. The 1,1,1-tris(hydroxymethyl)propane (TMP) was used as a core molecule and the $AB_2$ aduct prepared form 2,2-bis(hydroxymethyl)propionic acid (bis-MPA) and glycine was used as a building block. The first generation dendrimer was synthesized by coupling $AB_2$ aduct to the core using N,N-dicyclohexylcarbodiimide (DCC) as a dehydrating agent and 4-(dimethylamino)pyridinium 4-toulenesulfonate (DPTS) as a catalyst. Second generation dendrons were prepared for the synthesis of the second generation dendrimer. The benzyl protected focal point of dendrons was deprotected by catalitic hydrogenation in ethyl acetate. In the last step, dendrons with a free carboxylic group were coupled to a trifunctional TMP core to obtain the second generation dendrimer. Acetonide protected hydroxyl groups of the synthesized dendrimers were deprotected using ion-exchange resin Dowex in acetonitrile. Hydroxyl groups of the second generation dendrimer were further reacted with the aduct or the dendrons to yield dendrimers of the third and fourth generation. All synthetic steps proceeded in high to moderate yields and required purification by column chromatography to obtain homogeneous products regarding the structure and molar mass. The structure of the prepared products was determined by $^{1}H$ and $^{13}C$ NMR spectroscopy, the molar mass characteristics by size exclusion chromatography coupled to a light scattering detector (SEC-MALS) and the thermal properties by DSC. The results of these characterization techniques revealed that pure and monodisperse dendrimers were synthesized.

KM

# EVOLUTION OF METALLOGRAPHIC PURITY OF STEEL IN LADLE FURNACE AND VACUUM CAISSON

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Production of higher steel grades, such as steel for pipelines, requires also monitoring of contents of inclusions in steel. Steelworks use technological procedures that ensure the highest possible purity of steel. The aim of the presented work is to observe evolution of number and size of inclusions in steel during its refining in ladle furnace and in vacuum caisson. Steel was deoxidised in ladle furnace by aluminium and afterwards it was modified by CaSi cored wire. No modification of steel by CaSi was made in the second group of melts. The heats were processed by the following technological flow: OBM converter – ladle furnace LF – vacuum caisson (ISSM) – continuous casting. The following was established from evolution of number and size of inclusions during two modified technologies of steel refining:

application of modification by CaSi cored wire on the steel already deoxidised by aluminium has first caused an increase in number of inclusions, which was during vacuum treatment followed by substantial reduction of this number. This evolution of occurrence of inclusions in steel was typical namely for the smallest inclusions up to 1 μm,

in the case of larger inclusions (2 to 5 μm), reduction of their number during vacuum treatment was slower, probably due to joining of small inclusions into larger ones,

similar evolution of number of inclusions was observed also in the case of technological flow without modification of steel by CaSi, only total number of inclusions after degassing was significantly higher. The work was prepared within the frame of solution of the projects FR-TI1/477 and FR-TI1/186 under financial support of MPO ČR (Ministry of Industry and Trade of Czech Republic).

KM

# INFLUENCE OF THE ELECTROMAGNETIC STIRING OF THE MELT BY THE CONTINUOUS CASTING ON THE HOMOGENITY OF THE SOLIDIFIED STEEL

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The solidification morphology of steel depends on the thermal condition at the solidification line, which constitute the ratio of G/R (temperature gradient/growth rate). By casting of steel at the begining of the solidification enables the formation of transkristal structure. At the solidification boundary slidified shell/melt is formed a mushy structure. In condition of transkristal growth, crystals are coherent with the solid layer. This mixture is resisting any further movement and impending flow of the melt. Segregation resulting from reduced solubility at boundary of solidification, followed by transfer of elements with diffusion and mass flows. The transkristal region accelerates a macro-segregation, while in the region with equiaxed grains formed usually isotropic micro-segregation. Using electromagnetic stirrers (EMM) is required to increase the quality of continuously cast steel. Along the strand continuous casting plant can build one, two or three of the electromagnetic stirrer. The stirrer can be placed on the molds (MEMS), the secondary cooling zone (SEMS), and the crown area of the current root (FEMS). This paper shows the effect of stirring a melt in molds (MEMM), on the quality and homogeneity of the casting billets. Morfologija strjevanja neke zlitine je odvisna od termičnih pogojev na meji strjevanja (temperaturni gradient/hitrost rasti). Običajno je na začetku strjevanja morfologija zrn stebričasta. Pri strjevanju se tvori na meji med strjeno skorjo in talino, tako imenovano kašasto področje. Če je strjevalna makro struktura stebričasta, je rast zrn v kašastem področju koherentna s trdnim slojem. Mešanica se upira nadaljnjem gibanju, ter ovira tok taline. Izceje so posledica zmanjšanje topnosti na meji strjevanja, ki ji sledi prerazporeditev z difuzijo in masnimi tokovi. Kašasto področje na meji strjevanja vpliva na makroizcejanje, medtem ko je enakoosna zrnata (globulitna) oblika strjevanja združena z bolj izotropnimi mikroizcejami. Uporaba elektromagnetnih mešalnikov (EMM) je orodje za povečanje kvalitete kontinuirano ulitih jekel. Vzdolž žile kontinuirane livne naprave lahko postavimo več mešalnikov. Mešalnik lahko postavimo v kokili (MEMM), v področju sekundarnega hlajenja žile (SEMM) in na območju temena tekočega korena (FEMM). Za vsako tako aplikacijo je narejena optimalna izbira mešalca glede na kvaliteto jekla in velikost žile, ki se uliva.V prispevku je prikazan vpliv uporabe MEMM na kvaliteto oz. homogenost ulitih gredic.

KM

# INFLUENCE OF PRECIPITATES ON HOT DEFORMATION ABILITIES OF DUPLEX STAINLESS STEELS

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During hot working process of duplex stainless steels $\sigma$ – phase and intermetallic inclusions are eliminated, that can have great influence on efficiency of hot deformation process of the steels. In this work influence of temperature on precipitation of mentioned phases was established and the temperature range for successfully hot rolling process of the steels was defined. The investigation was made on two duplex steels, SAF 2205 and LDX 2101.

The experiments were made with hot tensile and hot rolling tests on flat and wedged specimens and metallografycal investigations of a rolled steels, in temperature range of 800 to 1250 °C. From results the most suitable hot rolling temperature range was ascertained and temperature ranges for elimination of $\sigma$ and also another phases which can hot working process of steels make worse.

KM

# ROBOT LASER HARDENED MATERIALS GGG 60 AND GGG 70 AND FRACTAL DIMENSION

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The Fractal dimension is a property of the fractal, which is maintained through all the extensions and is therefore well dened. In addition, it shows how complex the fractal is. We made patterns of a standard label on the materials according to DIN standard 1.7225. Chemical composition of the material contained 0.38-0.45 % C, max 0.4 % Si, 0.6-0.9 % Mn, max 0.025 % P, max 0.035 S% and 0.15–0.3 % Mo. We hardened tool steel with the laser at different speeds and different power. So we changed two parameters, speed $v \in [2, 5]$ mm / s with steps of 1 mm / s and temperature $T \in [1000, 1400]$ °C with steps 50 °C. In all these attempts we have made picture of microstructure. We made recordings of hardened surface area. Also, we wanted to know or find the fractal structure of the optimal parameters of hardening.

KM

# ROBOT LASER HARDENING WITH DIFFERENT ANGELS ON DIFFERENT MATERIALS

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We present a robot laser hardening with different angles on different materials. Also, it is interesting how parameters of angles impact to hardness of different materials. We present this problem on five different materials. We can change two different angles on laser beam. It mean that we can change angles on x-axis and y-axis. Here have we different result. This problems are apply on automate, military and space technology.

KM

# QUALITY OF SUPER CLEAN STEELS PRODUCED AT ZDAS, INC.

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Production of heavy steel forgings of microalloy steels gives the possibility to expect advantages associated with the benefit of application of microalloying elements and thermomechanical treatment for improving of mechanical properties of forgings to level by sheets, strips and tubes. The paper presents the influence of quenching temperature on values of mechanical properties and microstructure of F60 steel according to ASTM A694. Verification of quenching temperature influence contributes to optimization and determination of a complex method of microalloy steel heat treatment. Steel structure and mechanical properties after the quenching constitute initial as well as basic criterion to achieve requested mechanical properties at properly chosen tempering temperature. In the paper result obtained in the EUREKA programme of the E!4092 MICROST project are presented. The project was realized with financial support of the Ministry of Education, Youth and Sport of the Czech Republic.

KM

# WEAR OF REFRACTORY MATERIALS OF CERAMIC FILTERS OF DIFFERENT POROSITY AT CONTACT WITH HOT METAL

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The paper deals with investigation of development of refractory materials for fabrication of ceramic filters for filtration of steel. Ceramic filters are used for increasing the cleanness of steel and they must meet several strict requirements, such as ability to remove impurities, resistance to sudden changes of temperature, resistance to corrosion and erosion by metal. Use of filters must not lead to an excessive reduction of steel temperature, as this may lead to solidification of steel and thus to filter clogging. That's why special refractory material has been developed with reduced thermal capacity caused by increased porosity. Tests were made in laboratory of the Department of Metallurgy at VŠB-TUO in order to simulate industrial conditions of filtration of steel with focus on the evaluation of erosion and corrosion effects and also on determination of resistance and service life of ceramic filters.

KM

# IMPLEMENTATION OF THE CDV PROCESS FOR COLD FORMING TOOLS

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CVD (chemical vapor deposition) is an atomic surface modification process coating where a thin solid film is deposited on an underlying heated substrate via a chemical reaction from the vapor or gas phase. Coating temperature is around 1000 °C. When using this process for cold forming tools (former) the attention should be paid to the selection of tool material especially in view of its properties in the CVD coating process, interaction with the coating (adhesion) and appropriate structures. Böhler Steel S600 is the high-speed steel with Mo and W additions. S600 is characterized by its high toughness, good resistance to dimensional changes and overheating at the heat treatment. The paper presents the use of this material for the former, which is used in the production of seamless steel reducers. We focus primarily on evaluation of the material structure, coating thickness, and an economic effect.

KM

# PRELIMINARY INVESTIGATION ON NEW GRADE OF ARMOUR STEEL – PROTAC 500

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An investigation of new PROTAC 500 armour steel was conducted. Three plates were heat treated to different states. One was quenched, second and third were quenched and low temperature tempered at 220 °C and 280 °C for 3 hours. A tensile test, hardness measurements, and an instrumented Charpy test were performed. Metallography was performed by optical microscopy (OM). Ballistic resistances of all three steel plates were measured. The behaviour of steel was tested using armour piercing projectiles 7.62´39 mm API BZ. The best results were obtained in quenched state.

KM

# A CHARACTERIZATION OF GAS TURBINE INNER CASING MICROSTRUCTURE

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This contribution presents the application and results of an inner casing visual examination and a non-destructive examination by means of replicas. Both techniques are very efficient tool in a machine component surface examination (cracks, discoloration, pitting).

Visual inspection is the most common non-destructive testing technique that provides a means of detecting and examining a variety of surface flaws. Visual inspection is also the most widely used method to determine the general mechanical and structural condition of components and their supports by verifying parameters such as clearances, settings, and physical displacements; and to detect discontinuities and imperfections, such as loss of integrity at bolted or welded connections, loose or missing parts, debris, corrosion, wear, or erosion.

Surface replication makes possible to analyse a material microstructure and a various surface discontinuities occurring during service life of components. As the replica does not damage the surface of machine part and does not chemically affect surface condition, the machine part can be further in use if the inspection performed confirms its fitness for service. The methodology of non-destructive metallography is applicable to studies of the microstructure of parts of different devices and contributes to diagnosing the causes of damages, determining the type and condition of the material, and to assessing the surface condition with reference to the technology of production, material treatment or operating conditions in the system, which show a more or less explicit influence on the microstructural changes. Results of the periodic replica examinations of a component which operates at elevated temperatures can be used to assess the hidden thermal overheating of the component.

Both non-destructive examination methods were used to determine the condition of the gas turbine inner casing surface and casing microstructure.

KM

# CORROSION CHARACTERISTICS OF FOAMED Al AND AlSi12

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Metal foam is a class of attractive material that exhibits a unique combination of physical, mechanical, thermal, electrical and acoustic properties. Aluminum foams, produced by the powder-metallurgy route, have a high potential for use in weight-sensitive structural parts. Goal of this study was to evaluate properties and to optimize preparation of pre-cursors produced by the powder compacting process with different foaming agents and to evaluate corrosion properties. Various compacting pressures were used in the double-axial powder compacting process for two different aluminum powders, pure aluminum and AlSi12.

Studied aluminum foams with average pore size of 2.5 mm, were prepared by the powder metallurgy foaming method with the addition of titanium hydride, dolomite and calcite as a blowing agent. The corrosion resistance properties of the Al foams have been studied and the results were compared between different foaming agents and aluminum alloys. The results show that in order to get Al foams with better pore structures, calcite and/or dolomite should be added to the pure Al and AlSi12 alloy as the blowing agent.

KM

# STUDY OF HIGH-TEMPERATURE INTERACTION BETWEEN SYNTHETIC SLAGS AND STEEL

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The paper is devoted to selected aspects of the current issues of the high-temperature interaction of the synthetic multicomponent oxidic systems and selected grades of steel. Analysing the consequences of the interaction between slag and molten steel is an integral part of contemporary oriented research tha can be connected with next applied research in the field of production and refining of steel. The interactions between synthetic slag and molten metal is realized after the processing of liquid steel in the primary metallurgical aggregates – at the start of refining processes of secondary metallurgy. The addition of these synthetic systems (slag) significantly affects many technological processes and indirectly affects the final quality of cast steel. This influence can be seen on two levels: metallurgical and metallographic. Both of these levels of evaluation complement each other. For the evaluation of the metallurgical aspects of refining processes were used a number of thermodynamic relations – supplemented by empirically established formulas and coefficients. Metallographic analyses utilize contemporary tools in the study of structure and chemical composition of materials – from light microscopy to sophisticated systems microanalysis elemental composition using scanning electron microscope combined with X-ray energy dispersive microanalyzer. The present results arising from long-term cooperation between Department of Metallurgy, Faculty of Metallurgy and Materials Engineering, VSB-TU of Ostrava and ÚMVI, Faculty of Mechanical Engineering at Brno University of Technology and Military Technical Institute of Protection in Brno. It is obvious that this area deserves more oriented research and more extensive attention, particularly in the context of the ongoing needs of identification and quantification of phenomena taking place in the following metallurgical innovations. The presented research focused on the high-temperature interactions between synthetic slags and steel was carried out with financial support from GACR (Czech Science Foundation) under project ID No. 106/09/0969.

KM

# STRUCTURAL, THERMAL AND MAGNETIC PROPERTIES OF Mn, Cu OR Co AND X (X=Sr AND Ni) SUBSTITUTED-BARIUM FERRITE POWDERS PREPARED BY SOL-GEL METHOD

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Abstract In this study, Mn and Cu or Co doped BaFe12-x(Mn0.5Cu0.5X)x/2O19) and BaFe12-x(Mn0.5Co0.5X)x/2O19) (X=Sr, Ni) magnetic powders were prepared by sol-gel processing. After preparation of solution, strontium nitrate and zirconium isopropoxide as dopants (X=Sr and Ni) were added in an atomic scale. After preparation of solution, strontium nitrate and zirconium isopropoxide were added as dopants (X=Sr and Ni) in an atomic scale. The produced powders were subsequently calcined at 550 °C for 6 hours and sintered at 1000 °C for 5 hours to obtain the required phases. The powders were characterized by differential thermal analysis/thermogravimetric analysis (DTA/TG), X-ray diffractometer (XRD) and scanning electron microscopy (SEM), vibrating sample magnetometer (VSM). The results showed that dopant materials significantly change the particle shape of barium hexaferrite powders but lower the value of coercivity. Higher saturation magnetization was observed for the Mn-Co-Ni doped barium hexaferrite powder.

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# THE PHENOMENA OF SPECIFIC DAMAGES AT THE BOTTOM PLATES OF AN ABOVEGROUND FUEL STORAGE TANKS COMPOSED OF STRUCTURAL STEELS

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This paper describes the investigation of a corrosion failure of a bottom plates on an aboveground fuel storage tanks. Petroleum destilates are not corrosive unless water and some other species are contained in them at particular concentrations. Very heavy local damages like holes or deep pits with a diameter of 1 cm were observed on the bottom plates around the supports legs of internal floating roof and along the circumference of bottom near tank shell.

KM

# HEAT TREATMENT OF HIGH STRENGTH WEAR RESISTANT FLAT STEEL PLATES

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Thick plates of hot rolled, high wear resistant steel demand for suitable heat treatment consisting of heating, quenching and low temperature annealing.

In the precsented work, we optimized the heat treatment process of thick steel plates of high-strength wear resistant steel Nicrodur 500 dimensions 6000 × 2000 × 14 mm produced in the largest Slovenian steel producer ACRONI d.o.o.

The work presents, describes and analyzes walking beam and chamber furnaces as a line or aggregate.

There have been made measurements of temperature on test steel plates during the whole process.

The effectiveness and quality of performed heat treatment is evaluated on the basis of non-destructive investigative techniques, metallographic analysis and mechanical tests.

KM

# RELATION BETWEEN THE INJECTION OF LIGNITE TAR AND OTHER SIGNIFICANT PARAMETRES

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Extremely high energy demandingness of blast-furnace iron production and thereby also high pollution of carbon dioxide cause systematic effort aiming to decrease of specific consumption of fuels and deoxidizing agents during this process. As complete use of chemical and heat energy of used fuels (deoxidizing agents) as possible during provision of their other specific functions is one of the principal conditions of iron production rationalization. Control and even optimization of the fundamental technological parameters of iron processes using mathematical models are applied here more and more. At the Metallurgy Department of VŠB – TU Ostrava there was developed system of models enabling to respect basic limits of fuels' and deoxidizing agents' consumption and to determine needed technological data for the purposes of forward assessment as well as operative control.

KM

# STUDY OF MICROSTRUCTURAL AND OXIDATION BEHAVIOR OF YSZ AND YSZ/$AL_2O_3$ TBCS WITH HVOF BOND COATINGS

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The use of Thermal Barrier Coatings (TBCs) has resulted in a significant improvement of the efficiency of gas turbines and diesel engines. A typical TBC is a multilayered coating system that comprises an oxidation resistant metallic bond coating (BC) and a thermally insulating ceramic top coating (TC). Under service condition an $Al_2O_3$ inter-layer, the Thermally Grown Oxide (TGO), forms in the interface between bond and top coating using aluminium from the BC material and oxygen that attains from the environment through pore channels of the TC. The aim of the present study is to describe the TGO formation on metallic bond coats deposited by HVOF spraying technique. Therefore, TBCs that consist of YSZ top ($ZrO_2$ + 8 wt.% $Y_2O_3$) and YSZ-$Al_2O_3$ double layer systems with CoNiCrAlY bond coats are deposited on Inconel 718 superalloy substrates. The metallic bond coatings are applied via High Velocity Oxygen Fuel (HVOF); the ceramic top coatings via APS. The oxidation behavior of TBC systems were investigated. The examinations were performed at 1000 °C in normal atmosphere for 8, 24, 50 hours. In the present investigation, the formation and growth of TGO layers and microstructural changes during the oxidation test was studied and compared. The microscopic investigations by optical and scanning electron microscopy are complemented by energy dispersive X-ray analysis (EDX).

KM

# THE INFLUENCE OF SIMULATED PORE SOLUTION ON CORROSION STABILITY OF AISI 204Cu AND AISI 304 STAINLESS STEELS

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Conventional steel reinforcements embedded in concrete are passive due to a thin protective oxide layer formed on its surface in high alkaline media such as that contained in the pores of the concrete. However, these reinforcements suffer severe corrosion problems when the reinforced concrete structure is exposed to chloride contaminated environments and/or when the concrete cover is carbonated. There has always been an interest in the possible substitution of the common 300 nickel-bearing steels by the 200 series particularly in times of high nickel prices. It is well established that for 200 series with nickel at 4–5 % there is a broad similarity with 304 in standard corrosion tests such as pitting, salt spray testing and long-term exposure tests. In contrast, the ultra-low nickel grades have performed markedly poorly compared to 304 in these tests. In the present study, corrosion resistance of AISI 204Cu (low Ni, high Mn austenitic stainless steel) and more traditional AISI 304 type is studied when exposed to simulated pore solutions with different levels of contamination (chlorides). The study was conducted using the electrochemical techniques of cyclic voltammetry and potentiodynamic measurements. The compositions and depth profiles of the oxide films formed on the surface of both stainless steels in simulated pore solution (SPS) with and without the addition of chloride were studied by X-ray photoelectron spectroscopy (XPS) and scanning electron microscopy (SEM) with energy dispersive X-ray spectroscopy (EDS).

KM

# PREHYDRATION OF TRICALCIUM ALUMINATE (C3A) IN THE PRESENCE AND ABSENCE OF HEMIHYDRATE – STUDIED BY RAMAN SPECTROSCOPY

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Micro-Raman spectroscopy has been used in the study of the prehydration of tricalcium aluminate (C3A) in the presence and absence of hemihydrate. This technique was used to determine the molecular structure of samples. When combined with SEM (scanning electron microscopy) and EDS (Energy-dispersive X-ray spectroscopy), Raman spectroscopy can be a valuable analytical tool. Micro-Raman measurements were performed at room temperature using a Horiba Jobin Yvon HR 800 LabRAM instrument equipped with an Olympus BX40 microscope (focus graduation 1μm), a He-Ne 20 mW laser working at 633 nm, and a multi channel air-cooled CCD detector. The binary systems of tricalcium aluminate (cubic and orthorhombic) in the presence of hemihydrate were prehydrated at 80 °C, 80 % RH for 3 days. The samples were also analyzed by XRD (X-ray diffraction) to confirm the phase composition. The Raman spectras of unhydrous C3A and unhydrous hemihydrate samples agreed with the results of X-ray diffraction analyses. The results of the tests of the binary mixtures have shown that, by using Raman spectroscopy, $CaCO_3$ polymorphs can be detected, which was confirmed by means of X-ray diffraction.

KM

# TRIBOCORROSION PROPERTIES OF DENTAL ALLOYS

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Zavod za gradbeništvo

The use of nickel titanium alloy wires in dental practice has shown that the dental wires experienced fatigue fracture due to different wear processes. It is assumed that even due to excellent electrochemical and corrosion properties of titanium based alloys, microstructure of an alloy greatly affects the chemical and mechanical properties. Moreover, different surface treatments affect corrosion performance while they may have drawbacks, such as reduction of alloy volume which displays shape memory effect and a possible de-bonding from the matrix when a failure of an oxide film occurs. In the present paper, the two microstructurally different NiTi alloys are studied: – dental wires NiTi (50/50), superelastic alloy – base material, NiTi, a 2-mm sheet, superelastic alloy. First, the electrochemical properties of both samples are compared with their natural oxide films and polished surfaces in simulated saliva solution. For the test solution the one the one that best simulates natural saliva for NiTi alloys was chosen. Moreover, the effect of wear is studied for the two morphologically different materials by the use of tribometer with linear reciprocating movement. The tribocorrosion properties are studied. The wear mechanism is evaluated and compared. The corrosion products and wear characteristics is studied by the use of SEM/EDS analysis.

KM

# SIMULATION OF AGEING OF CF-8M STAINLESS STEEL

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Results of mechanical tests on CF-8M stainless steels were analyzed to find a correlation between Charpy-V impact toughness (CVN), Vickers hardness (HV5) and tensile strength (Rm) with time and temperature of isothermal ageing. These tests were performed on three alloys with different chemical compositions and delta ferrite contents. Alloys were designated as A (2 vol. %), B (11 vol. %) and C (with 27 vol. % of delta ferrite). All results were then described with the most suitable function. After that a computer program for prediction (calculating) of mechanical properties (impact toughness CVN, Vickers hardness HV5 and tensile strength Rm) was made. Program application was written in Visual Basic 6 environment. With this program is possible to predict a change of CVN, HV5 and Rm of CF-8M stainless steels depending on time, aging temperature and delta ferrite content of material, for aging temperatures from 290 to 350 °C (step 10 °C), delta ferrite content from 2 to 27 vol. % (step 1 vol. %). To avoid mistakes and to focus on time period of practical importance, the aging time is limited to 40 years. This principle used here allows predicting the mechanical properties of other material additional with any other chemical composition. The confirmation of this requires additional experimental data.

KM

# X-RAY DIFFRACTION STUDY OF $TiH_2$ FOAMING AGENT

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Four samples were prepared from commercially available foaming agent in form of $TiH_2$ powder of two different average grain sizes. One was studied as received, other three were subjected to thermal treatments at 450 °C lasting from 0.25 to 2 h. Bragg-Brentano X-ray diffractometer was used to measure X-ray diffraction spectra on all four samples. Close examination of the diffraction spectra showed that for as received sample and sample undergoing the longest thermal treatment they can be explained as deriving from cubic $TiH_{1.924}$, while for the other two samples they can be explained as deriving from tetragonal $TiH_{1.924}$. Constant unit cell volume phase transition between cubic and tetragonal phase in $TiH_{2-y}$ type compounds had been described in literature, unit cell parameters obtained from measured spectra confirm that within measurement error unit cell volume is indeed constant in all four samples.

KM

# MODELING OF MELT FLOW IN TUNDISH

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In this article the influence of dams on melt flow in tundish was modeled.
First theoretical backgrounds of continuous casting and modeling were described; i.e. parameters which determinate the similarity between model and the real metallurgical reactor.
Second – practical part of the work was divided in two sections: psychical and numerical modeling. In both cases the melt flow in tundish with and without dams was investigated. Three different heights of dams were used (1/3, 1/2 and 2/3 of melt height). Also positioning regard to the base point was varied.
Two types of results were obtained from numerical modeling. With the stream lines and with different surface areas the general characteristics of melt flow in tundish are shown. The details were obtained with usage of cut lines and then represented in two-dimensional or three-dimensional diagrams.
From results of both, physical and numerical modeling, we established that dams in tundish increase the chance of inclusion removal from the melt but on the other hand also zones without melt mixing can form.

KM

# QUALITY OF SUPER CLEAN STEELS PRODUCED AT ZDAS, INC.

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Production of Super Clean Steels for rotor forgings of compressors and generators for gas turbine units started at ZDAS with use of secondary metallurgy processes, ladle furnace and vacuum degassing. The development and optimization of Super Clean Steel production technology enables effective molten metal manufacture, conforming to the requirements for chemical composition and micro-cleanness. According to the results of current production, the effective producing of rotor forgings requires new technological steps in ingot casting. In the paper result obtained in the EUREKA programme of the E!4092 MICROST project are presented. The project was realized with financial support of the Ministry of Education, Youth and Sport of the Czech Republic.

KM

# OPTIMIZATION OF MECHANICAL PROPERTIES SUPERALLOYS NIMONIC 80A

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Superalloys Nimonic 80A has found its major application in production of parts in the car and airline industries. It is a relatively expensive material and it is very important to reduce production costs to acceptable levels. Because of that the research of production of superalloys with varying supplements of alloying elements was carried out. Surveys which were carried out have included chemical testing and testing of mechanical properties of superalloy Nimonic 80A, on which was done regression analysis of the influence of certain alloying elements that significantly affect the improvement of mechanical properties of materials made of Nimonic 80A. The results of regression are equations by which on the basis of known chemical composition, ie content of main alloying elements Al, Ti and Co is possible to predict the mechanical properties of materials at room and elevated temperatures. On the basis of the square regression equations, was carried out an optimization of the chemical composition of materials for selected values of mechanical properties.

KM

# TESTING OF MECHANICAL PROPERTIES OF STEEL NITRONIC 60 ON 750 °C

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Nitronic 60 is the commercial name for the austenitic stainless steel which according to UNS labeling system responds to steel S21800. Steel Nitronic 60 has excellent resistance to abrasion and adhesive wear and applied for work at high temperatures due to the resistance to creep and high temperature corrosion. This paper presents the results of mechanical testing of steel Nitronic 60 at a temperature of 750 °C for the samples in the solution annealed condition. It also presents the results of SEM analysis of tested samples. Standard A276, which refers to steel S21800 provides the results of tests of materials in the annealed condition at room temperature until the test results at high temperatures are usually presented by a commercial manufacturers.

KM

# LABORATORY ASSESSMENT OF MICROENCAPSULATED PHASE CHANGE MATERIALS

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Nowadays, microencapsulation of phase change materials (PCMs) is one of the promising approaches in integration of latent heat storage in various applications. In latent heat storage the thermal energy is stored by means of a reversible change of a state or a phase change of the storage medium. The phase change materials are often used in order to increase energy storage density. The most important properties of the latent heat storage medium are heat of fusion and temperature range of phase change. The correct determination of the physical and chemical properties is essential for practical use of phase change materials.

The method to determine the change of heat in cooling or heating process is called calorimetric method. Process, when any material undergoes a phase change can be described by following values: temperature range of phase change, phase change enthalpy, heat capacity in solid and liquid phase.

The Differential Scanning Calorimetry is a thermo-analytical technique. The difference in the amount of heat required to increase temperature of a sample and the reference is measured as a function of temperature. Both the sample and the reference are maintained at nearly the same temperature throughout the experiment.

Our experiments started with the determination of the melting range and heat of fusion of the microencapsulated phase change materials. The second group of experiments focused on the analysis of the gypsum plaster containing 30 % of the microencapsulated PCMs. The cmicrocapsules Micronal DS 50008 X were tested as a heat storage medium. There were tested temperature rates of 20, 10, 1, 0.5 and 0.1 °C/min. Higher crystallization temperatures were observed for the slow cooling and heating ramp. The peak melting temperatures rise with the increase of the heating rate.

The results from laboratory experiments show dependence of the melting and solidification temperatures on the temperature ramp. This fact is very important for the use in building structures and choice of the system for charging and discharging of phase change materials. The acquired thermo-physical characteristics were used as inputs in the numerical modeling of the PCMs in various applications.

KM

# INFLUENCE OF COMPACTING TECHNIQUES ON FOAMING PROCESS OF ALUMINIUM FOAMS

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Aluminium foams are prospective class of cell materials that offer a variety of applications in fields such as lightweight structures. Production of aluminum foams by the powder-metallurgy process depends on preparation of pre-cursors. In general, pre-cursors consist of compacted metallic powder that is sintered at pre-determined temperature. Due to high temperature of sintering, foaming agent decomposes into a solid component that is built into the matrix material, and a gas component that causes foaming of the matrix material. Powder metallurgy is method for making close-cell foams and it is the best selection, especially for production of net-shape parts, providing excellent quality of end products.

In our research work, powders, precursors and foams, are made from different metallic powders (Al 99.7 % purity, AlSi12 alloy) with different foaming agents ($TiH_2$, $CaCO_3$, $CaMg(CaCO_3)_2$). We have devoted special attention to precursor preparation using different compacting techniques and I compared green densities of precursors on foaming effect. Different powders have different compacting properties and to achieve a great green density, double side compression, hot and cold extrusion were used. All the used methods were interacting compared and the result of the best method is the most homogeneously foamed aluminium foam.

KM

# INJECTION OF BROWN COAL TAR IN RELATION WITH SIGNIFICANT PARAMETERS OF BLAST FURNACE

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Extremely high energy requirements of blast-furnace iron production and high pollution of carbon dioxide cause systematic effort aiming to decrease of specific consumption of fuels and deoxidizing agents during this process. The paper deals with the injection of alternative fuels into a blast furnace and its effect on the blast furnace operation. The statistical relation in injection of brown coal tar and significant parameters of the aggregate is studied. Correlation coefficients indicating tightness in tar injection and other significant technological parameters such as specific coke consumption, theoretical combustion temperature and emission of blast furnace are calculated.

KM

# ANTICORROSION PROPERTIES OF SOL-GEL COATINGS ON THE BASIS OF 3-GLYCIDOXYPROPYLTRIMETHOSYSILANE

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Recent environmental regulations in numerous countries led to the replacement of hexavalent chromium compounds with other anticorrosion coatings. One of possibilities is also the deposition of barrier coatings, one of them being sol-gel coatings. Various alkoxy precursors were tested for anticorrosion purposes and among trialkoxysilanes 3-glycidoxypropyltrimethoxysilane (GPTMS) showed promising results. The important aspect of GPTMS is that on one side of its molecule sol-gel processes can occur, while on the other side of the molecule, the epoxy ring can open and form covalent bonds with amino groups. In this way compact and dense 3D network forms. As a source of amino groups aminopropyltrimethoxysilane, aminopropyl heptaisooctyl POSS and poly(dimethylsiloxane), aminopropyl terminated ($H_2N$-PDMS-$NH_2$) were used, the latter mainly due to the hydrophobic character of poly(dimethylsiloxane) chains. The condensation reactions were followed by IR spectroscopy, revealing that methoxy bands at 2840 and 820 $cm^{-1}$ disappeared from the spectra 30 min after the addition of 0.5 M acetic acid. Unfortunately, the IR bands of epoxy ring and silanol ?(Si-OH) stretching modes were superimposed at 910 $cm^{-1}$. The anticorrosion properties of coatings were characterised by different analytical techniques like potenciodynamic curves, cyclovoltammetry with a redox probe and electrochemical impedance spectroscopy. This research was funded from Slovenian research agency (ERA NET project Bonaco and Programme P1-0030).

KM

# EFFECT OF CHANGE OF CARBIDE PARTICLES SPACING AND DISTRIBUTION ON CREEP RATE OF MARTENSITE CREEP RESISTANT STEEL

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The creep rate dependence of particles coarsening and spacing as well as distribution in analysed considering quoted equations. A simple method for assessment of particle spacing is proposed. Accelerated creep rates at 580 °C for CrV and CrVNb steel after different tempering times at 800 and 650 °C are calculated and determined experimentally. The rate of microstructural processes increases the creep rate at 800 °C in the CrV steel by 36 times and in the CrVNb by 57 times greater.

KM

# RHEOLOGICAL BEHAVIOUR OF MESYLATE IMIDAZOLIUM-BASED ALKOXYSILYL-FUNCTIONALISED IONIC LIQUIDS

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One of the fields where ionic liquids have become increasingly important is their application as electrolytes in various electrochemical cells. However, despite their low vapour pressure the leakage from cells remains an important drawback. It was suggested to solve this issue by the preparation of polymerisable ionic liquids, therefore, we started the synthesis of iodide imidazolium-based ionic liquids that are alkoxysilyl-functionalised. Namely, alkoxy groups can react in sol-gel processes and form 3D network and therefore, the investigation of their rheological properties can give an insight in the most appropriate conditions of gelation. When iodide anion is exchanged by the mesylate one, such ionic liquids can dissolve certain amount of different lithium salts and be applied as electrolytes in battery-type of electrochromic devices. Herein we aim to describe the rheological properties of the newly synthesized bis end-capped 1,14-bis(3-(3-(3-methoxysilyl)propyl))imidazolium 1-il)-3,6,9 trioxa undecan dimesylate ($PEO_3$-di-TMSPIm+OMs-),1,29-bis(3-(3-(trimetoksisilil)propil))imidazolijev-1-il)3,6,9,12,15,18,21,24-oktaoksa heksakosan dimesilat (PEO8-di-TMSPIm+OMs-) and also organic-inorganic hybrid bis N-triethoxysilyl propylcarbamatoil PEO 400. The change of the structure from sol to gel was followed by rotational and oscillatory rheological measurements in order to show the difference in the gelation of mesylate ionic liquids and their mixtures with co-solvents. The research leading to these results has received funding from the European Community's Seventh Framework Programme (grant agreement n° 200431, INNOSHADE) and Programme P1-0030.

KM

# EVALUATION OF STEEL DESULPHURIZATION IN LADLE DURING UTILIZATION OF BRIQUETTING FLUXING AGENTS FOR SLAGS

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Fluxing agents for slags are routinely used at the steel processing in the ladle. Their basic task is to contribute to the creation of active slag that helps to the refining processes. A number of fluxing agents based on $Al_2O_3$ are commonly used in steelmaking industry. They are produced in various forms. The VŠB-TU Ostrava, FMME, Department of Metallurgy collaborates with the company JAP Trading, s.r.o. in the field of research and development of briquetting fluxing agents. These fluxing agents are made from secondary corundum raw materials created at production of electro-melted corundum. The paper presents the experience obtained from the plant experiments aimed at utilization of briquetting fluxing agent for slags in the conditions of steelwork TŘINECKÉ ŽELEZÁRNY, a.s. Objective of the plant experiments consisted in obtaining of basic information on refining capabilities of slags by assessment of the degree of steel desulphurization and its course. The substance of the research consisted in execution of plant experiments with fluxing agents for steelmaking slags based on $Al_2O_3$ at selected secondary metallurgy unit. During experiments continuous analysis of chemical composition of steel and slag was performed and temperature of steel was measured. Following the achieved results evaluation of steel desulphurization by the help of basic parameters (degree of desulphurization ηs, basicity, content of easily reducible oxides, $CaO/Al_2O_3$ ratio, Mannesmann s index etc.) was made. Currently evaluation of behaviour and course of dissolution of fluxing agents in steelmaking slags was realized. The work was prepared within solution of the program TIP project reg. No. FR-TI2/319 and FR-TI1/351.

KM

# THE EFFECT OF THE COOLING RATE ON THE SOLIDIFICATION SEQUENCE OF SELECTED STAINLESS STEELS

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In this study the solidification of an AISI 304LN stainless steel and the duplex stainless steel SAF 2205 at different cooling rates was studied using differential scanning calorimetry (DSC).
The samples were linearly heated above the liquidus temperature to 1550 °C at heating rates of 5, 10, and 25 K/min. The solidification (cooling) scans from 1550 °C involved the same selected ramps.
After the DSC measurements the samples were metallographically analyzed in order to reveal the variations in the solidification microstructures.
It was found that the cooling rate critically influenced the solidification. The solidification behavior, which depends on the cooling rate, determines the evolution of the microstructure.
In both cases, the cooling rate has an influence on the liquidus temperature and the width of the solidification interval. The liquidus temperature decreases with an increasing cooling rate. The value of reaction enthalpy in the solidification interval increases with an increasing cooling rate.

KM

# FINAL STRUCTURE PREDICTION OF CONTINUOUSLY CAST BILLETS

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In steel production, controlling and monitoring of quality, grade and structure of final steel products are being very important issues. It has been shown that the temperature distribution, the magnitude of temperature gradients as well as the cooling strategy during the continuous steel casting have a significant impact on material properties, a structure and a prospective defect formation of cast products. In the paper introduced model is an accurate computational tool intended for investigating the transient phenomena in continuously cast billets, for developing the caster control techniques and also for determining the optimum cooling strategy in order to reach all quality requirements. The numerical model of temperature field is based on the finite difference implementation of the 3D energy balance equation with the enthalpy approach. It allows to analyse the temperature field along the entire cast billet. Since the steel billets are produced constantly 24 hours per day, the transient temperature field is being computed in a non-stop trial run. It enables to monitor and investigate the formation of temperature field in real time within the mould and the secondary and tertiary cooling zones, whereas the observed information can straightway be utilized for the caster control optimization in a sense of the whole machine or an individual part. The application of presented model is demonstrated on two examples from real steelworks in Třinec, Czech Republic and Podbrezová, Slovakia. The influence of secondary cooling setting on the surface and inner defects formation and the final structure of 150 x 150 mm billet is also discussed for various operational conditions.

KM

# NUMERICAL AND EXPERIMENTAL INVESTIGATION OF CHEMICAL AND STRUCTURAL HETEROGENITY SOLIDIFICATION MASSIVE DUCTILE-CAST-IRON ROLLER

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The quality of the working rollers used for rolling rails is determined by the chemical and structural composition of the material of the rollers and the production technology. It is necessary to cast rollers with significantly improved utility properties, mainly high wear-resistance and optimal mechanical and structural properties. It is therefore necessary to find and ensure optimal relationships between the matrix structure and the resultant values of the mechanical properties of the rollers in order to maximize the length of life. The requirements introduced here cannot be ensured without knowledge of the kinetics of the solidification. Therefore numerical and experimental investigation of temperature field of the solidifying roller was conducted. The kinetics of the solidification has a measurable and non-negligible influence on the chemical and structural heterogeneity of the investigated type of ductile-cast-iron. Tying on to the results of the model of the temperature field of the cast rollers, an original methodology was developed for the measurement of chemical microheterogeneity. The structure of this cast-iron is created by a great amount of the transition form of graphite and small amount of globular graphite and also lamellar graphite and cementite, whereas the structure of the metal matrix is perlitic. The volume amounts of the structural components were determined using the quantitative metallographic analysis, according to which the places for the analysis of the element composition using X-ray energy-dispersive spectral micro-analysis were selected. The chemical and structural heterogeneity of the cast roller is therefore a significant function of the method of melting, modification and inoculation and the successive procedures of risering, casting and crystallization after cooling.

KM

# INFLUENCE OF COOLING RATE AND CHEMICAL COMPOSITION ON THE MICROSTRUCTURE OF THE Al-Mn-Be-Cu ALLOY

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Aluminum based alloys with quasicrystals became interesting because QC particles can be used as an alternative mechanism for hardening of some alloys. Al-Mn-Be-Cu alloys were produced by melting and chill casting into round molds of diameters of 2, 4, 6 and 10 mm. This allowed us to establish the influence of the cooling rate and chemical composition on the formation, fraction and morphology of the QC phase. Two chemical compositions were selected for that purpose. The major difference was the content of the Mn (4,5 and 1,8 at. %). For our analyses LOM, SEM and EDS were used. For determining the fraction of the QC phase computer software was used. Cooling rates were estimated by heat calculations and measuring DAS.

It was found that at cooling rates between 500 and 1350 $K \cdot s^{-1}$ the preferred phase formed was a QC phase – especially in the form of the quasicrystalline eutectic ($\alpha_{Al}$ + phase *i*). It also appeared as the primary phase. The fraction of the phase *i* increased with the decreasing diameter. Fractions of the phase *i* in the individual castings were higher in the alloy with a higher manganese content. In the case of the cooling rate below 500 $K \cdot s^{-1}$, the phase *i* did not form. Instead the competitive *H* phase appeared. In our case the only crystalline phases present $\alpha_{Al}$, $\theta$-$Al_2Cu$ and *H* phase. Also, morphology of the phase *i* depended on the content of the alloying elements and the cooling rate. In the alloy with a higher Mn phase *i* possessed dendritic form, while in the alloy with lower Mn it was in form of needles. With the distance from the edge of the sample and decreasing cooling rate the dendrites grew, the primary branches were thicker and the secondary branches started to grow as well. In the case of the needle morphology, the length and the thickness of the needles grow with increasing distance from the sample edge.

KM

# ELECTROCHROMIC IRON OXIDE THIN FILMS FOR POLYMERIC SUBSTRATES

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Iron oxide thin films with intercalation properties have been prepared by sol-gel alkoxide route and also from inorganic salt precursors, applying the thermal-treatment at T ? 250 °C. Herein we present a novel peroxo sol-gel route that enable the preparation of iron oxide thin films at temperature of 150 °C, i.e. appropriate for their deposition on polymeric ITO-PET substrates. Such films enable their roll-to-roll (R2R) deposition and the construction of flexible electrochromic (EC) devices in combination with nickel oxide films. As deposited iron oxide films were of pale yellow colour and exhibited reversible cathodic coloration (brown) and anodic bleaching (pale yellow to transparent). It was found that coloration efficiency ?(?) reached values of ~30 $cm^2$/C, being comparable to anodic substoichiometric nickel oxide films and also cathoic WO3 films. The monochromatic optical modulation of about 30 % was achieved at ? = 634 nm during switching between +1 V and -2.1 V vs. Ag/AgCl reference electrode. The constructed flexible EC device composed of glass/FTO/NiOx (150 °C)/Li-ion-conductive-polymer-membrane/FeOx (150 °C) /FTO/glass confirmed the applicability of iron oxide films in such systems and optical modulation of about 20 % at 634 nm. The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7) under grant agreement n° 200431 (INNOSHADE).

KM

# MICROSTRUCTURE IN SAF 2507 SUPER DUPLEX STAINLESS STEEL

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The change of microstructure for a super duplex stainless steel SAF 2507 during hot rolling was investigated. Its evolution during hot deformation was very different in each phase. The dominant restoration mechanism for ferrite and austenite were dynamic recovery (DRV) and dynamic recrystallization (DRX), respectively. Also, the effect of temperature on the deleterious phase precipitation was investigated. The specimens were heat treated isothermally in the temperature range 800 °C to 1000 °C. Hardness tests, and optical and scanning electron microscopy were used to detect the sigma phase.

KM

# SYNTHESIS OF ALUMINIDE ON STEEL SUBSTRATE

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The spark alloying enables transfer of metallic material from the electrode into substrate. Due pulsed spark the heat transfer into substrate is limited. Exothermic reaction at formation of aluminides enables diffusion bonding among substrate and added material. The basic condition is that substrate is able to form aluminide. Presented are results of light microscopy and EDS analyses of in situ formed nonstechiometric Fe-aluminides. The characteristic of aluminide is formation of protective $Al_2O_3$ layer that is stable even at temperatures higher than 950 °C at which the $Cr_2O_3$ oxide start to degrade. In comparison with stainless steel the resistance of the surface to oxidation increases. In the case of Fe-aluminide increases also the resistance to sulphidation. That means the thin layer of Fe-aluminide can be used in thermal power plants for protection of boiler tubes exposed to sulfur from the coal.

KM

# DETERMINATION OF FERRITIC STAINLESS STEEL PROPERTIES FOR THE STRUCTURAL APPLICATION IN THE CONSTRUCTION INDUSTRY

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Ferritic stainless steels are low cost, price-stable, corrosion-resistant steels. Although widely used in the automotive and domestic appliance sectors, structural applications in the construction industry are scarce. The project SAFSS seeks to develop the necessary information which will enable comprehensive guidance on ferritic stainless steels to be included in the relevant parts of the Eurocodes and other accompanying standards and guidance. Presented are test methods for determination of steel properties, necessary for implementation in Eurocode and other standards as well as results of mechanical tests of bolted connections and atmospheric corrosion on test stand.

Feritna nerjavna jekla uvrščamo med cenejša, cenovno stabilna korozijsko odporna jekla. Množično se uporabljajo v avtomobilski industriji in v industriji gospodinjskih aparatov, za konstrukcije pa le v posameznih primerih. V okviru projekta SAFSS želimo pridobiti potrebne informacije o lastnostih feritnih nerjavnih jekel, kar bo omogočilo vključitev te vrste jekla v Eurocode in v druge ustrezne standarde in navodila. Predstavljene so preskusne metode za določanje lastnosti jekla, potrebnih za vključitev v Eurocode in v druge standarde ter rezultati mehanskih preiskav vijačenih veznih spojev in atmosferske korozije na stojalu.

KM

# MAGNESIUM ALLOYS FOR HYDROGEN STORAGE

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Hydrogen is considered as potential fuel for the future transportation. In addition, it is also promising medium for the storage of energy from renewable sources. However, hydrogen storage still represents technological and also safety problems, because hydrogen is explosive gas and easily penetrates through many materials. For this reason, hydrogen storage requires expensive pressure and cryogenic containers. A promising alternative is hydrogen storage in the form of metallic hydrides. Hydrides are stable and safe compounds and release hydrogen upon heating at sufficient temperatures. Among hydrides, magnesium-based hydrides have been extensively studied, because magnesium is light, relatively inexpensive and capable of storing up to 7.6 wt. % of hydrogen in the form of $MgH_2$. Classical methods of hydride synthesis include elemental synthesis from metal and gaseous hydrogen at high temperatures and pressures. This method is, however, difficult and expensive, and it results in high costs of Mg-based hydrides. For this reason, hydrogen storage in pressure and cryogenic containers is still preferred at present. Recently we have shown that preparation of Mg-based hydrides can be realized by a more simple electrochemical process in which a selected magnesium alloy is the cathode and reacts with atomic hydrogen formed by electrochemical reaction to directly produce Mg-based hydrides. In this study, structure, phase composition and electrochemical hydriding efficiency of various Mg-based alloys are characterized to find the most prospective hydrogen storage materials.

KM

# HEAT TREATMENT OF TUBES FROM MICROALLOYED STEELS IN ŽELEZIARNE PODBREZOVÁ INC.

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Microalloyed steels (HSLA) have wide range of use in construction applications in automotive, building and machine industry. Zeleziarne Podbrezova deliver products to customer according to European norm EN10208-2 and API5L. The goal of the research is produce from one chemical composition of steel, different steel grades according to both norms. Goal of the research was to reach different properties on one chemical steel composition with heat treatment.

In article are presented results of laboratory heat treatment of tubes from microalloyed steel in a temperature range 650 – 950 °C. For test were used hot rolled tubes with dimension 42,4 × 3,2 mm and 42,4 × 5,6 mm and cold drawed tubes with dimension 36 × 5 mm.

Observed were mechanical properties, microstructure and substructure by different temperatures of heat treatment.

KM

# AES ANALYSIS OF INTERNALLY OXIDIZED MICROALLOYED 24-CARAT GOLD

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Gold is one of the most desirable metals in medical applications, due to its superior characteristics regarding chemical resistance and biocompatibility, which were proven by various clinical tests. Main problem of pure gold lies in its poor hardness (27HV), low yield stress (20 N/mm$^2$) and consequent weak wear resistance.

Latest reports in development of gold alloys with improved properties, have shown importance of some alloying elements from rare earths (RE) group, which have ability to improve mechanical properties already in very small concentrations. In this research lanthanum was chosen on basis of strengthening effects criterias. Chemical characteristics of lanthanum can besides solid solution and cold work strengthening reflect also dispersion strengthening with $La_2O_3$ particles, which can form under suitable conditions.

Alloying elements in gold structure can not react with oxygen under normal circumstances, because of its negligible solubility in gold solid solution $\alpha_{Au}$. To achieve conditions for internal oxidation, thin Au-0.5La ribbons were made with rapid solidification technique. Rapid solidification enabled metastable structure oversaturated with point defects. For monitoring thermodynamical processes in material, we used annealing at 750 °C with different time periods ($t_1$=16 min, $t_2$=49 min, $t_3$=90 min). Metallographic preparation of Au-0,5La samples proved to be very challenging. Best results were obtained with cutting in perpendicular direction to the ribbon length. Samples were cleaned in alcohol for 30 minutes, then ion etched with argon ions (3 keV and 0,5 μA) for 10 minutes.

With AES (Auger Electron Spectroscopy) method presence of oxidized microalloying elements was proven. AES also enabled determination of particles size and particle distribution in surface layer. With analysis of samples, thermally treated under different conditions, the optimal conditions for internal oxidation of Au-0,5La alloy was determinated. Dispersion hardening was also monitored with microhardness measurement.

AM

# SIMULATION OF LATENT HEAT THERMAL STORAGE INTEGRATED WITH THE ROOM STRUCTURES

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The phase change of a material is accompanied with the release or absorption of a huge amount of heat. That makes the phase change a phenomenon effectively usable in various thermal storage applications. There is a number of materials with the melting temperature lying within the thermal comfort range for indoor environments. These materials can be used in building-integrated thermal storage. The performance of such latent heat thermal storage integrated with the room structures was investigated through numerical simulations and experiments. The studied case involved two adjacent rooms of the same dimensions. The hydrated-salt based phase change material (PCM) was used as a thermal storage medium. A comparative approach was adopted in which the internal structures of one of the rooms contained the PCM while the structures in the other room did not. The simulation model of the rooms was created in TRNSYS 17 and this model was coupled with a PCM model created in MATLAB. The enthalpy approach was used for the simulation of phase change. The adopted approach allowed for different time steps in the room model and the PCM model (the time step in the PCM model needed to be shorter). The data from the real scale experiments (ventilation rates, temperature of supply air, outdoor temperature, solar radiation intensity, etc.) as well as the physical properties of the PCM acquired in laboratory testing were used as inputs to the simulation models. The simulation results were compared to the experimentally obtained data and evaluated.

AM

# PREPARATION OF HOMOGENOUS COARSE-GRAINED ZNO-BASED CERAMICS DOPED WITH $Bi_4Ti_3O_{12}$

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ZnO-based varistor ceramics is polycrystalline ceramics characterized by their non-linear current-voltage (I-V) characteristic. Breakdown voltage of the varistor depends on the average ZnO grain size: for high-voltage applications, small average grain size is required while for low-voltage applications coarse-grained ceramics is required. In addition, a narrow distribution of grain sizes is advantageous to obtain superior I-V characteristics. $Bi_2O_3$ is the essential dopant for the occurrence of the varistor effect to occur, while $TiO_2$ is the typical additive for the preparation of coarse-grained low-voltage varistor ceramics. Both dopants can also be added in the form of $Bi_4Ti_3O_{12}$ (BIT) compound. Sintering of ZnO with small additions of $Bi_4Ti_3O_{12}$, according to the conventional sintering regime by slow heating, results in the formation of inversion boundaries (IBs) only in some ZnO grains. These grains grow exaggeratedly and the resulting microstructure is inhomogeneous, composed of a few extra-large ZnO grains in matrix of small ZnO grains.

AM

# CONCENTRIC ELECTRON PROBE – A NEW ANALYTICAL METHOD CHEMICAL COMPOSITION OF INTERFACES ON THE SUB-NM SCALE

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Measuring the exact chemical composition of an interface or a boundary within crystalline matrix is a key issue in materials science. The main drawback encountered in quantification of analytical spectra obtained by i.e. energy-dispersive X-ray spectroscopy (EDS) or electron energy-loss spectroscopy (EELS) is associated with the estimation of volume of analysis. Therefore in most instances the fraction of the analyzed interface is not precisely known leading to erroneous interpretation of the interface structure. Most common techniques for analyzing the interface composition are line profiling and spatial difference method. Line profiling is based on acquiring several spectra across the interface, while the spatial difference method relies on the normalized difference between spectrum on the interface and that recorded on the crystal close to the interface. Both methods suffer from rather inaccurate estimation of the volume of analysis due to local specimen thickness variations. In order to improve the poor accuracy and precision of these methods we have developed a new technique for accurate measurement of chemical composition of solids at the atomic scale. It is based on acquiring both EDS or EELS spectra with concentric electron probes (CEP). Our method is two orders of magnitude more precise and accurate than the conventional spatial difference technique, allowing determination of down to ~0.1 atoms/nm$^2$, depending on the type of the trace element in the interface plane. Because of its high precision we could extend the use of this method not only to accurately measure the amount of the trace element on the interface but also to determine complex solute distribution profiles in the interfacial region. In this type of applications of the CEP method the simple step-distribution profile is replaced by an appropriate Gibbsian distribution function under which the amount of the solute is integrated over the cylindrical probe centred across the interface. The equations are solved to obtain a matrix/dopant intensity ratio as a function of the CEP beam radius.

AM

# TWO NUMERICAL MODELS OF SOLIDIFYING AND COOLING OF A CERAMIC CASTING OF EUCOR

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Corundo-baddeleyit material (CBM) – EUCOR – is a heat- and wear-resistant material even at extreme temperatures. The solidification and cooling of EUCOR in a non-metal (sand) mold is a very complicated problem of heat and mass transfer with a phase and structural changes. A numerical model of the temperature field of the entire system comprising the casting of EUCOR, the mold and ambient was created and used an original application of the software ANSYS. It was possible to use all sophisticated sub-programs of ANSYS, such as automatic mesh generation, pre-processing and post-processing. The simulation of the release of the latent heats of phase or structural changes was carried out by introducing the thermodynamic enthalpy function. It enables the evaluation of the temperature field within the actual casting and mold at any point in time within the process of solidification and cooling. The paper introduces the results of an original optimization of the technology of casting of EUCOR. Furthermore, it is possible to calculate the temperature gradient at any point and time, and also determine the local solidification time and the solidification interval of any point. The local solidification time is one of the input parameters for the second cooperating model of chemical heterogeneity. This model and its application on EUCOR samples prove that the applied method of measuring the chemical heterogeneity provides the detailed quantitative information on the material structure and makes it possible to analyze the solidification process. The analysis of this process entails statistical processing of the measurement results of the heterogeneity of the EUCOR components and performs the correlation of individual components during solidification. The verification of both numerical models was conducted on a real cast 350 × 200 × 400 mm block.

AM

# MICROSTRUCTURE DEVELOPMENT OF Ni-GDC ANODE MATERIAL FOR IT-SOFC

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NiO-GDC based materials is a potential candidate for the suitable low-temperature SOFCs anode material. In the present research work modified combustion synthesis was used for the preparation of NiO-GDC. The main advantage of the preparation method employed was, that after the synthesis both phases NiO and GDC in the product were randomly distributed on a nanometre scale. The citrate-nitrate (c/n) ratios in the reaction mixtures were 0.15 and 0.18. The prepared powder were isostatically pressed into pellets, sintered at 1200 °C, 1250 °C, 1300 °C, 1350 °C and 1400 °C, reduced and subsequently submitted to microstructure analysis. Crystallite size of both phases in as prepared powders as well as the grain size of nickel in reduced samples depended much on the slight variation of the c/n ratio in the starting reaction solution. In as synthesized samples crystallite sizes were calculated as 4,3 and 40 nm for GDC phase and 7,6 and 48 nm for NiO phase for samples with c/n ratio 0.15 or 0.18, respectively. In sintered and reduced samples under different conditions the final average particle size of Ni ranged from 71 to 146 nm and from 143 to 254 nm, while GDC grains ranged from 84 to 193 nm and from 96 to 247 nm for samples with c/n ratio 0.15 or 0.18, respectively. Temperatures from 1200 to 1250 °C were recognized as the most appropriate temperature interval which provided the smallest Ni grains in the final Ni-GDC cermet with an average Ni-particle diameter around 70 nm.

P

# REBOUND AND VISCOELASTIC PROPERTIES OF CROSSLINKED RUBBERS

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Since advantageous properties of crosslinked rubbers, such as high elasticity, are exhibited in rubbers amorphous state, these materials, owing to their polymeric structure, retain some viscoelastic characteristics, which, however, are quite beneficial for particular purposes. Due to covalent intermolecular bonding, crosslinked rubbers cannot flow, but certain stress-strain phase difference during time-dependent deformation still exists, causing internal friction with heat generation and subsequent viscoelastic traits in form of energy hysteresis, stress relaxation and Mullins effect. These phenomena may then expediently be used for applications in vibration damping, tyre traction, dynamic sealing, abrasion resistance, etc. Viscoelastic properties of crosslinked rubbers can effectively be described by mechanical dynamic functions: the storage modulus , a characteristic of elastic energy stored during deformation proces, the loss modulus , responsible for energy dissipation due to internal friction, and their ratio, a function of the stress-strain phase angle , , called the loss tangent, providing simultaneous information on resilience and energy loss. These quantities can readily be measured, necessitating, however, sophisticated and often expensive equipment. Yet, sometimes, when theory allows it, a good material characterization may be obtained by simpler and cheaper methods. Such is the case concerning of crosslinked rubbers, itself accountable for the above-noted application issues. This quantity, namely, is rigorously linked with a specific pendulum rebound from rubber specimen surface and thus promptly obtainable by a plain experiment. The aim of this work is to show the relevant theoretical relationship between the rebound and , as well as various supporting results from experience.

P

# DEVELOPMENT OF 3D PRINTER FOR THERMOPLASTIC MODELLING

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Additive technologies are entering the market in all price segments and the development of new machines and materials is rapidly growing. Machines under 2000 EUR are more and more interesting for home made and educational use. This paper presents the development of the 3D printer that shapes the parts layer by layer by depositing the material on the predefined position. The development is presented from an engineer point of view. Presented are the construction steps, the control and actuator solutions. ABS plastic was analysed for the material properties. The 3D printer evolved from prototype to pre-production phase.

NN

# THE INFLUENCE OF SELECTED PARAMETRS OF HYDROTHERMAL SYNTHESIS ON THE PROPERTIES OF $TiO_2$ PHOTOCATALYST

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Titania is one of the most commonly used materials in everyday life. It is mostly used as a white pigment, however, it has also shown some remarkable properties as a photocatalyst. We have studied the influence of selected synthesis parameters on the photocatalytic activity in the visible light and some other properties of nanocrystalline titania. The goal was to study whether we can get photocatalytically active titania in the visible light spectrum from two precursors, namely titanium tetrachloride and titanium oxosulphate, using a simple synthesis approach. We have focused primarily on identifying and optimizing the most photocatalytically active mixture of rutile and anatase. We have synthesized $TiO_2$ by employing the hydrothermal method. The variables in synthesis were the type of precursor ($TiC_{l4}$ or $TiOSO_4$), pH, addition of isopropanol and precursor concentration. The products were characterized using XRD, photocatalytic activity measurments, BET specific surface area measurements and FE-SEM. The results have shown that lowering pH and adding isopropanol to the reaction mixture before heating favor formation of the rutile phase and thus increase the photocatalytic activity in the visible light. The starting concentration also has a major influence on the anatase:rutile ratio. In samples in which the mass concentration of $TiOSO_4$ in water was between 10 and 20 % the anatase:rutile ratio was increasing with increasing concentration. FE-SEM images of rutile have shown elongated particles, 20–100 nm in length and 10–40 nm in width, while anatase particles were spherical in shape and about 10 nm in diameter. The most photocatalytically active samples consisted of about 80 % rutile and 20 % anatase.

VT

# ETCHING RATES OF DIFFERENT POLYMERS IN AN OXYGEN PLASMA

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Comparison of etching of different polymers in an oxygen plasma was studied. The plasma was created in an electrodeless radiofrequency discharge at a frequency of 27.12 MHz and a power of 200 W. Oxygen pressure was fixed at 75 Pa. The degradation of the polymers by oxidation with plasma particles was monitored by measuring the weight loss of the polymer samples. The samples were weighed just before mounting into the plasma reactor, and then again just after the plasma treatment. The following polymers were used in this study: PET (amorphous and semicrystalline), PMMA, PS, LDPE, HDPE, PVC and PTFE. When comparing etching rates of different polymers we could not find any good correlation between the chemical structure of polymers and their etching rates. The polymer etching rate was linearly increasing with treatment time. This was explained by the heating of the samples during plasma treatment. The only exception was PTFE where the etching rate was constant. For PVC polymer extremely high etching rates were observed. While a characteristic of PMMA polymer was very low etching rate at the beginning which was followed by an exponential increase of the etching rate with treatment time.