General Poster Session

Sponsored by: The Minerals, Metals and Materials Society, TMS Electronic, Magnetic, and Photonic Materials Division, TMS Extraction and Processing Division, TMS Light Metals Division, TMS Materials Processing and Manufacturing Division, TMS Structural Materials Division

Program Organizer: Mark Palmer, Kettering University

Mon PM-Wed PM
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A Low Cost Method for Manufacturing of Aluminum/Alumina Composite by Anodizing and CRB Process: Roohollah Jamaati[1]; *Mohammad Reza Toroghinejad*[1]; E. Zahrani[1]; [1]Isfahan University of Technology

In this work, Al/Al2O3 composite strips are manufactured by a low cost method consist cold roll bonding (CRB) process of anodized aluminum strips. This technique has the flexibility to control the volume fraction of metal matrix composites (MMCs) by varying the oxide layer thickness on the anodized aluminum strip. Meanwhile pre- and post-rolling annealing treatment was performed on some produced MMCs. Microstructure, hardness, tensile strength, and elongation of composite strips are investigated as a function of alumina quantity and the applied production method. It is found that higher quantities of alumina improve hardness and tensile strength, while the elongation value decreases negligibly. Furthermore, pre-rolling annealing was found to be as the best method for producing this composite via the anodizing and CRB processes. Finally, it was found that both monolithic aluminum and aluminum/alumina composite exhibited a ductile fracture, having dimples and shear zones.

A Model for Diffusion Bonding of Cu and Al Plate by Hot Compression: *Yong-Shin Lee*[1]; Sang-Hun Yoon[1]; Sangmok Lee[2]; [1]Kookmin University; [2]KITECH

It is well known that bonding of bimetal such as Cu and Al plates by hot compression is accomplished by diffusion. Here, hot compression experiments with Cu and Al plates are carried out for the wide ranges of experimental conditions such as temperature, and compressive load, and load holding time, which are known as the most important factors for the success of diffusion bonding. It is very difficult to observe the bonding and deformation behaviour near the contact surface. Finite element simulations for hot compression tests are also performed to examine the detailed behaviours of state variables near the bonded surfaces. Eventually, the bonding criterion for Cu and Al plates by hot compression is given in terms of temperature, compressive load, and holding time, which will be used to design a combined process of hot compression and hydrostatic extrusion of Cu clad Al bar.

A Study on the Characteristics of Truck Materials Using Structural Steel: *Sung Cheol Yoon*[1]; [1]Korea Railroad Research Institute

The truck of railroad vehicle is major part affecting the operational performance of vehicle and supporting the vehicle load. A truck is composed of frame, wheel, axle, suspension, and damping device. Among these parts, the truck supporting vehicle weight is considered one of the most important parts. This study aims to check out problems related to the characteristics of truck materials by measuring the stress in each truck location after giving maximal vertical load, right and left load, and front and rear load. Before the test, a stress distribution analysis of the truck was performed after conducting a structural analysis. A material test was then performed after deciding on the measuring location by referring to the structural analysis findings. As a result of the material characteristic test, it was verified that the truck meets safety requirements of a railroad vehicle.

A Study on the Effect of Sintering Atmosphere on the Microstructural Properties of Injection Molded T42 High-Speed Steel: *Kyoung-Rok Do*[1]; Sung-hyun Choi[1]; Jinhwa Kim[1]; Young-Sam Kwon[2]; Young-Sam Kwon[2]; Kwon-Koo Cho[1]; In-Shup Ahn[1]; [1]Gyeongsang National University; [2]Cetatech, Inc

HSS have high strength, wear resistance, and hardness together with an appreciable toughness and fatigue resistance. PIM was received attention owing to shape without additional processes. The experimental specimens were manufactured using the PIM with T42 powders (59 vol.%) and polymer (41 vol.%). The green parts were solvent debinded in n-Hexan at 60° for 24 hours and thermal debinded at N2-H2 mixed gas atmosphere for 18 hours. Specimens were sintered in high vacuum (10-5mtorr), low vacuum (10-2mtorr), N2, H2, and Ar gas atmosphere. When sintering at 1240°, the specimen sintered at high vacuum had highest hardness (520Hv). The Carbides were smaller (1μm) and well distributed. The grain size was 10μm. When sintering at high vacuum over 1260°, the carbides were changed to eutectic carbide and located at grain boundary. The grain growth was observed. The specimen sintered at other atmosphere had lower density and hardness than high vacuum.

A Study on the Structural Safety of the High-Speed Railroad: *Sung Cheol Yoon*[1]; Jeongguk Kim[1]; Joon Hyung Ryu[1]; Kang Youn Choe[1]; Gyeong Hoan Park[2]; [1]Korea Railroad Research Institute; [2]Hyundai Rotem

This study describes the structural analysis and load test to evaluate the safety of the high-speed railroad frame. It aims to evaluate the structural safety of the high-speed railroad frame when adding tare weight and passenger load to it. The high-speed railroad frame is considered an important railroad vehicle structure supporting major equipment such as electrical devices and heavy machines. It is composed of an underframe, side frame, roof, and interior materials. The load test was performed based on the loading conditions of "The guide on safety standard of railroad vehicle" of the Railroad Safety Act currently being used in Korea. The internal stress measuring location of the load test was selected by referring to the structural analysis findings. The high-speed railroad frame was found to be safe in terms of design load as a result of seven types of load tests such as the load test on operational condition.

Abnormal Grain Growth in Alloy 2195 Friction Stir Welds: *Anupam Kundu*[1]; Tony Reynolds[1]; [1]University of South Carolina

In this study we examine the effects of welding parameters, post weld deformation levels, and deformation temperature, on the propensity for AGG in 2195 friction stir welds. Three welding parameters sets were used. The welding speed was held constant while high, medium, and low tool rotation rates were applied resulting in three different power levels and, consequently, three different initial weld nugget grain sizes. Subsequently, deformations in compression up to engineering strains of 50% were imposed at room temperature, 200°C, and 340°C. Deformed specimens were solution heat treated in a salt bath for times up to 1 hour and the grain growth was characterized by optical microscopy. Depending on the starting condition and the deformation conditions, varying levels of secondary recrystallization, normal grain growth, and AGG were observed.

Aerosol Route Synthesis of Lithium Borate Spheres Using Lithium Nitrate and Boric Acid Solution: *Burcak Ebin*[1]; Sebahattin Gurmen[1]; Cuneyt Arslan[1]; [1]Istanbul Technical University

Lithium borate has a potential to use various field from solid state batteries to sensors owing to its high conductivity and piezoelectricity. In this study, lithium borate spheres were synthesized by thermal decomposition of lithium nitrate and boric acid aerosols droplets atomized in ultrasonic nebulizer under air atmosphere. Energy dispersive spectroscopy (EDS) was performed to determine the chemical composition of prepared structures. Boron detected in the EDS analysis, and peaks of possible impurities were not observed. Also, size, shape, and surface morphology of samples were characterized by scanning electron microscope (SEM). Images revealed that non-agglomerated lithium borate particles were produced in spherical morphology with smooth surface, but particles had relatively wide size distribution between 50 nm and 1100 nm. The X-ray diffraction measurement was employed to identify

the crystalline phase, and the absence of clear diffraction peaks in the pattern indicates that obtained lithium borate particles have amorphous structure.

Aging Effect of Aluminized Coating Layer for Ni-Base Superalloy: *Tae Sun Jo*[1]; Jeong Hun Lim[1]; Dae kyung Kim[1]; Young Do Kim[1]; [1]Hanyang University

Ni-base superalloy is a candidate material for the high temperature applications such as turbine blades, structural materials for nuclear reactors, and high-temperature gas-cooled reactors. In this work, aluminized Ni-base superalloy was investigated about the formation and growth of coating layer by high temperature aging. Al-pack cementation was carried out at 1000° C for 1 h in Ar using an Al_2O_3 crucible containing the specimen and a powder mixture of Al : Al_2O_3 : NH_4Cl = 15g : 83g : 2g. The aluminized Ni-base superalloy was aged at 950°C for 480 h in air. The phase analysis of coating layer was carried out by XRD, SEM, EPMA and TEM. The hardness of coating layer was measured by nanoindentation. This work was financially supported by Ministry of Education, Science and Technology (MEST) through the Nuclear Hydrogen Technology Development (NHTD) program.

An Empirical Model of Rehydration/Rehydroxylation Kinetics for Archaeological Ceramics: *Patrick Bowen*[1]; Timothy Scarlett[1]; Jaroslaw Drelich[1]; [1]Michigan Technological University

Fired-clay ceramic rehydroxylation dating has recently been proposed as a new chronometric dating tool for use on archaeological ceramics. The technique relies upon the well-known characteristic of fired clay objects to take up water in a slow manner, which has been shown to follow a (time)^1/4 power law. Experiments were conducted in which the mass measurements taken from 19th century ceramic artifacts revealed a deviation from the (time)^1/4 power law over a wide range of temperatures. These findings have led to the formation of a general empirical equation which describes the observed rehydration/rehydroxylation behavior.

An Investigation of the Electrochemical Properties of TiAlCrN PVD Coated in STS304: *Min-Seok Moon*[1]; Kee-Do Woo[2]; Chan-Won Kwak[3]; Jin-Won Han[3]; Myeong Han Yoo[2]; Dae Up Kim[4]; [1]Chonbuk National University, Jeonju Institute of Machinery Carbon Composites; [2]Chunbuk National University; [3]Se-Won Hard Facing Co., Ltd.; [4]KITECH

In the PEM fuel cell need to reduced weight and total fabrication cost of a fuel cell stack, and increased durability during the operating condition. Typically bipolar plates are a key component of PEMFC and other Fuel cells. In order to reduce both the weight and cost of the bipolar plates, nowadays consider attention is being paid to developing metallic bipolar plates to replace dense graphite. In this study, try to TiAlCrN nitride coating process on an austenitic stainless steel (STS304) using a PVD technology (plasma enhanced reactive evaporation) to increase the corrosion resistance of the STS304. Contact angle, SEM, and potentiodynamic tests were used to characterize the TiAlCrN Nitride coating process on the STS304. This study is focus on the best PVD nitride coating process for the corrosion resistance in the PEMFC operating conditions, and could potentially be used in PEMFCs as a bipolar plate material requirement.

An Investigation of Wire Drawing of Hyper-eutectoid Steel Wires: *Byung In Jung*[1]; [1]POSCO

The mechanical properties of high strength steel wires are affected tremendously by wire-drawing process. Among the parameters of drawing process, the approach angle of drawing die is one of the most important parameters in the process. It can create microstructural inhomogeneity inside the material, resulting in the loss of strength and the degradation of ductility. The degradation of ductility in drawn steel wires often causes "delamination," the longitudinal fracture during stranding wires for tire cords or bridge cables. The optimized wire drawing conditions effectively increased the attainable tensile strength and minimized the occurrence of delamination. The effects of several wire drawing parameters on the mechanical properties and microstructures were investigated by finite element analysis and the simulated results were compared to the wire drawing experiments.

Analysis of Human Osteoporosis Compact Bones by Neutron Scattering and X-Ray Diffraction Methods: *Yong Choi*[1]; A. Pirogov[1]; Doo Jin Baik[1]; E. J. Shin[1]; B.S. Seong[1]; [1]Sunmoon University

Neutron scattering and X-ray diffraction methods were applied to analyze nano-structure of normal and osteoporosis Korean compact bones to give a criterion for more precise decision and find a unique healing method about bone diseases like osteoporosis. The SANS profiles of the bones show a directional and regular distribution of plate-like bony crystals and bundles of bony crystals between collagen fibers. Lattice parameters of the bones depend on the type of bones and sex. Osteoporosis compact bones have less amounts of the bony crystal than normal compact bones. The change of the lattice parameters of the bony crystal is observed, especially, in case of the bones with low bone mineral density(BMD). It is related to mineralization process and the extraction of calcium and oxygen ions at special sites of the unit cell.

Application of the Creep Continuum Damage Mechanics Unified Law for a Gas Turbine Rotor: *Ali Nayebi*[1]; Hamid Ranjbar[1]; [1]Iran

In this research the unified creep continuum damage mechanics model was used to model the stress – strain behavior of a gas turbine rotor. The unified damage law can be applied for the creep and LCF damage. It is based on the increment of the accumulated inelastic strain which can be due of creep damage or of the low cycle fatigue damage. Based on the relaxation tests, the parameters of the unified CDM model, including S and s and Norton constants, were optimized and determined. Creep damage was modeled and stress – strain evolution in the gas turbine rotor was obtained. A careful three dimensional thermal analysis permitted to determine the thermal stresses which was superposed on the mechanical stresses of the gas turbine rotor. The Replica tests were done on the four points of the rotor surface and the formation of the creep voids was verified by an SEM.

CALPHAD and DFT Assessment of Metallic Alloy Fuel Materials: *Saurabh Bajaj*[1]; Raymundo Arroyave[1]; Alexander Landa[2]; Patrice Turchi[2]; [1]Texas A&M University; [2]Lawrence Livermore National Laboratory

A promising choice for fuel in Gen-IV reactors are metallic alloys where an actinide is alloyed with a high-melting transition element. The burn-up process in these systems leads to transmutation to minor actinides and variability in fuel chemistry and thus, a phase stability study would be beneficial in improving our understanding of alloy formation in these alloys. In the present work, phase diagram calculation (CALPHAD) and the DFT based EMTO-CPA methods are employed to investigate heats of formation of the bcc and intermetallic δ-phase. This δ-phase forms in a hexagonal C32 structure and is analogous to the high-pressure ω-phase in pure Zr. Examples include UZr2, NpZr2 and U2Ti. A random occupation of atomic sites makes these phases non-stoichiometric in nature. The work at LLNL was performed under the auspices of U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344.

Characteristics of the Gas Dispersion Generated through a Jet Sparger in Aqueous Media: Ramiro Garcia[1]; *Francisco Tavera*[1]; [1]Universidad Michoacana

In the gas-liquid and gas-liquid-solid systems where chemical reactions and mass transfer phenomena take place, the efficiency of such process depends on the characteristics of the dispersions. Four jet spargers with variable gas discharge were installed in both a flotation laboratory cell and a 0.50 m flotation column, in order to produce a gas dispersion in liquid media.Experimental data of bubble diameter, gas holdup, and bubble surface area rate were obtained. The average Sauter bubble diameter was measured for every experimental point through the photography-image analysis technique, whereas the estimated bubble diameter was calculated by applying the drift flux model. The gas holdup was measured through a sensor based on conductivity. A mathematical from experimental data was derived relating the bubble diameter with the pressure drop inside the bubble generator, the superficial flowrate in the tailings stream, the surface tension of the media, and the dimensional characteristics of the sparger. The model was validated by running a set of experiments in a 0.50 m flotation column with the same four spargers installed. Experimental results show that there

is possible to scale-up or design bubbles for a given application using the spargers described in this work.

Characterization and Synthesis of Adsorption Material with Hematite and Polystyrene: *He Dewen*[1]; Zhou Huannian[1]; [1]Central South University

In this study, a three dimensionally ordered macroporous (3DOM) hematite was prepared with a polystyrene template and characterized by X-ray diffraction (XRD), scanning electron microscope (SEM), transmission electron microscope (TEM), and nitrogen adsorption isotherm. The 3DOM hematite has a porous structure with macropores of 200-nm in diameter and walls of 20-nm in thickness. The adsorption of Pb2+ and Cd2+ ions in aqueous solution by 3DOM hematite was also evaluated. At room temperature, each gram hematite adsorbs 12.5 mg of Pb+ and 7.0 mg of Cd+. The results suggest that 3DOM hematite may be a promising adsorbent to remove Pb+, Cd+, and possibly other heavy metal ions from aqueous solution.

CO2-Corrosion of Steels Exposed to Saline Water Environment: *Anja Pfennig*[1]; [1]HTW Berlin

With CO2 being one reason for climate change carbon capture and storage (CCS) is discussed to mitigate climate change. When emission gases are compressed into deep geological layers CO2-corrosion can easily cause failure of injection pipes. Different steels used as injection pipe X46Cr13 and X20Cr13 were tested as well as X35CrMo17 and X5CrNiCuNb16-4 in a laboratory environment similar to the conditions of the CCS engineering site at Ketzin, Germany. Samples were exposed to synthetic aquifer saturated with technical CO2 at a flow rate of 3 l/h. After 1000 h of exposure time pits are found on all 3 with maximum pit heights around 20 µm. Corrosion rates obtained via mass loss vary in a wide range (0,005 to 2.5 mm/year). The precipitations within the corrosion scale revealed a complicated multiphase layer containing siderite FeCO3, goethite a-FeOOH, lepidocrocite g-FeOOH, mackinawite FeS and akaganeite Fe8O8(OH)8Cl1,34 and spinelphases of various compositions.

Coarsening of Beta´ Precipitates in an Isothermally-Aged Fe75-Ni10-Al15 Alloy: Orlando Soriano Vargas[1]; *Victor Lopez-Hirata*[2]; Hector Dorantes-Rosales[2]; Maribel Saucedo-Muñoz[2]; Erika Avila-Davila[3]; Susana Lezama-Alvarez[2]; [1]Universidad Autonoma del Estado de Mexico; [2]Instituto Politecnico Nacional (ESIQIE); [3]Instituto Tecnologico de Pachuca

The coarsening process of the beta prime precipitates was studied in an isothermally aged Fe75-Ni10-Al15 alloy. The aging treatments at 750, 850, and 920 °C caused the precipitation of the beta prime phase with the B2 type crystalline structure in a bcc ferritic matrix phase. As the aging progressed, the initial rounded shape changed to cuboids aligned in the <100> directions of the ferritic matrix, and finally to rectangular plates also aligned in the same direction. The coarsening process of the beta prime phase was faster as the aging temperature increased. Nevertheless, the highest hardness and slowest overaging process took place during the aging at 920°C. This increase in hardness seems to be associated with the more rapid formation of the cuboid precipitates aligned in the <100> direction of the ferritic matrix.

Combined Processing of ECAP and Cold Rolling to Enhance the Performance of Metallic Materials: *Hiroyuki Miyamoto*[1]; [1]Doshisha University

The effect of simple shear deformation by equal-channel angular pressing (ECAP) for one pass on the texture and ridging of ferritic stainless steel sheets with 16 mass% chromium has been investigated. Hot rolled and annealed sheets of 4 mm thickness were ECA-pressed for one pass, prior to cold rolling and final annealing. The grains were subdivided by grain-scale heterogeneous plastic deformation, namely, deformation bands, during simple shear by ECAP. Deformation bands appear to contribute to the fragmenting layered structure after cold rolling and facilitate recrystallization of the so-called colonies having {hkl}<110> texture, which are otherwise difficult to recrystallize in final annealing. In other words, strain energy can be stored more effectively by combining simple shear and cold rolling than by cold rolling alone. Recrystallization occurred at a much lower temperature in the process including ECAP than in a conventional cold-rolling only process,thus enhancing its formability and reducing ridging.

Composition Control of CaO-MgO-Al2O3-SiO2 and CaS Inclusions in Pipe Line Steel: *Suzhou Wu*[1]; Jiongming Zhang[2]; Pan Gao[2]; Zhizheng Li[2]; [1]Wuhan Univeristy of Science and Technology; [2]Univeristy of Science and Technology Beijing

Non-metallic inclusions in ultra-low sulfur pipeline steel during refining and continuous process were investigated. The result shows that during the initial stage of LF refining, the inclusion in steel mainly are spherical, polygonal and clusters of Al2O3. After alloying treatment, some Al2O3 inclusions contain SiO2 and MgO in steel. Most of Al2O3 inclusions transformed to mCaO·nAl2O3 containing SiO2 and MgO, and some of them are CaS. Thermodynamic calculations get best window for calcium treatment and show that it is not only to generate CaS inclusion easily, but also to generate aluminum calcium inclusions of high Al2O3 content when aluminum content in high sulfur steel is relatively high.

Correlation of Porosity Detected by Computed Tomography and Fatigue Strength of Aluminium Alloys: Thomas Pabel[1]; Georg Geier[1]; Daniel Habe[1]; Joerdis Rosc[1]; Peter Schumacher[1]; Tose Petkov[1]; [1]Austrian Foundry Research Institute

The aim of the current research was to verify the impact of a suboptimal melt quality on the static and dynamic mechanical properties of aluminium castings. The particular interest was to use the possibilities of computed tomography to describe volumetric casting defects and to compare these results with measured mechanical properties. The results of static materials testing and the S/N curve are in excellent correlation with that of the CT evaluations as well as the density index.The selected resolution in the CT gave an adequate description from the pore space. In the future it should be possible to forecast the reduction of the mechanical properties due to an increased gas content based solely on NDT using CT. The results can now be implemented in FEM analysis to calculate a maximum pore level for a given load situation.

Determination of Coating Thickness of Anti-Fingerprint Steel Coils Using Ultraviolet Spectra: *Chi-Hyuck Jun*[1]; Yong Sun Shim[1]; Sang Moo Hwang[1]; [1]POSTECH

Coating thickness is one of target variables for quality control in steel industry. To determine the coating thickness of anti-fingerprint steel coils rapidly, ultraviolet-visible spectra can be utilized. We propose a variable selection procedure based on the variable importance in projection of partial least square regression in order to build an efficient calibration model. It is found that the prediction performance appears better in the reduced model using the proposed variable selection than the full model with full spectra absorbance. It is also shown that the first differencing as a data preprocessing technique works well for the prediction of coating thickness.Keywords: Partial least square, variable importance in projection, data preprocessing.

Development and Characterization of Milled Silver Powder Addition to Polypropylene Feedstock for Injection Molding: *Kübra Yumakgil*[1]; A. Umut Söyler[1]; Gizem Yilmaz[1]; Candan Tamerler[1]; Burak Özkal[1]; [1]Istanbul Technical University

In the present study, polypropylene-silver composites were prepared via addition of milled Ag powder to polypropylene (PP) matrix and subsequently injection molding was applied for final shaping. In order to add the milled Ag powders to granular PP feedstock two different approaches were studied prior to mixing them in extruder to obtain homogeneous dispersion in PP matrix. The effects of different ratio of silver on the properties of composites were analyzed by using different characterization techniques (DSC, FTIR, SEM and XRD). DSC analysis was used for determination of crystallinity that highly affects the antibacterial behavior of composites. Moreover, the thermal analysis and FTIR studies showed there is no degradation on the polypropylene matrix with addition of the silver content.

Development on Management Information System on Cleaner Production Assessment in Electrolytic Aluminum Industry: *He Dewen*[1]; Liu Lei[1]; Zhou Huangnian[1]; [1]Central South University

In this paper, the impact to environment and society by electrolytic aluminum industry were studied, and evaluation index and method of cleaner production in electrolytic aluminum industry is put forwards, and the management information system are developed by VB and SQL, and database of cleaner production indicators and enterprise information is built. Then the functional structure of management information system is consisted of four parts as follows: system management, cleaner production assessment indexes management, enterprise information management and cleaner production assessment method management. By the ways of checking, modifying and renovating the indicators' information, the management information system can be used as effective tool not only for the government to carry out management of enterprise cleaner production, but also for electrolytic aluminum enterprises to provide with concretely action promoting cleaner production.

Diffusion Bonding Process for Aerospace Components: *Ho-Sung Lee*[1]; Jong-Hoon Yoon[1]; Dong-Hyuk Shin[2]; [1]Korea Aerospace Research Institute; [2]Hanyang University

In diffusion bonding process, the metal components being joined undergo only microscopic deformation and the joining region is homogeneous and complete metallurgical bonding is possible without secondary materials or liquid phases. In the present work, diffusion bonding of titanium in an inert environment has been investigated to fabricate several aerospace components with various complex configure. Micrographs of diffusion bonded titanium alloys show grain boundary rearrangement and complete bonding and therefore homogeneous microstructure can be obtained. The optimum condition for diffusion bonding of Ti-6Al-4V in an inert environment was obtained at 875□ with applying gas pressure of 4MPa for 1 hour.

Effect of Beam Width on Melt Pool Geometry and Solidification Microstructure in Beam-Based Solid Freeform Fabrication: *Srikanth Bontha*[1]; Nathan Klingbeil[2]; [1]Temple University; [2]Wright State University

Laser and electron beam-based deposition of titanium alloys is currently under consideration for application to aerospace comments. The success of these promising technologies will depend on the ability to control geometric and mechanical properties of fabricated parts, which requires an understanding and control of melt pool size and microstructure. As such, the focus of this work is the effect of beam width on melt pool geometry and thermal conditions controlling microstructure in beam-based solid freeform fabrication. Process maps that relate deposition process variables to solidification cooling rates and thermal gradients have been previously developed using the Rosenthal solution for a moving point heat source. Present work, extends the approach to include the effects of beam width by superposition of the Rosenthal solution for both 2-D thin-wall and bulky 3-D geometries. Results suggest that intentional variations in beam width could potentially enable significant changes in melt pool geometry without affecting microstructure.

Effect of Cooling Rates and Mn Content on Grain Boundary Serration of Silicon Steel: Xianyong He[1]; *Qin Peng*[1]; Quanzhi Sun[1]; Lei Wang[1]; Changjiang Song[1]; Qijie Zhai[1]; [1]Shanghai University

To investigate the effect of cooling rates and Mn content on grain boundary serration, four groups of silicon steel samples with different Mn contents and thicknesses which corresponding to different cooling rates were prepared for this research. It was observed that the lower the cooling rates, the easier the occurrence of serration and the more the proportion of equiaxed grains zone. Also it can be found that serration is more prominent and grains are more refined with the increasing of Mn content. It is suggested that Mn segregation which affected by cooling rates and Mn content is responsible for occurrence of grain boundary serration. The serration is formed by hindrance of Mn solute element to the interface tension of residual liquid at the end of solidification process.

Effect of Magnesium Ion on Electrodeposited Zinc: *Gang Xie*[1]; Yu Xiaohua[1]; Li Rongxing; [1]Technology Center of Yunnan Metallurgy Group Co.Ltd.

the effect of Mg2+ on current efficiency and electrical power consumption of electrodeposited zinc was researched through changing temperature of sulfate electrolyte and Mg2+ Concentration. Sulfate electrolyte density, viscosity and electrical conductivity were determined at the difference of temperature and Mg2+ Concentration. The result shows that at certain Mg2+ Concentration, electrical conductivity increases and electrical power consumption decreases with increasing temperature. At certain temperature, electrical conductivity increases and electrical power consumption decreases with decreasing Mg2+ Concentration. Sulfate Electrolyte destiny and Viscosity show increasing trend with decreasing temperature and increasing Mg2+ Concentration. Sulfate electrolyte electrical conductivity increases with increasing temperature and decreasing Mg2+ Concentration.

Effect of Microstructure Change on Magnetic Property of Nd-Fe-B Sintered Magnets: *Jin Woo Kim*[1]; Se Hoon Kim[1]; Dae-Gun Kim[1]; Young Do Kim[1]; [1]Hanyang University

Sintered Nd-Fe-B magnets have been widely used due to their excellent magnetic properties. They are normally composed of $Nd_2Fe_{14}B$ hard magnet phase as matrix and Nd-rich phase on grain boundary. According to several authors, it was reported that the distribution of Nd-rich phase was affected to the magnet property. Thus, the magnetic properties of sintered Nd-Fe-B magnets will be improved by modification of microstructure. In this study, the modification of microstructure was carried out by modified sintering process. The modified-sintering process was repeated to apply the liquid phase sintering by heating and cooling between certain temperatures. Consequently, the modified sintering process led to uniform Nd-rich distribution which had the improved magnetic properties

Effect of Ni Addition on the Production of As-Cast Bainitic Ductile Iron: *Alex Ossa*[1]; Sandra Murcia[1]; Marco Paniagua[1]; [1]Eafit University

Ductile iron is widely used due to its low cost and higher ductility than other cast irons. There has been an increased interest during the last years in increasing the strength of these irons by means of heat treating. This work study the fabrication of ductile cast irons with martensitic and bainitic structures in the as cast condition, reducing costs related to heat treating processing and improving the mechanical behavior of the material. Cast irons alloyed with Ni ranging from 0% up to 5% were fabricated in order to evaluate the effect of Ni content on the phase transformations and mechanical properties of the material. The effect of cooling speed in the phase transformations and properties was studied using moulds with different wall thicknesses. Optical and electronic microscopy, tensile testing and charpy impact testing were used to characterize the ductile cast irons.

Effect of Predeformation and Heat Treatment Conditions in the Modified SIMA Process on Microstructural of a New Developed Super High-Strength Aluminum Alloy Modified by Al-8B Grain Refiner: Mohammad Alipour[1]; Masoud Emamy[1]; *Jafar Rasizadeh*[1]; Mostafa Karamouz[1]; Mortaza Azarbarmas[1]; [1]Kargar street

This study was undertaken to investigate the influence of Al–8B master alloy on the structural characteristics of Al–12Zn–3Mg–2.5Cu aluminum alloy. The optimum amount of B containing master alloy for proper grain refining was selected as 3.75 wt.%. In order to examine the effectiveness of the modified SIMA process, structure of the alloy prepared by the modified SIMA process were studied. The microstructure evolution of reheated Al–12Zn–3Mg–2.5Cu aluminum alloy was characterized by SEM and optical microscopy. In this study the relation between the induced strain with size and shape of grain size has been studied. Results indicated that with the increase of strain, sphericity of particles, their size decreases and sphericity takes place in less reahiting time. Optimum combinations of average globule size and shape factor were obtained in holding time of 20 min and 590 °C for the samples predeformed up to 60%.

Effect of Pulse Magnetic Field on Normal Grain Growth of Grain Oriented Silicon Steels during Primary Recrystallization Annealing: *Qiangqiang Xia*[1]; Lijuan Li[1]; Junjun Huang[1]; Lihua Liu[1]; Qijie Zhai[1]; [1]School of Materials Science and Engineering, Shanghai University

Pulsed magnetic field was applied to investigate the normal grain growth of grain oriented silicon steels during primary recrystallization annealing. Three pieces of cold-rolled sheet were firstly annealed at 700° for 10 minutes; then two of them were annealed with and without a pulsed magnetic field of 1T with the direction parallel to the rolling direction at 700° for 30 minutes respectively. Microstructures and textures of the three annealed samples mentioned above were finally characterized by optical microscopy and Electron Backscatter Diffraction (EBSD) technique. The results indicate that pulsed magnetic field can promote the normal grain growth, and can affect the texture development by increasing the intensity of {001}<120> component and decreasing the intensity of a and □ fibers. Magnetocrystalline anisotropy energy and grain boundary mobility are employed to account for the pulsed magnetic field annealing mechanism.

Effect of Soldering Flux in Sn3.0Ag0.5Cu on Electrochemical Migration: *Junghwan Bang*[1]; [1]Korea Institute of Industrial Technology(KITECH)

Recently, there is a growing tendency that fine-pitch electronic devices are increased due to higher density and very large scale integration. This finer pitch of printed circuit board decreases the insulation resistance between patterns or electrical components, which will induce electrical short in electronic circuit by electrochemical migration when it exposes to long-term in high temperature and high humidity. In this research, the effect of soldering flux acting as an electrical carrier between conductors on electrochemical migration was investigated. The surface of PCB was treated with OSP finished. Solder paste of Sn3.0Ag0.5Cu was screen printed on the PCB and then the PCB was reflowed. Thereby, specimen for ion migration test was fabricated. electrochemical migration test was conducted under the condition of DC 48 V, 85 degree Celsius, and 85 % relative humidity. The fundamentals and mechanism of electrochemical migration was discussed depending on the existence of flux after reflow process.

Effect of Tungsten on the Microstructure and Mechanical Properties of the Ni-Base Superalloy Inconel 740: *Sung-yong Lee*[1]; Kyoung Soo Shin[1]; Sun Jin Kim[1]; [1]Hanyang Univ.

The energy crisis and the environmental restriction have been serious issues in the recent society. It could be solutions for these problems to increase operating temperature and pressure in the pulverize coal-fired power plants since higher operating temperature and pressure can improve the efficiency and reduce the emission of harmful gases like CO2. In addition, it is required to develop new material which can support in the target steam condition (more than 700°, 37.5MPa). For this reason, SMC(Special Metals Corporation) developed "Inconel 740" used in the ultrasupercritical steam boiler tubes. In this study, we succeeded in improving the stability of Inconel 740 by adding tungsten, and also the effect of tungsten on the coarsening rate of gamma prime precipitates was investigated. Furthermore, the microstructural changes and mechanical properties with tungsten content, aging time, and aging temperature were examined.

Effects of Al–5Ti–1B Grain Refiner on The Structure, Hardness and Tensile Properties of Al-12Zn-3Mg-2.5Cu Aluminum Alloy: Mohammad Alipour[1]; Masoud Emamy[2]; *Jaafar Rasizadeh*[1]; Mortaza Azarbarmas[2]; Mostafa Karamouz[2]; [1]Kargar street; [2]Tehran University

In this study the effect of Al–5Ti–1B grain refiner on the structural characteristics, hardness and tensile properties of Al–12Zn–3Mg–2.5Cu aluminum alloy was investigated. The optimum amount for Ti containing grain refiners was selected as 2 wt.%. T6 heat treatment was applied for all specimens before tensile testing. Significant improvements in mechanical properties have been obtained with a combination of grain refiner and T6 heat treatment. After heat treated specimens, the average tensile strength of 495 MPa was found to be increased to 605 MPa for sample refined with 2 wt.% Al–5Ti–1B. The fractography of the fractured faces and microstructure evolution of Al–12Zn–3Mg–2.5Cu aluminum alloy was characterized by SEM (Scanning electron microscopy) and optical microscopy.

Effects of Silicon Content and Cooling Rate on Distribution and Size of Inclusion in Silicon Steel Thin Strip: *Qin Peng*[1]; Lei Wang[1]; Xianyong He[1]; Rong Yang[1]; Changjiang Song[1]; Qijie Zhai[1]; [1]Shanghai Key Laboratory of Modern Metallurgy & Materials Processing, Shanghai University

The twin roll thin strip continuous casting is a technology with near rapid solidification, which can be used to produce high performance silicon steel. To physically simulate the fabrication of silicon steel thin strips, the suction casting experiment was carried out by a vacuum casting apparatus. Strips with different silicon content and cooling rate were prepared, and the inclusion distribution of the strips was observed by scanning electron microscope (SEM). The experimental results show that the number of inclusions increases with the increasing of silicon content and the decreasing of cooling rate. Moreover the size of the biggest inclusions decreases with the increasing of silicon content and cooling rate.

Electrical Properties of SiOC Low-k Films: *Teresa Oh*[1]; [1]Cheongju University

SiOC films made by the chemical vapor deposition were analyzed the chemical shift by the Fourier transform infrared spectra and photoluminescence spectra. The chemical shift obtained in Fourier transform infrared spectra resulted from the increase of right shoulder Si-O bond in the main bond due to the delocalization and lowering polarization of carbon in Si-CH3. The right shoulder bond of Si-O increased after annealing because of the delocalization due to the charge dispersion of carbocation, so the final materials became more stability than as deposited film. The phenomenon of the delocalization in the carbon bond of Si-CH3 was also confirmed by the chemical shift in the photoluminescence spectra. The PL intensity decreased due to the delocalization after annealing. However, the sample due to the localization of carbon showed higher intensity and moved to higher wavelength, and the shapes of the main bond also involved the strong shoulder bonds.

Electron Backscatter Diffraction of Ni and Cu Powder Particles Impacted at High Velocity: *Yu Zou*[1]; Eric Irissou[2]; Jean-Gabriel Legoux[2]; Stephen Yue[1]; [1]McGill University; [2]Industrial Materials Institute (IMI), National Research Council Canada (NRC)

Micron-sized Ni and Cu powder particles were deposited at supersonic velocity on steel substrates to form coatings using the method of cold spraying, respectively. The microstructural evolution was investigated using electron backscatter diffraction and nanoindentation. We found non-uniform microstructure with ultrafine grains in the size of 200 nm with relatively higher hardness appeared in the cold sprayed Ni coating. However, the cold sprayed Cu shows more uniform microstructure and homogeneous hardness distribution. These formed microstructures and corresponding hardness are interpreted in terms of dynamic recrystallization in cold spraying and static recrystallization during the cooling process.

Electron Beam Melting and Recycling of Hafnium: *Katia Vutova*[1]; Vania Vassileva[1]; Georgi Mladenov[1]; Elena Koleva[1]; Tirthalli Prakash[2]; Nagegownivari Munirathnam[2]; [1]Institute of electronics, Bulgarian Academy of Sciences; [2]Centre for Materials for Electronics technology

In this paper, experimental results for different regimes, data for chemical analysis and theoretical investigation of the process parameters at electron beam melting and refining (EBMR) of hafnium samples are presented and discussed. Thermodynamics conditions and mechanisms as possibilities for the refining process Hf are described and analyzed. Calculated data for the refining kinetics of EBMR of Hf shows that the refining rate is determined not only by the process of mass transport of the impurities through the liquid metal and by the evaporation from the molten pool surface, but also by a great extent by other processes. The results show that the minimal impurities' concentrations are obtained at 12 kW electron beam power and short heating time.

Electrosynthesis, Characterization, and Thermal Property Analysis of Pentakis(Diethylamido)Tantalum: *Yang Jian-guang*[1]; [1]Central South University

Pentakis(diethylamido)tantalum (PDEAT) was synthesized by electrochemical reaction involving diethylamide with a sacrificial tantalum anode and stainless steel cathode in the presence of tetraethylammonium bromine as the conductive additive and acetonitrile as the inert support electrolyte. The condensates were isolated by the reduced pressure distillation of as-synthesized crude PDEAT below 5 kPa. The final product was characterized by FT-IR and NMR spectroscopy. The thermal properties of the resulting PDEAT were analyzed by TG-DTG. Results indicate that the resulting compound was indeed PDEAT. The vapor pressure of the compound was calculated from the Langmuir equation, while the enthalpy of vaporization was calculated from vapor pressure-temperature data using the Clausius-Clapeyron equation. The concentration of the impurities in the sample were detected via ICP-Mass spectroscopy, and it was found that the purity of the compound synthesized could reach 99.995%.

Evaluation of the Effect of Residual Silver in Copper on the Cementation Process by Factorial Design and Multiple Regression Analysis: *Duygu Agaogullari*[1]; Ismail Duman[1]; Özgül Keles[1]; [1]Istanbul Technical University

Residual silver in cementator copper was studied to examine its effect on the efficiency of cementation process in form of reduced silver (process output) by considering reaction duration, silver content and rotation speed of copper electrodes. The experiments were conducted at room temperature with 100 mm^2 non-rotating and rotating disc copper electrodes (0 and 500 rpm) alloyed with different Ag ratios (0.5 and 10 %). The reactions were carried out in nitrate solutions in certain reaction time (10 min. and 2 h). Experiments were designed by full factorial design (2k) method and analyzed using ANOVA and multiple regression analysis. The maximum amount of reduced silver was obtained at a silver content of 0.5 % with non-rotating disc copper electrode in 2 h reaction duration. The most effective parameter on the cementation process was determined as reaction duration. Correlation coefficients (R^2 and R^2_{Adj}) were calculated as 0.978 and 0.948, respectively.

Evaluation of the Structural Strength in Railroad Car: *Sung Cheol Yoon*[1]; Jeongguk Kim[1]; [1]Korea Railroad Research Institute

To check the structural strength of the body of the railload car, load was added to the underframe of the railload car. The objective of this study is to evaluate whether or not the underframe of a railload car under the maximal strength is safe. The carbody of rolling stock is a principal structure that supports major equipment of the underframe and the freight. Therefore, the strength evaluation of this structure is important. Both structural analysis and loading test were performed under the loading condition. Prior to the evaluation of structural strength, finite element method was used for structural analyses on stress distribution in a carbody of a railload car. The strain gauges were attached on the car based on FEM results. The test results showed that the carbody is safe under the condition of the designed load.

Explosive Generation of High Pressures and Temperatures and Areas of Their Application: *Nikoloz Chikhradze*[1]; V. Kabulashvili[1]; [1]Georgian Technical University

The possibilities for generation of ultr-high pressures and temperatures using the different schemes of detonation of an explosives are discussed. It is demonstrated that ultra-high pressures and temperatures generated by explosives of different shape could be effectivelly used for the industrial production of super hard materials and ultra-disperse powders.

Flux Effect on Electrochemical Migration of Sn3.0Ag0.5Cu Solders: *Junghwan Bang*[1]; Sehoon Yoo[1]; Changwoo Lee[1]; [1]Korea Institute of Industrial Technology(KITECH)

Flux effects on the electrochemical migration (ECM) were investigated in this study. Flux in solder paste is the source of the impurities like halogen species, which influences the ECM properties. Generally, flux is not cleaned after soldering process in recent automotive electronic industries. However, most ECM researches on solder interconnection have performed with solder-dipped or flux-cleaned samples which were not able to understand the flux effect. In the present study, "no-clean" and "flux-cleaned" samples were used to understand the flux effect for ECM. In this study, Sn3.0Ag0.5Cu solder pastes were printed and reflowed on OSP-treated Cu pad. ECM test was conducted under the condition of DC 48 V, 85°C, and 85 % RH. Both Sn and Cu was migrating species in the ECM test of Sn-3.5Ag-0.5Cu solder/Cu pad structure. As compared with flux cleaned test samples, solders with flux residue showed high rate of ECM failures.

Generation and Control of Two Way Shape Memory Effect for SMA Coil Spring: *Kwang Jee*[1]; Jun Han[1]; Woo Jang[2]; Je Min Park[3]; [1]Korea Institute of Science and Technology; [2]Chosun Univ.; [3]Hongik University

A coil spring has a peculiar demerit that it works only in one direction when it is closed. Since no further compression can be applied to the closed coil, there are some difficulties in generating TWSME. One of example is a SMA coil spring which expands on heating and contracts on cooling. An open coil spring should be severely contracted to generate the TWSME. However, contraction is limited to the initial stroke of the coil, so it is difficult to obtain such TWSME. In this work, we introduce a new method of compression of closed coil by reversing the coil winding orientation. According to our invention, a severe compression can be attained by reversing the coil orientation and extending severely. Some more applications of the 'reverse of coil orientation' to TWSME are presented.

High Temperature Corrosion of Ni-25Cr-20Co Alloys at 1073-1373 K in SO2 Gases: *JaeHo Lee*[1]; SangHwan Bak[1]; Minjung Kim[1]; DongBok Lee[1]; [1]Sungkyunkwan University

Structural components are exposed to highly corrosive environments containing sulfur and oxygen in high-temperature gas turbines, petrochemical units, and coal gasification systems. Thus, the SO2-gas corrosion-resistance is of considerable industrial interest for practical applications. In this study, the corrosion performance of INCONEL 740 whose composition is Ni-25Cr-20Co-2Nb-1.8Ti-0.9Al-0.7Fe-0.5Si-0.5Mo-0.03C was investigated at 1073-1373K for up to 100 hr in an Ar-0.2% SO2 atmosphere. The INCONEL 740 alloy corroded parabolically at 1073 and 1173K for up to 10 hr, and no scale spallation occurred. However, the parabolic law was not obeyed at 1273 and 1373K. The formed scales consisted of Cr2O3, (Ni,Co)Cr2O4 and TiO2. Sulfur was distributed at the scale/matrix interface and internal precipitates. Acknowledgement. This work was supported by the Human Resources Development of the Korea Institute of Energy Technology Evaluation and Planning (KETEP) grant funded by the Korea government Ministry of Knowledge Economy (No. 20101020300460).

Horizontal Directional Solidification of Zn-Al Alloys: *Alicia Ares*[1]; Sergio Gueijman[2]; Carlos Schvezov[1]; [1]CONICET/FCEQyN-UNaM; [2]FCEQyN-UNaM

Zinc-Aluminum alloys were solidified in horizontal form and the results obtained analyzed. During solidification the distribution of temperatures were measured by using thermocouples located strategically. From the measured temperatures the following parameters were derived; the local temperature gradient, the cooling rate and the velocities of the liquid and solidus fronts. Comparing the location of the transition and the values of these parameters it was found that the temperature gradient reaches minimum values of as low as 1 °C/cm, and velocities of the fronts of around 0.1 cm/s. In addition the grain size and secondary dendritic arm spacing was measured along the samples. The spacings and grain sizes are correlated with thermal parameters and compared with the predictions from available models. The results are presented and discussed in the frame of the results obtained for other alloys.

How to Control Strength and Grain Structure of 304L Stainless Steel during Forging: *Nathan Switzner*[1]; Jamie McQueen[1]; Wayne McLarren[1]; Robert Bergen[2]; Chris San Marchi[3]; [1]Honeywell FM&T; [2]Precision Metal Products; [3]Sandia National Labs - Livermore

304L forgings were made using a High Energy Rate Forging (HERF) press at hot working temperatures 843 °C (1550 °F) and 941 °C (1725 °F). Strain was varied from 0.4 to 1.8 EQPS (calculated using ABAQUS). Mechanical testing and microstructural analysis were conducted on the forgings. Room temperature yield strength increased with strain from about 0 to 0.7 EQPS.

However, higher strain levels of 1.4 to 1.8 EQPS decreased yield strength due to recrystalization. Material deformed at 843 °C (1550 °F) began to recrystallize at a strain value of about 1.1 EQPS, but material deformed at 941 °C (1725 °F) began to recrystallize at about 0.7 EQPS. ABAQUS coupled thermal simulation estimated a temperature increase of 80-120 °C (150 200 °F) due to rapid deformation in the HERF press. Therefore the strength and grain structure of 304L forgings may be controlled using two parameters—forging temperature and shape change, i.e. strain.

Improved Dual Duct Boosted Suction (DDBS) System Doubles Pot Suction, Reduces Roof Emission: *Peter Klut*[1]; Erik Dupon[1]; [1]Danieli-Corus

Potroom emission and working environment within the potroom are becoming more and more an issue with the authorities and the potroom workers. A large portion of the potroom emission is emitted during pot maintenance or during tapping when the covers of the pot are removed. By doubling the gas flow from the pot during these periods the emission can be brought back to normal levels. The DDBS system doubles the gas flow by using the existing pressure differential over the restriction orifice or control damper to direct the gas to the DDBS ducting instead of using dedicated DDBS dampers. For combined pots the required number of dampers can be reduced up to 70% compared to existing systems. Test executed at an Australian smelter proved that this is a feasible technology which reduces Smelter Potroom Emissions significantly, and requires minimal investment and operating costs.

Influence of Cr Addition on Crystallization Behaviour and GMI Properties of FeCoBSi Amorphous Wire: *Rajat Roy*[1]; Satnam Singh[1]; Partha Sarkar[1]; Ashis Panda[1]; Amitava Mitra[1]; [1]National Metallurgical Laboratory (CSIR)

The effect of Cr addition on crystallization behaviour, electrical resistivity and giant magneto impedance (GMI) in amorphous wires with a nominal composition of $(Fe_{0.5}Co_{0.5})_{78-x}Cr_xSi_8B_{14}$ (x= 0, 4, 7 and 10 at%) has been investigated. The quality of the wires improves with increasing Cr content owing to the Cr-oxide layer at the surface of wire. During isochronal annealing of the wires, crystallization behaviour is examined by DSC thermograms and electrical resistivity. The substitution of a small amount of Fe and Co with Cr increases the thermal stability and GMI properties of amorphous wires. It is interesting to note that the crystallization peak shifts to the highest temperature and thermal stability is also higher when Cr addition increases from 7 to 10 at%. The GMI properties of all wires are maximized at the frequency of 400 kHz and at driving current amplitude of 10 mA.

Influence of Limestone Composition on Lime Desilication of Green Liquors: *Andrey Panov*[1]; Alexander Suss[1]; Natalia Kuznetsova[1]; Irina Paromova[1]; [1]RUSAL VAMI

At processing of mixed type/monohydrate bauxites traditional ways of desilication are less effective due to peculiarities of silica containing minerals. Introduction of calcium compounds in the head of process makes excessive scaling of heating surfaces. As alternative, desilication of green liquor with reduced amount of lime milk with subsequent reuse of the residue at digestion in order to capture more silica, is considered. During the tests, influence of composition of initial limestone, method of Ca-containing compound preparation, impurities, etc. on desilication efficiency and sediment particle size has been studied.

Influences of Alloying Elements on Grain Sizes in Friction Stir Processed Pure Aluminum and Aluminum Alloys: *Tomotake Hirata*[1]; Taiki Morishige[2]; Masato Tsujikawa[2]; Kenji Higashi[2]; [1]Technology Research Institute of Osaka Prefecture; [2]Department of Materials Science, Osaka Prefecture University

A friction stir processing (FSP) technique has been developed for use with aluminum and magnesium alloys. The microstructure was evolved into fine grains by the dynamic recrystallization during FSP. In this study, FSP was used to pure aluminum and aluminum alloys and the influence of alloying element on the grain size was investigated. In addition, the relationship between the grain size and the Zener–Hollomon parameter was investigated. There was observed difference in grain size between these materials. The recrystallized grain of FSP-ed ultra-high-purity (99.999%) aluminum was particularly large, compared to the grain sizes of other materials, when subjected to the same processing conditions. In contrast, grain sizes decreased with an increase in the Zener–Hollomon parameter in all materials. However, the grain size reached a certain minimum value at high-strain-rates of processing. Compared to other processed aluminum materials, the minimum grain size was found for each material.

Interfacial Microstructure and Mechanical Properties of the Friction Stir Welds between AA6061 and Ti-6Al-4V Alloy Sheets: *Kwang-jin Lee*[1]; [1]Korea Institute of Industrial Technology

Butt joining was carried out using a friction stir welding method for 5mm-thick AA6061-T6 and Ti-6Al-4V alloy plates. Sound joints were successfully obtained. Mechanical properties were evaluated using tensile test and Vickers hardness test. Interfacial microstructure, in particular, newly formed interfacial region and the distribution of additional elements at the weld interface was precisely examined using TEM-HAADF (High Angle Annular Dark Field) technique and element mapping method, respectively. Thin foils were prepared using a Focused Ion Beam (FIB) method. Root area of probe in stir zone (SZ) revealed a mixture of fine recrystallized grains of aluminum alloy and lots of titanium alloy particles pushed away from the base metal due to strong stirring by the tool fabricated by WC-Co. Interestingly, segregation of Si was detected at the weld interface. Fracture surface revealed very complicate sequence according to the tool position.

Interfacial Reactions at the Sn-xBi/Au Couples: *Yee-wen Yen*[1]; Wei-Kai Liou[2]; Chao-Ming Chen[3]; Meng-Kuang Huang[3]; [1]National Taiwan University of Science and Technology; [2]Lunghwa University of Science and Technology; [3]National Taipei University of Technology

The interfacial reactions between Sn-50wt%Bi, Sn-57wt%Bi, Sn-65wt%Bi, and Au substrate, aged at 80, 100, 120°C for 12 to 350 h had been investigated in this study. The Bi contents were 57 and 65wt% in the Sn-Bi alloys, the Au-Sn intermetallic compounds (IMCs) were observed at the interface. The Au-Sn IMCs and ternary Sn-Bi-Au metastable phases were formed at the Sn-50wt%Bi/Au couple. However, this ternary Sn-Bi-Au metastable phase was transferred into the AuSn4 phase, when the reaction was extended over 72 h. Increasing the Bi contents in the Sn-Bi alloys could make the large (Bi) phases be segregated on the solder/Au interface to decrease the IMCs growth. The IMC growth mechanism in all reaction couples is diffusion-controlled. The lowest value of the reaction activity energy could be found in the Sn-57 wt%Bi couples.

Intermetallic Phases and Microstructure in AlSi Alloys Influenced by Fluid Flow: *Piotr Mikolajczak*[1]; Lorenz Ratke[2]; [1]German Aerospace Center, Poznan University of Technology; [2]German Aerospace Center

In secondary AlSi alloys, the presence of small amounts of Fe causes the formation of intermetallic phases, which have a negative effect on the mechanical and physical properties of castings. To understand the effect of fluid flow on the microstructure and intermetallic phases, Al-5/7/9 wt pct Si 0.2/0.5/1.0 wt pct Fe alloys have been directionally solidified under defined thermal and fluid flow conditions (rotating magnetic field). The primary Al-phase, interdendritic eutectic and intermetallic phases were studied using light microscopy and SEM with EDX. An essential observation is that fluid flow can shorten the length of the ß-Al5FeSi plates accompanied with an increase in the density number. The presence of broken and curved ß-phases was observed, beside common straight ones. The secondary dendrite arm spacing is not effected by fluid flow, probably due to the presence of intermetallics in the interdendritic space.

Investigation of Inclusion Evolution Mechanism during the Refining and Continuous Casting Process of 28MnCr5 Steel: *Suzhou Wu*[1]; Zhizheng Li[2]; [1]Wuhan Univeristy of Science and Technology; [2]University of Science and Technology,Beijing

By means of SEM, EDS and other experimental means, 28MnCr5 gear steel produced in a steel plant was researched. The size, appearance and number of inclusions in LF refining process, VD vacuum refining process and

casting billet were studied. The results show that the independent manganese sulfide were mostly massive, some spherical or rod-like. Compound manganese sulfide were a core part of inclusion spinel or calcium aluminate, manganese sulfide outside. The size of manganese sulfide inclusions were in 5μm~15μm. By using of thermodynamic calculation software FactSage, the relationship between steel elements and slag composition and inclusions in steel was calculated. The results show that according to the thermodynamic calculation of the low melting point area and lower oxygen content in selected area, the range of inclusion area was selected: SiO2 0%~9%, Al2O3 33%~51%, CaO 49%~58%.

Investigation of Molybdenum Double Perovskites for Use in Anode Supported Solid Oxide Fuel Cells: *Adam Weisenstein*[1]; Stephen Sofie[1]; [1]Montana State University

In this study molybdenum-based double perovskites were investigated for application as electrochemical fuel electrodes, e.g. SrxMMoO6, where M represents Ni, Ti and V. Also, A-site deficiencies were investigated as Srx varied from Sr1.8 to Sr2. Double perovskite powders were synthesized by ball milling for 48 hours, flash freezing, sublimation and calcination at 1000°C for 6 hours. Pellets were then made and sintered under reducing conditions for 24 hours in temperatures ranging from 1200°C to 1400°C. The phase composition and phase evolution were characterized by x-ray diffraction and DC electrical conductivity was measured at temperatures ranging from 20°C to 800°C in 95% N and 5% H. Thermal analysis was also utilized to characterize thermal and dimensional stability.

Investigation of the Thermodynamic Factor of Diffusion Coefficient for Lithium Ion Migration in Lithium Titanium Dioxide: *Zheng Liang*[1]; Guangsha Shi[1]; [1]University of Michigan

The chemical diffusion coefficient for the Li-ion diffusion within the host crystal structure depends on the overall Li concentration. This coefficient can be factored as a product of a self-diffusion coefficient D*, and a thermodynamic factor θ, according to D =θD*. The thermodynamic factor serves as a measure for the deviation of the Li chemical potential from thermodynamic ideality. It can be expressed as a function of Li chemical potential μ, absolute temperature T, and Li concentration x derived from our model.Curve of θ is plotted as a function of lithium concentration at a given temperature from numerical methods. Also, this quantity can be obtained from grand canonical monte carlo simulation as the fluctuation of the number of lithium ions within a reference volume. Both the two methods agree with each other and we can gain further information from the thermodynamic factor – Li concentration curve.

Libyan Industrial Complex Case Study and Gear Failure: Ali Tajouri[1]; *Mosbah Akreem*[2]; [1]Faculty of Engineering, University of Alfatah; [2]Libyan Industrila Research Center

Gears are the necessary parts for transmissions of power and has wide spread in various machines, such as metal cutting machines, mixers, vehicles, heavy duty machinery and lifting machines as well. The main cause and reasons of gear failures are error in design, manufacturing, and applications. This investigation considers the fracture of gear on mixer machine it cause sudden stop of main Libyan industrial complex production. Samples were tested, an interpretation of results was performed, in order to identify the cause of failure, it was found that the gear material is medium carbon steels and its selection is according to the standards. Microstructure investigation clearly indicate that hardness and materials microstructure greatly affected by heat treatment and it was performed in good manner. The main cause of this case failure is contributed to non precise gear mounting during periodical maintenance.

Libyan Made Steels Quality and Standers: *Ali Tajouri*[1]; [1]Faculty of Engineering, University of Alfatah

LISCO established in 1989, designed to produce 2.3 million tons liquid steel per year .Direct Reduction of iron (DRI) with Medrix process. EAF LISCO steel making utilizing the abundant supply of locally natural gas ,Where Imported high quality prefluxed iron pellets is reduced .The complex produces various steel products such as Hot and Cold Rolled Sheets. Libyan manufacturing companies uses local made sheets for different commercial use. During cutting of LISCO sheets using automatic cutter, final product was deformed. Steel samples have been subjected for chemical analysis, mechanical tests (hardness and tensile tests), heat treatment and finally microstructure was studied. The investigated samples, considered in accordance with the use for heavy duty trucks, tension and Vickers hardness testing as well. Those testing and examinations, confirm that crucial deformation problem of plate during the shaping depends mainly on the asymmetry of residual stresses, related principally to the difference of work-hardening intensity.

Liquid Phase Sintering and Age Hardening of Different P/M Aluminum Alloys: *Padmavathi Chandran*[1]; Anish Upadhyaya[1]; [1]Indian Institute of Technology, Kanpur, India

The P/M aluminum alloys offers light weight combined with excellent specific properties such as high strength, thermal stability that are attractive for structural applications in automotive and aerospace industries. The main objective of the present work is to study the sintering and age hardening of 2712 and 6711 aluminum alloys. The powders were pressed at 200 and 400 MPa followed by sintering in a range of temperature under high vacuum (10-6 torr)and nitrogen. The 6711 alloy compacts under supersolidus liquid phase sintering (SLPS) leading to better densification and mechanical properties. One striking constrast was remarkably higher ductility observed for 6711 alloy under vacuum. It interesting to note that T6 condition not only enhanced tensile strength by about 75% without any reduction in ductility. As highlighted above, the retention of ductility levels in the naturally aged 6711 alloy was noticed.

Manufacture and Properties of Cold Spray Deposited Large Thickness Cu Coating Material for Sputtering Target: Jin-Hyeon Cho[1]; Young-Min Jin[1]; Dong-Yong Park[2]; Hyung-Jun Kim[3]; Ik-Hyun Oh[4]; *Kee-Ahn Lee*[1]; [1]Andong National University; [2]Tae-Kwang Tech.; [3]RIST; [4]KITECH

This study attempted to manufacture a large thickness Cu coating layer as sputtering target material via a cold-spray coating process. The result of observation of the layer's purity and microstructure showed that a purity level (99.47%) similar to that of early powder 2N5 was maintained, and that the manufacture of cold spray deposited, a thick ~20 mm Cu coating material for sputtering target was successfully performed. As a result of EBSD mapping, the average grain size near the interface and around the center measured 1.48 μm and 1.49 μm; they were small and non-uniform compared to the 1.91 μm near the surface. Post annealing heat treatment, overall porosity declined, and grain size & texture became uniform. Based on the aforementioned findings, this study suggests that using cold-spray deposition, large thickness Cu-coating layers as sputtering target is practically applicable.[supported by "the program for the Industrial Strategic Technology Development" and "the program for the Training of Graduate Students in Regional Innovation", Korea]

Manufacturing and Macroscopic Properties of Cold Sprayed Cu-In Coating Material for Sputtering Target: *Kee-Ahn Lee*[1]; Young-Min Jin[1]; Jin-Hyeon Cho[1]; Dong-Yong Park[2]; Ju-Ho Kim[2]; [1]Andong National University; [2]Tae-Kwang Tech

This study attempted to manufacture a Cu-In coating layer via the cold spray process and to investigate the layer's applicability as a sputtering target material. To examine the microstructural and property changes made to the Cu-In coating layer and Cu coating layer (comparison material), ICP, XRD, SEM, and other tests were conducted; purity, density, hardness, porosity, and bond-strength were measured. The results showed that coating layers with thickness of 20 mm (Cu) and 810 μm (Cu-In) could be manufactured via cold spraying under optimal process conditions. Pure Cu and intermetallic compounds of Cu7In3 and CuIn4 were found to exist inside the layer regardless of annealing heat treatment. The Cu-In coating layer manufactured via cold spraying and annealing can be said to be applicable as sputtering target. [supported by "the program for the Industrial Strategic Technology Development" and "the program for the Training of Graduate Students in Regional Innovation", Korea]

Measurement of Fatigue Damage in Al/Ni and TiW/Ni Metal Interconnections on Glass by Nanoindentation: *Jae Ho Kim*[1]; Chul Min Joe[1]; Yeo Hyoun Yun[1]; Yong Jun Oh[1]; [1]Hanbat university

Chip-on-glass packages require highly reliable bonding of interconnect materials to glass. We performed fatigue test with two metal multilayer interconnects-Al/Ni and TiW/Ni-on glass, and evaluated the fatigue damage in the materials by nanoindentation. The Al/Ni interconnect was prepared by anodic bonding of Al to glass, Ni plating, and then patterning into lines. The TiW/Ni interconnect was prepared by TiW sputtering, Ni plating and patterning. The two types of interconnects were then subjected to three-point bending fatigue tests. The tests were interrupted at regular time intervals for the nanoindentation measurement. The Al/Ni interconnect showed greater fatigue resistance than the TiW/Ni one. From the nanoindentation measurements, the hardness and Young's modulus of both types of interconnects gradually decreased as the fatigue cycle progressed; however, the degradation was severer in the case of the TiW/Ni than the Al/Ni. The correlation between fatigue damage and indentation response was discussed in detail.

Mechanical Performance of Tungsten Inert Gas Welded Aluminum Alloy 6061-T6: Daniel Steves[1]; *Jahan Rasty*[1]; [1]Texas Tech University

The use of aluminum welding is used in everyday applications from manufacturing small brackets to commercial airliner fittings. Due to its light weight and resistance to corrosion, aluminum has become one of the leading materials used today. The fusion of aluminum parts by means of welding is a complex process and takes a very skilled welder to make sure the integrity of the material is not susceptible to failure. Different studies have taken place on welded aluminum, in particular type Al 6061-T6, to test whether this alloy meets the standard requirements. Researchers have conducted numerous experiments quantifying the hardness and tensile strength of the weld area, however there is very little done on time dependent trials. Because welded AA 6061-T6 ages naturally, these changes must be accounted for in cases such as static and dynamic loading conditions. These tests are required to understand the properties that welded structures take.

Mechanical Property of In-Situ Particulate Reinforced Titanium Matrix Composites by Investment Casting: *Bong-Jae Choi*[1]; Seul Lee[1]; Jeong-Il Youn[1]; Young-Jig Kim[1]; [1]Sungkyunkwan University

The aim of this research is to evaluate the microstructure and tensile property of in-situ (TiB+TiC) particulate reinforced titanium matrix composites (TMCs) synthesized by investment casting process. Boron carbide (1,500° and 150°) was added to the titanium matrix during vacuum induction melting which can provide the in-situ reaction of 5Ti + B4C -> 4TiB +TiC. 0.94, 1.88 and 3.76wt% of B4C were added into the melt. The phases identification of in-situ synthesized TMCs were examined using scanning electron microscopy, X-ray diffractometer, electron probe micro-analyzer and transmission electron microscopy. Tensile property of TMCs was investigated in accordance with the reinforcements size and volume fraction. The improvement of tensile property of titanium matrix composites were caused by load transfer from the titanium matrix to reinforcement and grain refinement of titanium matrix and reinforcements.

Membranes Obtained from PA6/HDPE Blends Via Precipitation by Immersion: Carlos Cunha[1]; Gustavo Brito[1]; *Pankaj Agrawal*[1]; Helio Lira[1]; Tomas Melo[1]; [1]Federal University of Campina Grande - UFCG

Currently the use of polymeric membranes has grown considerably, so research in this area has been following this development. Alternatives have been sought for the separation processes due to economic and environmental issues. The use of polymer blends to obtain membranes appears to be differential, since we can add features such as processing, improvement of properties and low cost. In this study, Polyamide 6 (PA6) and High Density Polyethylene (HDPE) blends in various compositions were prepared in a counter-rotating twin screw extruder at 240°C and 50 rpm. The influence of the compatibilizing agent was also investigated. To obtain the membranes, the blends were dissolved in formic acid and then immersed on a coagulant liquid for precipitation. The membranes were characterized by SEM. The results showed the characteristic pores for microfiltration process.

Microstructural and Mechanical Performance of Cold-Rolled Al Base Alloys: S.R. Casolco[1]; *S. Valdez*[2]; [1]ITESM-Puebla; [2]UNAM-ICF

The Al base alloys could be strongly influenced by the microalloying elements, modifying the microstructural and mechanical performance. An Al alloy added with zinc and silver was studied in as-cast and cold-rolled conditions by means of tensile testing machine, scanning and transmission electron microscopy. The flow stress and elongation were improved by the alloying addition, especially by the Ag content. The Ag-solute in low concentration, is homogenously distributed in the AlZn matrix, which should contribute to increase the deformation. However, a high content of Ag decreases the solubility and precipitate as $AgZn_3$. This microstructural evolution, influenced the deformation mechanism in aluminum alloys. In addition, microstructural performance of Al base alloys added with Zn and Ag show the presence of solid solution zinc-rich hexagonal close-packed (hcp) crystal structure, named η-phase and α-Al solid solution with Zn dissolved into the matrix. The silver concentration in AlZn alloy modifies the ε-type precipitates.

Microstructural and Mechanical Properties (Hardness) Investigations of 0.61%Al-1.11%Si Austempered Ductile Iron: Ali-Reza Kiani-Rashid[1]; *Behtash Hashemi*[1]; [1]Ferdowsi University of Mashhad

The effect of aluminium as a strong graphitizing element is known. A lot of investigations have been made by researchers to replace silicon with aluminium in gray and ductile cast irons. The influence of aluminium in increasing the oxidation resistance at high temperatures is increasing the hardness and strength of material. So, in this research, by adding a few values of aluminium in presence of silicon, that is tried to determine the microstructure of sand mould casting samples by using optical and electron microscopes. Thus, the phase transformations are investigated by doing suitable heat treatments by austenitising at 890°C and austempering at 350, 400 and 450°C. Furthermore, hardness measurements are used for determining the mechanical properties of the material.

Microstructural Characterization of Sintered Fe-Mn-Si Based Shape Memory Alloy Prepared Via Mechanical Alloying Technique: *A. Umut Soyler*[1]; Burak Özkal[1]; Leandru G. Bujoreanu[2]; [1]Istanbul Technical University; [2]The "Gh. Asachi" Technical University

In this study, microstructural characterizations of Fe-Mn-Si based shape memory alloys fabricated via mechanically alloying and sintering were investigated. Powders were mechanically alloyed for 4 h using a Spex mixer/mill at room temperature and compacted powders were sintered at 1150 °C for 2 h under Ar atmosphere. Microstructural and phase characterizations of the sample was performed using SEM/EDS and XRD analysis. Moreover, X-ray photoelectron spectroscopy (XPS) studies were conducted in order to obtain a quantitative composition analysis with depth profiling. On the basis of the performed characterization studies, it is revealed that Fe-Mn-Si sample MA'd for 4 h has almost uniform homogeneity in its microstructure.

Microstructural Evolution in Fe-based Oxide Dispersion Strengthened Alloys - A Computational Study: *Samrat Choudhury*[1]; Christopher Stanek[1]; Blas Uberuaga[1]; [1]Los Alamos National Laboratory

Nanostructured ferritic alloys (NFAs) (with usual composition 12– 14 wt% Cr, 0.25 wt% Y and 0.5 wt% Ti) are considered excellent candidate materials for structural applications in nuclear reactors as they exhibit exceptionally high creep strength due to the presence of highly stable nanometer sized Y-Ti-O precipitates(NPs). Understanding the high stability of these NPs requires an investigation of the precise structure, compositions, and stages of nucleation and growth of these NPs. Experimentally it has been observed that Y_2O_3 precipitates exhibit similar structural features as these NPs, such as formation of core-shell structures. In this work, as a first step, we will present the possibility of applying a phase-field model to understand the nucleation and growth of Y_2O_3 precipitates under an applied stress in Fe-Cr alloys. We will also present ab-initio calculated thermokinetic parameters and diffusion coefficients of atomic species and compare them with experimental measurements wherever available.

Microstructural Observations and Electromagnetic Interference Shielding Characteristics of Tin Based Alloy Thin Films: Hung Fei-Yi[1]; *Hung Fei-Shuo*[2]; Chiang Che-Ming[2]; [1]Institute of Nanotechnology and Microsystems Engineering, Center for Micro/Nano Science and Technology, National Cheng Kung University; [2]Department of Architecture, National Cheng Kung University

The elements Sn, Al and Cu not only possess electromagnetic interference (EMI) shield efficiency, but also have acceptable costs. In this study, the sputtered Sn-Al thin films and Sn-Cu thin film were used to investigate the effects of the annealed, film thickness and the compounds properties on the electromagnetic interference (EMI) characteristics. The results show that Sn-xAl film increased the electromagnetic interference (EMI) shielding after annealed. For as-sputtered Sn-xCu films with higher Cu atomic concentration, the low frequency EMI shielding could not be improved. After annealing, the Sn-Cu thin film with lower Cu content possessed excellent EMI shielding at lower frequencies, but had an inverse tendency at higher frequencies. For both the Sn-xAl-0.5Ni and Sn-xCu-0.5Ni thin films, after crystallized treatment, the sputtering films had higher electric conductivity and saturation magnetization, however the EMI shielding was not enhanced completely.

Microstructural Properties and TEM Analysis of Amorphous Reinforced Aluminum Matrix Composite by Friction Stir Processing: *Liu Peng*[1]; [1]Shandong Jianzhu University

A novel aluminium matrix composite reinforced with Al-based amorphous was fabricated by friction stir processing (FSP). The hardness of composite has shown increase to a certain extent. The maximum tensile strength of composite was about 410MPa. A large number of ultrafine grained structures with size 90~400nm constitutes the composite. These ultrafine grained structures are composed of a-Al and a-Al amorphous structure. The existence of ultrafine grained structures will contribute greatly to improving the structure and properties of this composite.

Microstructure and Properties of Laser Shock Processed Ti6Al4V, X5CrNi18-10 Steel and Pure Aluminum Materials: *Kusinski Jan*[1]; Magdalena Rozmus-Górnikowska[1]; [1]AGH University of Sciences and Technology

The effect of the Laser Shock Processing on the microstructure and properties of Ti6Al4V, X5CrNi18-10 steel and aluminum was studied. Examination of the treated surfaces showed that the laser shock processing caused an ablation and melting of thin surface layer of all isamples. It indicates that process was not purely mechanical but thermo-mechanical. However, TEM micrographs revealed that under the thin melting layer, there were a high density of dislocations observed in the treated surface of all investigated materials. Presence of high density of dislocations, stacking faults and deformation twins testified that the laser shock processing caused sever plastic deformation of the surface layer of the investigated materials. Compressive residual stresses were measured using x-Ray diffractometry technique. The increase in hardness was observed and related to an increase in the dislocation density, microtwinning and grain refinement.

Modeling and Experimental Activities for Heavy Castings and Forgings: *Dianzhong Li*[1]; Mingyue Sun[1]; [1]Institute of Metal Research, Chinese Academy of Sciences

The Materials Process Modeling Division, IMR, CAS has been promoting for more than 10 years research activities on multi-scale modeling of materials for hot-processing. In the following, we highlight some selected achievements and impacts in this area: To satisfy domestic strategic requirements, such as nuclear and hydraulic power, marine projects and high speed rail, we have developed several casting and forging technologies, which combine advanced computing simulations, X-ray real time observation techniques and industrial-scaled trial experiments. These technologies have been successfully applied in various industrial areas and yielded a series of scientific and technological breakthroughs and innovation. Important examples of this strategic research include the hot-processing technologies of the Three Gorge water turbine runner, marine crankshaft manufacturers, backup rolls for hot rolling mills and the production of huge steel ingot.

Modeling of Weld Penetration in High Velocity GTAW: *Ustun Duman*[1]; Patricio Mendez[2]; [1]Colorado School of Mines; [2]University of Alberta

This work presents a scaling analysis to predict penetration depth in high current and high travel speed Gas Tungsten Arc Welding (GTAW). Scaling laws based on the governing equations of heat transfer phenomena provide closed form expressions that capture the essence of a welding process explicitly. In high productivity GTA welding, the pressure and shear stress of the plasma results in a gouging region under the welding torch. Experimental studies were performed to estimate the range of validity of the gouging penetration model using D.C. GTAW on five different metals (A36 structural steel, AISI304 stainless steel, CP Aluminum and AA5083 Aluminum alloys, and CP Titanium grade 3). The welds were generated with the bead-on-plate technique using a map of welding parameters of travel speed and current values, where travels speeds varied between 2-19 mm/s and the current values varied between 225-700A.

Modulation of the Degree of Heterogeneity with Compositional Control and Heat Treatment in Cu-Zr-(Y, Gd)-Al Bulk-Forming Metallic Glasses: Jin Woo Kim[1]; *Eun Soo Park*[1]; [1]Seoul National University

In the present study, we systematically explored the heterogeneity in Cu-Zr-(Y, Gd)-Al bulk-forming metallic glasses. Firstly, we will report a large amount of substitution over 15 at.% can lead to nanometer-scale phase separation in Cu-Zr-rich and Cu-(Y, Gd)-rich glass phases, which exhibit extreme brittleness. Secondly, a small amount of substitution under 5 at.% generates atomic scale heterogeneity in monolithic BMGs, which can be detected with small/wide angle X-ray scattering. In this case, the plasticity of BMGs is improved by heterogeneous viscous flow. This atomic scale local heterogeneity grows with elevating temperature and is preferentially crystalized in supercooled liquid region. The results suggest that heterogeneity in amorphous matrix can be modulated by both the optimization of tailoring combinations of constituent elements and heat treatment, which can enhance plasticity of BMGs. These concepts could prove to be useful in the design of a novel composite material with desirable properties.

Modulus Dependence on Large Scale Porosity: *Paul Allison*[1]; Mark Horstemeyer[2]; Hayley Brown[2]; [1]US Army Engineer Research and Development Center; [2]Mississippi State University

This work compares the existing theoretical expressions for the porosity dependence on elastic constants to experimental data for a commercially available FC-0205 powder metallurgy (PM) steel. The modulus of compression, tension, and ultrasound based data at varying porosity levels are plotted graphically against the theoretical expressions. An equation by McAdam (1950) was able to most accurately predict the experimental data with the adjustment of only one material constant.

MWCNT Based Structures as Negative Electrodes for High Capacity Lithium Ion Batteries: *Indranil Lahiri*[1]; Sung-Woo Oh[2]; Yang-Kook Sun[2]; Wonbong Choi[1]; [1]Florida International University; [2]Hanyang University

Among different varieties of rechargeable batteries, Li-ion batteries have become most popular. Despite their established market, researchers have shown great deal of interest in developing new, improved electrode materials for lithium ion batteries leading to higher specific capacity, longer cycle life and extra safety. The present study deals with development of multiwall carbon nanotubes (MWCNT) based anodes for Li-ion batteries. The novel anodes were prepared from interface-controlled MWCNTs, directly grown on copper current collectors. The anode structures have shown very high specific capacity (almost three times as that of graphite), excellent rate capability, nil capacity degradation in long-cycle operation and introduced a higher level of safety by avoiding organic binders. Enhanced properties of the anode were well related to high Li-ion intercalation on the walls of CNTs, as observed in HRTEM. These MWCNT based anode structures may be considered as best suitable materials for application as anode in Li-ion batteries.

Nanocomposites Based on Polymer Blends: Effect of the Organoclay on the Thermo-Mechanical Properties and Morphology of PA6/HDPE and PA6/Compatibilizer/HDPE Blends: *Pankaj Agrawal*[1]; Akidauana Oliveira[1]; Gustavo Brito[1]; Carlos Cunha[1]; Edcleide Araujo[1]; Tomas Melo[1]; [1]Federal University of Campina Grande - UFCG

The effect of the organoclay on the thermo-mechanical properties and morphology of PA6/HDPE and PA6/compatibilizer/HDPE blends was investigated. The blends and nanocomposites were prepared by extrusion followed by injection molding at 240ºC and characterized by X-Ray diffraction, Thermogravimetry, mechanical properties and Scanning Electron Microscopy. The results showed that when the organoclay was added to PA6/HDPE blend, the clay peaks were shifted to lower 2θ angles indicating that the polymers were intercalated between the clay platelets. When the organoclay was added to PA6/compatibilizer/HDPE blend, the clay peaks almost disappeared, indicating that an exfoliated structure was formed. The organoclay decreased the thermal stability of PA6/HDPE blend and has little effect on that of PA6/compatibilizer/HDPE blend. The addition of the clay increased the modulus and decreased the impact strength of the blends. The presence of the clay decreased the HDPE particles size on PA6/HDPE blend and changed the morphology of PA6/compatibilizer/HDPE blend.

NiAl2O4/Al2O3 Nanoparticles with Perfect Catalytic Activity: *S. F. Rahnemaye Rahsepar*[1]; H. Dastjerd[2]; E. Zahrani[2]; [1]Islamic Azad University, Shareza; [2]Isfahan University of Technology

Steam reforming of methane was carried out to make synthesis gas and hydrogen on the NiAl2O4/Al2O3 catalysts with perfect activity. The experimental results indicated that the modification of impregnation samples at various calcination temperatures led to the formation of nanoparticles of NiAl2O4/Al2O3. It means that NiO with Al2O3 could be transformed into the surface spinel structure of nickel aluminate during heat treatment at high temperature, which was confirmed by TPR, XRD and TG/DTA patterns. The TG/DTA measurements showed thermal decomposition was a three-step process with crystallization of the spinel phase started at a temperature 443oC. The nanoparticles' size was calculated from the line broadening of X-ray diffraction peaks, they are between 5.7-8.4 nm. These results were confirmed by SEM and TEM. The NiAl2O4/Al2O3 catalysts had high conversions and selectivity for SRM reaction. This is due to structural surface properties of NiAl2O4 and the ability to reduce of the carbon deposition.

Nondestructive Characterization of Railway Bogies Using Infrared Thermography Technique: *Jeongguk Kim*[1]; [1]Korea Railroad Research Institute

The railway bogies are composed of weldments with reinforced materials. Therefore, the nondestructive inspection of the weldments is required for the integrity of railway bogies. In this paper, the railway bogies were nondestructively characterized using the infrared thermography technique. The thermographic detection of the weldments of bogies was performed using the lock-in thermography method with an infrared camera. Through lock-in thermography, the optimal frequency of heat source was determined for the best flaw detection. In this investigation, the lock-in thermography was employed to develop a nondestructive evaluation tool for the detection of flaws in railway bogies. Moreover, the nondestructive evaluation results for railway bogies have been presented.

Optical Properties and Electrical Properties of Transparent Conductive Films of Magnesium Hydroxide Based Compounds: *Masafumi Chiba*[1]; Mikiteru Higashi[1]; Hideo Kiyota[1]; Mikihiko Maizono[1]; Toshiro Kuji[1]; [1]Tokai University

Indium oxide doped with tin oxide, or ITO, has been widely used as an electrode material for flat panel displays. However, the rare metal in ITO is a limited natural resource. We succeeded in developing a material composed solely of elements with abundant reserves. We would like to present the results of analyzing the optical properties and the electronic structure of an Mg-based compound films based on its electrical conductivity. On average, its transmittance of visible light was 90%. The structures were observed by X-ray photoelectron spectroscopy (XPS). In addition, a comparison between the calculated electronic state around the valence band and the result measured by XPS of the obtained film reveals that they are in extremely close agreement. Part of this work was supported by Grant-in-Aid for Challenging Exploratory Research (22656076) of Japan Society for the Promotion of Science.

Oxidation Behavior of Spark Plasma Sintered ZrB2-SiC Composites: Ipek Akin[1]; Filiz Sahin[1]; Onuralp Yucel[1]; *Gultekin Goller*[1]; [1]Istanbul Technical University

ZrB2-SiC composites containing 40 and 60 mass% SiC were prepared by spark plasma sintering (SPS) at 1770°C for 300 s under a pressure of 40 MPa. Oxidation behavior of these samples was characterized by exposing them to 1400, 1500, and 1600°C in an ambient atmosphere for 180 min, and by measuring the weight gains of the sample. The oxide layers were characterized by field emission scanning electron microscopy with energy dispersive spectroscopy analysis. At 1400 and 1500°C, layered structures consisted of a SiO2 rich outer layer, a thin ZrO2-SiO2 layer, ZrO2-containing layer and unaffected ZrB2-SiC. However, at 1600°C, active oxidation of SiC was observed and changed oxidation mechanism significantly. The consumption of SiC particles resulted in a formation of oxide regions mainly composed of SiO or SiO2 and ZrO2. Unaffected ZrB2-SiC region was not observed at 1600°C.

Phase Change Materials in Thermal Energy Storage for Concentrating Solar Power (CSP): *Corey Hardin*[1]; Anoop Mathur[2]; Rajan Kasetty[2]; Chris Dames[1]; Reza Abbaschian[1]; Javier Garay[1]; [1]UC Riverside; [2]Terrafore Inc.

States of the art concentrating solar power (CSP) plants use molten inorganic salts for thermal energy storage (TES). Utilizing latent heat storage in addition to sensible heat storage systems can potentially result in a 30% reduction in amount of molten salt, 60% reduction in container size, and a 2-3% improvement in overall system efficiency. One of the main issues with using phase change materials is that solidification often reduces total heat transfer, reducing the efficiency of the storage system. The natural affinity of the salt is to solidify onto the cold heat exchanger tubes and even a very thin layer of this solid on the heat exchanger can lead to an order of magnitude drop in heat transfer. By analyzing surface energies and nucleating agents solid accumulation in the heat exchanger can be prevented. Results from these analysis and experimental data will be presented.

Phase Diagram Calculation and Its Applications to Materials Design and Development: *Fan Zhang*[1]; Weisheng Cao[1]; Shuanglin Chen[1]; Y. Austin Chang[1]; [1]CompuTherm, LLC

Phase diagrams are the road maps for materials scientists and engineers in materials design and process optimization. Traditionally, phase diagrams were determined primarily by meticulous and costly experiments. Nowadays, complex multi-component, multi-phase equilibria can be calculated by the CALPHAD approach. Moreover, this approach has in recent years been applied to a broader field of materials science and engineering beyond phase diagrams, such as solidification, coating, joining, and phase transformation. It has therefore become increasingly important in materials design and development and process optimization. In this presentation, I will use examples to demonstrate how phase diagram calculation can be integrated with key experiments in accelerating materials design and development. I will also demonstrate that the applications of this approach can be further extended by integrating it with kinetic models and microstructural models for the prediction of phase transformations and microstructure evolution of multi-component alloys.

Phase Transformation and Magnetic Properties of Pr2Co7 Intermetallics: *Najeh Mliki*[1]; Riadh Fersi[2]; Lotfi Bessais[3]; [1]LMOP, Faculté des Sciences de Tunis; [2](1) LMOP, Faculté des Sciences de Tunis, (2) CMTR, ICMPE, UMR7182; [3]CMTR, ICMPE, UMR7182, CNRS-UPEC

Pr2Co7 alloys with high coercivity were synthesized by mechanical alloying and subsequent annealing. X-ray diffraction analysis by Rietveld method was used to determine their structure and lattice constants. The crystallization, phase components and magnetic properties of the alloys were investigated systematically. For samples annealed at TA= 800°C, the main phase of those alloys is hexagonal of the Ce2Ni7 type structure whereas at

TA= 1050°C, the main one is rhombohedral of the Gd2Co7 type structure. The coercivity increases with annealing temperature reaching a maximum for TA =800°C. The highest is equal to 18 kOe at 293K and 23 kOe at 10K. This leads to the formation of a magnetically hard Pr2Co7 phase. This high coercivity is attributed to the high anisotropy field of the Pr2Co7 phase and its nanoscale grain size. Its Curie temperature is about 600K.

Prediction of Hexagonal Lattice Parameters of Non-Stoichiometric Apatites by Artificial Neural Networks: *Zafer Evis*[1]; Umit Kockan[1]; [1]Midde East Technical University

Hexagonal lattice parameters and unit cell volumes of non-stoichiometric apatites (A10(BO4)6C2), were predicted from their ionic radii by artificial neural networks. Multilayer perceptron network was used for training. Best results were obtained with Bayesian regularization method with four neurons in the hidden layer with 'tansig' activation function and one neuron in the output layer with 'purelin' function. Errors of lattice parameters for the predicted data with approximate formulas were less than 1% for a and 2% for c. Non-stoichiometric apatites with exact formulas generated up to around 3% errors for both lattice parameters because of their complex B sites.

Preparation and Current Distribution Performance of Pb-Al Layered Composite Anode Materials: *Shenggang Zhou*[1]; Peixian Zhu[1]; Yong Sun[1]; Lida Sun[2]; [1]Kunming University of Science and Technology; [2]Honghe University

Taking Sn as the third element in the Pb-Al immiscible system, the Al-Sn-Pb layered composite materials at different temperatures were prepared by solid-liquid coating method. Microstructure of the layered composite materials was studied by scanning electron microscope (SEM) and Energy Dispersive Spectrometer (EDS), and then the current distribution performance as the anode material for zinc electrowinning in ZnSO4-MnSO4-H2SO4 system was characterized by electric analysis module of ANSYS program . The results showed that, introducing of Sn reduced the enthalpy heat of mixing of Pb-Al system to be negative, and inter-diffusion of elements in the interface region occurred, and a metallurgical bonding interface between Pb and Al formed. Compared with the traditional Pb alloy anode, the Pb-Al layered composite anode showed a more uniform current distribution performance.

Preparation and Electrochemical Properties of Nanostructured Lithium Manganese Oxide Based Cathode Particles: *Burcak Ebin*[1]; Sebahattin Gurmen[1]; Cuneyt Arslan[1]; [1]Istanbul Technical University

Novel lithium-ion battery cathode materials based on layered manganese oxides was developed by a single step fabrication process. In this research, carbon / lithium manganese oxide nanocomposite particles were prepared by ultrasonic spray pyrolysis method from the stoichiometrically dissolved tartaric acid, lithium and manganese nitrate. It is intended to improve the cycling performance of the cathode materials by decreasing particle size and increasing electrical conductivity by carbon addition to the structure. The particle morphology, size, crystallinity and chemical composition were investigated by field emission scanning electron microscopy (FE-SEM), X-ray diffraction (XRD) and energy dispersive spectroscopy (EDS). Analyses show that porous submicron particles obtained by nanoparticles with graphite and cubic crystalline structured lithium manganese oxide was successfully fabricated. Electrochemical measurement demonstrated that cells containing carbon / lithium manganese oxide nanocomposite particles could improve capacity and cycling stability of the battery.

Preparation of $(Ti_{0.8}Mo_{0.2})C$-Ni Cermets by Mechanical Alloying: *Hiroyuki Hosokawa*[1]; Kiyotaka Kato[1]; Koji Shimojima[1]; Akihiro Matsumoto[1]; [1]National Institute of Advanced Industrial Science and Technology

The microstructural evolution of $(Ti_{0.8}Mo_{0.2})C$-Ni powders by mechanical alloying of pure titanium, nickel, carbon and molybdenum as starting powder were investigated by both X-ray diffraction (XRD) using CuKα radiation and electron microscopy with energy-dispersive X-ray spectroscopy (EDS). The powders were mixed gradually and the size of the mechanically alloyed particles was submicrometer order. The C peak, the Ni peaks and the Mo peaks disappeared and the TiC peaks appeared after several hundred hour milling time. The peaks of the TiC structure in this work showed a trend toward higher angles, compared with the referenced TiC peaks. The particles consisted of nano ordered grains. The nickel might be transformed from crystallized phase into an amorphous phase by mechanical alloying.

Probing Li-Ni Cation Disorder in $Li_{1-x}Ni_{1+x-y}Al_yO_2$ Cathode Materials by Neutron Diffraction: *Lu Cai*[1]; Zengcai Liu[1]; Ke An[1]; Chengdu Liang[1]; Xun-Li Wang[1]; [1]Oak Ridge National Laboratory

The power of neutron diffraction to detect lithium and its ability of differentiating cations enables the probing of cation disorder in cathode materials of lithium-ion batteries. We will present the research on probing the cation mixing of $LiNiO_2$ with and without Al^{3+} substitution. $LiNi^{3+}O_2$ is an attractive cathode material, but the cycling properties has been greatly depressed by the Ni^{2+} entering into Li^+ sites. Al3+ substitution of Ni^{3+} stabilizes the structure of lithium nickelate ($LiNi_{1-y}Al_yO_2$) and reduces the formation of Ni^{2+}, therefore mitigating the migration of Ni^{2+} into the Li^+ sites. The Rietveld refinement of the powder neutron diffraction patterns will be used to determine the cation disorder of Li and Ni in samples synthesized at different conditions. The correlation of structure with synthesis conditions will be discussed in details. We expect the results will provide guidance on the development of new materials to meet the needs of lithium-ion batteries.

Process Modeling and Reduction of Copper Loss in Smelting Slag: *Pengfu Tan*[1]; [1]Xstrata Copper

A series of technical improvements have been implemented to address the issue of high copper losses in Rotary Holding Furnace (RHF) slag, which experienced in Xstrata Copper Smelter at Mount Isa in 2007 and 2008. The copper losses in RHF slag was more than 3% in 2006 and 2007. The thermodynamic models, viscosity model have been applied in the operation of Xstrata Copper Smelter in Mount Isa. The theory of RHF KPIs has also been developed to reduce the copper losses in RHF slag. The RHF KPIs Theory has been applied in Mount Isa Copper Smelter. The copper losses in RHF slag have been dropped from 3.1% in 2007 to 0.76% in Apr 2009. The average copper loss in RHF slag in 2009 and 2010 is about 0.9%.

Processing of Multifunctional Oxides for Photonic Applications: *Elias Penilla*[1]; Javier Garay[1]; [1]UC Riverside

Polycrystalline ceramics are desired materials for applications in demanding environments because they offer high hardness, high melting points and chemical stability. Moreover, their development as transparent materials has seen a recent resurgence in activity due to their viability as optical-structural materials as well as for light emitting applications such as laser host materials. We report the development of a novel processing procedure for the derivation of bulk nanocrystalline ytrrium aluminum garnet (YAG) and neodymium-doped YAG optically transparent ceramics via a reactive-CAPAD approach. We have investigated the effects of processing temperature, and pressure on the resultant sample density, densification rate, microstructure, and ultimately on the resultant optical properties, e.g. transmission, reflectance, absorbance, etc.

Reactive Sintering Behaviors of the Formation of ZrC in Tungsten Matrix Composites: *Tae-Woo Kang*[1]; Hyun-Joo Choi[1]; Dong-Hyun Bae[1]; [1]Yonsei University

Dense ZrC/W composites have been fabricated by sintering the ball-milled mixture of W powders, MWNTs and Zr2Cu powders at 1400□. While the milling process, Zr2Cu powders are effectively dispersed in MWNTs embedded W powders. During the subsequent sintering process, at first, WC particles are formed by decomposition and reaction of carbon atoms in MWNTs. Secondly, Zr2Cu particles react with newly formed WC particles resulting in the uniformly dispersion of ZrC particles in W matrix. Hardness of the composite increase with increasing volume fraction of MWNTs and Zr2Cu, exhibiting more than two times enhanced hardness, as compared to that of pure W. Mechanical properties, according to the process variables, such as particle morphology, volume fraction, milling condition, sintering temperature and time, will be presented.

Research on the Carbothermic Reduction Conditions of Mill Scale from Continuous Casting Processes: *Fahri Demirci*[1]; Onuralp Yucel[1]; [1]Istanbul Technical University

This study concerns itself with the carbothermic reduction of mill scale, which is an iron oxide layer that forms on the surface of materials subjected to hot rolling or continuous casting. The mill scale is pelletized before undergoing reduction in a rotary kiln. The final product is direct reduced iron pellets with different amounts of metallic iron. Chemical and XRD analyses are carried out on samples obtained at different periods of time during the reaction. The effect of temperature, reductant type and amount of reductant is investigated by comparing the results reached by performing experiments with different parameters. Metallization degree, which is the ratio of metallic iron to total iron, and phase structure of the samples provide the necessary data to determine the effect of the parameters. It was found out that different types of reductants offered different temperature and stoichiometry dependency with regards to the reduction potential they provide.

Separation of Antimony from a Stibnite Concentrate through a Low-Temperature Smelting Process to Eliminate SO2 Emission: *Yang Jian-guang*[1]; Tang Chao-bo[1]; [1]Central South University

The main purpose of this study is to characterize and separate antimony from a stibnite concentrate through a low-temperature sulfur-fixing smelting process. This paper reports on a study conducted on optimization of process parameters, such as flux and zinc oxide weight percentage, in charging, smelting temperature, smelting duration on the antimony yield, resultant crude antimony grade, and sulfur fixing rate. A maximum antimony recovery of 97.07%, crude antimony grade of 96.45%, and 98.61% sulfur fixing rate are obtained when a charge is smelted at 880°C for 120 minutes. This smelting operation is free from atmospheric pollution because zinc oxide is used as the sulfur fixing agent. Based on the results of the chemical content analysis of as-resultant zinc sulfide, more than 90% zinc sulfide can be recovered, and the recovered zinc sulfide grade can reach 66.7%.

Simultaneous Heat and Moisture Transfer and Shrinkage during Drying of Ceramic Materials: *José Nascimento*[1]; Ariosvaldo Sobrinho[1]; Luiz Pontes[2]; Marcos Baracho[1]; [1]UAEMA / UFCG; [2]UFPB

The ceramic industry presents industrial processes with a large consumption of energy and high environmental impact. These industries are developing products of low quality due to inadequate drying and firing processes. Therefore, the purpose of this study is to contribute for the improvement of drying process by presenting a drying experimental study of the samples of clay for red ceramics (hollow and solid bricks), with different dimensions and initial moisture contents. In the drying processes, several air temperatures and air relative humidity were used, and thus several curves of the drying kinetics and volumetric retraction are shown and analyzed. Mathematical equations for predict lost of water and dimension variations during the process were obtained. It was verified that drying process takes place in the falling rate period and shrinkage happens in two distinct periods.

Simultaneous Recovery of Valuable Metals from Wastes with Reducing Metal Bath Technologies: *Juergen Antrekowitsch*[1]; Stefan Steinlechner[1]; Thomas Griessacher[1]; [1]University of Leoben

Heavy metal containing wastes from metallurgical industry today generally offer more than one valuable metal to recover. To make a simultaneous recovery possible from the technical and economical point of view, special technologies have to be developed mainly based on metal bath technologies. Such processes, tending to be zero waste solutions, are evaluated by their mass and energy balances. Furthermore typical difficulties and limits for an feasible processing are discussed within the paper. Especially zinc containing wastes are investigated which offer the special situation that valuable products can be recovered in the metal bath and in the off gas. First of all the amount of energy necessary for such a combined recycling of metals are an indication for their feasibility in future. Beside this some results of lab-scale investigations are described, showing first experiences concerning possible yields and product qualities for some selected residues treated with the mentioned processes.

Spatially-Correlated Microstructural Characterization: From Centimeters to Nanometers: *Dawn Janney*[1]; Timothy McJunkin[1]; Tammy Trowbridge[1]; Jill Scott[1]; [1]Idaho National Laboratory

The Idaho National Laboratory uses a variety of analytical instruments to characterize the chemistry, crystal structures, and microstructures in nuclear and other solid materials. With recent procurement of micro-X-ray diffractometer (MXRD) and focused ion beam (FIB) instruments it is possible in principle to analyze exactly the same volume of material on spatial scales spanning seven orders of magnitude (centimeters to nanometers). In practice, however, each instrument is operated independently, and it is difficult to ensure that each instrument collects data from the same area or to correlate data from the same area collected by different instruments. This presentation describes recently developed techniques for correlating data from instruments including scanning electron microscopes and an X-ray micro-focus diffractometer with video camera.

Study of Dislocation Density Field and Local Elastic Strain around the Triple Junction: *Samikshya Subedi*[1]; Brent Adams[1]; Sadegh Ahmadi[1]; [1]Brigham Young University

In this poster, measurement of dislocation density and local elastic strain is demonstrated using High resolution electron backscatter diffraction (HR-EBSD) technique. A large grain (average of 3mm) columnar iron sample having three grains and a triple junction within the gage section was prepared, decorated with four platinum-based fiducial markers. Cross correlation of the fiducials before and after the load gives the measure of macroscopic strain within the material. In order to find the local elastic strain the simulated pattern method is applied, where strain-free reference patterns are compared with experimental patterns, recovering strain by cross-correlating selected regions of interest within the EBSD patterns. Local elastic strain and dislocation density is recovered at each scan point. These data are presented as fields on the microstructure geometry.

Study on Microstructure and Mechanical Properties of Ti-Nb-(Zr, Mo)-CPP Composites Consolidated by Spark Plasma Sintering: *Kee-Do Woo*[1]; Duck-Soo Kang[1]; Sang-Hyuck Kim[1]; Sang-Hoon Park[1]; Ji-Young Kim[1]; [1]Chonbuk National University

Ti and its alloys such as Ti-6Al-4V alloy have been widely used for biomaterials due to their excellent biocompatibility, low density, excellent corrosion resistance and good balance of mechanical properties .However, some problems of Al and V, which are contained in mostly used Ti-6Al-4V have been reported. Calcium phosphate (CPP) materials have gained clinical acceptance for bone substitution because of their similarity to the mineral part of bone and their recognized biocompatibility. The aim of this study is to fabricate superior biocompatible Ti- Nb-(Zr, Mo)-CPP composites using SPS. Microstructure and phase composition of Ti-Nb-(Zr, Mo)-CPP composites were investigated by scanning electron microscopy (SEM) and X-ray diffractometer (XRD). Wear behavior, strength and corrosion resistance of the sintered Ti- Nb-(Zr, Mo)-CPP composites and Ti-6Al-4V ELI alloy have been observed.

Study on Preparation of ZnO/TiO2 and Its Photocatalytic Activity: *Wu Daoxin*[1]; [1]Changsha University of Science and Technology

With $Ti(C_4H_9O)_4$ and $Zn(Ac)_2 \cdot 2H_2O$ used as raw materials, oxalic acid as the complexing agent and anhydrous ethanol as solvent. the ZnO/TiO_2 photocatalytic nanocomposite materials was prepared by Sol-gel method and characterized by XRD,DRS and FS, and catalyst for photodegradation experiments. The results showed a good absorption performance of ZnO/TiO_2 when TiO_2 composite was 40% (mole fraction), calcination temperature was 400°,which indicated that red shift occurred. With sunlight as the light source, pH=5.0, catalyst concentration was 1.0mg.L^{-1}, concentration of methyl orange was 5.0mg.L^{-1}.The result showed that ZnO/TiO_2 powders(40%,400°) had the most photodegradation efficiency, and the degradation efficiency of 96.5% after 4 hours.

Study on Reactor Selecting with Indigestible Ore and Suspension Digestion: *Cao Wenzhong*[1]; Tian Weiwei[1]; Wang Lei[1]; Zhong Hong[1]; [1]Environmental and chemical engineering institute, Nanchang university

Suspension digestion of bauxite, digestion equipment and new technology have been studied. In the vertical reactor system, the experimental particle size range of criteria was determined by the flow pattern around the particles, so that velocity of suspended particles in the slurry was calculated more simply and accurately. The flow mechanism of suspended mineral particles and digestion kinetics were investigated in laboratory. That predicted design parameters of the bauxite digestion. The results show that digestion of diasporic bauxite. Bayer alumina process should adopt the suspended digestion process. Key words: suspension digestion, design parameters, lndigestible ore, suspension velocity

Study on the Characteristic of Crystalline Silicon Solar Cells: Teresa Oh[1]; Gil Jae Jung[2]; *Jae Jun Lee*[2]; [1]Cheongju University; [2]Young Sung Middle School

In recent years, the problem of silicon feedstock shortage is a major concern for most solar cell manufacturers. One of the solutions is to realize a high output conversion efficiency and low processing cost. Material costs account for about half the price of energy generated by a solar module built according to the current industrial technologies. From the electronics point of view, the same efficiency could be achieved by thin films of semiconductor supported by inexpensive substrates, thereby reducing the cost per kilowatt. In this study, the phosphorus oxychloride for n+ type doping were diffused on a p+ Si, SiC and poly Si using the carrier gas of N2 by LPCVD. Recombination losses are related to the metal to semiconductor contact areas and the series resistance losses are due to the resistance contributed by the metal fingers, metal to semiconductor contact resistance, bus bar and emitter region.

Study on the Interface Behavior of Ore Powder in Organic Media: *Li Dan*[1]; [1]Central South University

In this paper, the intaitace behavior of pyrite powdrs disparsed in acetone, chloroform, cyclohexane, cyclohexanol, toluene, tetrahydrofuran, sodium dodecyl sulfate with n-dodecanethiol as modifier was studied. The despersion nature of pyrite powder is also investigated in solvents through ultraviolet spectroscopy, oscillation, scanning electron microscopy, and electron spin resonance method. Ultraviolet spectrum analysis illustrates the sequence of dispersion as: sodium dodecyl sulfate> tetrahydrofuran> cyclohexanol> cyclohexane> toluene> acetone> chloroform. Dispersion property of powder were measurced with Oscillation method. It was found that the dispersion propenting of modified pyrite poeedr is better than that of the uninodified powders. The smaller the particle size the better the dispersion. Powder's particle SEM morpholugy shows that the porticles of pyrite midifiel with sodium dodecyl sulfate are uniform and agglomeration of poutices is not obvious. Surface activity of powder modified with n-dodecanethiol surfactant is large ,pyrite powersare more easily dispersed in other organic solvents.

Study on the Microstructure Evolution of Fe-6.5wt.%Si Powders Fabricated by High Pressure Gas Atomization: *Liang Zhu*[1]; Kefeng Li[1]; Yuanyi Guo[1]; Changjiang Song[1]; Qijie Zhai[1]; [1]Shanghai Key Laboratory of Modern Metallurgy & Materials Processing

Silicon steel with 6.5wt.%Si have a great potential application in electric fields because of good properties such as high permeability, high electric resistivity, and low anisotropy. However, due to the brittleness of high silicon Fe-Si alloy, the silicon content is generally less than 3.5wt.% for the conventional silicon steel. In this paper, high pressure gas atomization technology was used to produce Fe-6.5wt.%Si powders so as to obtain desired components by powder compacting. During atomization process, the size of atomized droplets is in a wide range. The specific surface area of the droplet would be sharply changed with the change of droplet diameter, which results in significant difference of heat transfer and cooling rate. This paper mainly studied the microstructure evolution of Fe-6.5wt.% Si powders with the change of powder size. At last, the microstructure forming course was theoretically analyzed.

Study on the Photocatalytic Oxidation of Water Splitting Over W^{6+}-Dopant of Rutile TiO_2: Wu Daoxin[1]; *Yin ZhouLan*[1]; [1]Central South University

In this paper, W^{6+}-doping rutile titania were prepared by low temperature hydrolysis using Tetrabutyl titanate ($C_{16}H_{36}O_4Ti$) as raw material. Powers were characterized by XRD,DRS,PL,BET. The photocatalytic activity of W^{6+}-dopant of r-TiO_2 was investigated with Fe^{3+} as electron acceptor at pH=2.0 under 365nm UV irradiation. The O_2 production rate reached 480μmol.$L^{-1}h^{-1}$. Results show that rutile titania were final transformated at sintering temperature 850°. The photocatalytic activity of W^{6+}-doping rutile titania increases with higher photoluminescence performance and photo absorption. The photoinduced electrons are easily captured by oxygen vacancy so that the recombination of photoinduced electron and hole pairs is effectively inhibited. These are responsible for the enhancement in the photocatalytic activity.

Study on Thermal Decomposition of Precursor of Nb^{5+} Doped Rutile TiO_2 Treated by Ultrasonic: *Wu Daoxin*[1]; [1]Changsha University of Science and Technology

In many applications, anatase TiO_2 powders consisting of particles with a large surface area are used as the photocatalysts. In contrast to these compounds,oxidation of water efficiently proceeds on large rutile TiO_2 particles.The thermal decomposition behavior of precursor of Nb^{5+} doped rutile TiO_2 were prepared by sol-gel method. With ultrasonic treatment of 100W and 30min were investigated in TG-DSC, XRD, SEM and DRS. It has been showed that Ultrasonic treatment could be made use of the phase transition. Ultrasonic treatedment could facilite the growing of crystal .Ultrasonc-treated doped TiO_2 phase transformation from anatase to rutile at 400°~500°,which was 100° lower than untreated ones. The absorbing performance of Nb5+ doped rutile TiO_2 powders treated by ultrasonic was better than that of without treatment while wavelength above 400nm. The ultrasonic treatment ould also also lead to the decrease catalysts size. The doped catalysts will have been showed better catalytic activity.

Synthesis and Characterization of Flame Retarding UV-Curable Boron Containing Hybrid Coatings: *Bihter Zeytuncu*[1]; Vezir Kahraman[2]; Onuralp Yucel[1]; [1]Istanbul Technical University; [2]Marmara University

A series of UV-curable boron containing hybrid coatings prepared by anhydrous sol-gel technique. The chemical structure of hybrid coatings was characterized by FT-IR, RT-IR, 1H-NMR and 29Si-CP MAS-NMR techniques. UV curable coatings were applied on polycarbonate substrates. The physical and mechanical properties of UV-cured coatings such as pendulum hardness, pencil hardness, contact angle, gel content, MEK rubbing test, tensile test, abrasion resistance, chemical resistance, flame retardant, anti-stain and gloss were examined. Thermal gravimetric analysis (TGA) was made. Results of all analysis conducted on free films and coatings were discussed. The morphology of the hybrid materials was examined by SEM. The hybrids were nanocomposites.

Synthesis of Nanocrystalline Cu3B2O6 Particles by Ultrasonic Spray Pyrolysis Method: Burcak Ebin[1]; *Sebahattin Gurmen*[1]; Cuneyt Arslan[1]; [1]Istanbul Technical University

The copper boron oxide (Cu3B2O6) attracts great attention due to the combination of its structural and unique physicochemical properties such as high thermal and chemical stability. The other interesting behaviors of the Cu3B2O6 structure are its antiferromagnetism, non-toxicity and hybrophobic properties, which allow it several potential applications. In this research, nanocrystalline Cu3B2O6 particles were produced by ultrasonic spray pyrolysis (USP) method using aqueous solution of copper nitrate and boric acid in desired concentration. Particles obtained thermal decomposition of precursor under constant air flow rate at 1000°C furnace temperature. Then samples were structurally characterized by X-ray diffraction (XRD), scanning electron microscope (SEM) and energy dispersive spectroscopy (EDS). The results show that nanocrystalline Cu3B2O6 particles in nearly spherical morphology were prepared successfully. Also, XRD analysis reveal that obtained Cu3B2O6 particles have anorthic crystal structure and their crystalline size are nearly 29 nm, which are calculated by Scherrer equation.

Technical Developments and Improvements in Xstrata Copper Smelter in Australia: *Pengfu Tan*[1]; [1]Xstrata Copper

Xstrata Copper Smelter at Mount Isa in Australia has operated one copper Isasmelt furnace, two Rotary Holding Furnaces (RHFs), four Peirce-Smith P-S converters, two anode furnaces, one casting wheel, slag crushing and screening plant, and ESP dust recovery plant. Some recent technical developments and improvements have been presented and discussed in this paper. Those improvements include: development of smelting and converting process models, slag chemistry models and slag viscosity model; reduction of copper loss in RHF slag; reduction of converter foamover frequency; improvement of yields and throughput; ESP dust recovery plant trials, lab tests, commissioning and operations; and improvement of Isasmelt brick campaign life.

Texture Evolution during Annealing on a Hot Rolled AISI 310 Austenitic Stainless Steel: *Jesús Sandoval*[1]; Maribel De la Garza[1]; Rafael Colás[1]; Victor Páramo[2]; Adriana Salas[1]; Martha Guerrero[1]; Ivan Houbaert[3]; [1]Universidad Autónoma de Nuevo León; [2]Frisa Aerospace S.A. de C.V.; [3]Ghent University

This work presents the study of the texture evolution during annealing on a hot rolled AISI 310 austenitic stainless steel. As received, the material presented the typical hot rolling texture components with similar intensities; however in the annealed samples, the major texture components are concentrated on the ß fiber, primarily the Brass {110}<1-12> and Sulfur components {123}<63-4>, as well as the Goss component {110}<001>. The results show that at higher annealing temperatures and times, an increment on the intensity of such texture components take place. Similar results were obtained by Electron Backscattering Diffraction (EBSD) analysis technique. The inverse pole figures showed an increase on the fraction area of with <634> and <211> direction, <100> direction was found to be constant during the annealing.

The Carbonation Reaction of Waste Cement and the Sequestration of CO2: *Kwangsuk Yoo*[1]; Seong-Ho Lee[1]; Sung-Ho Hwang[1]; Ji-Hwan Ahn[1]; [1]Korea institute of geosicence and mineral resources

The rate of CO2 emission has kept increasing every year and the global warming is now a major issue. The generation rate of construction waste increased drastically in Korea, reaching 65 million tons in 2008. This study research discuses on the ability of waste cement for the fixation of CO2 gas and the property changes of the surface of waste cement during carbonation reaction. Especially, in this study, there was an investigation on the effect of the physicochemical properties of the carbonated surface of waste cement. The specific surface area and CEC of carbonated waste cement had linearly increased with the increase in the carbonation percentage. It can be seen that Si component was transformed from linear polysilicate anions in C-S-H gel into a silica with 3-dimension and the formation of Al(OH)3 gel. And the carbonation percentage in the base of CaO content also increased up to 35%.

The Corrosion of (Fe, Ni)-Alloys in N2-H2S-H2O Mixtures at 600-800°C: *Min Jung Kim*[1]; Chenguang Zhao[1]; Dong Bok Lee[1]; [1]Sungkyunkwan University

The corrosion of (Fe, Ni)-alloys in simulated IGCC gas atmospheres were studied at 600-800°C in N2/H2S/H2O gases. IGCC is a key technology to realize high efficiency and good environmental performance for electricity generation. The corrosion resistance increased in the order of SUS 430, SUS 310, Alloy 800, and IN 625. Ni and Cr increased the corrosion resistance of the alloys. The scale formed consisted primarily of an outer (Fe, Ni)S scale plus an inner CrS scale in the case of SUS310, an outer FeS scale plus an inner (CrS, Cr2O3)scale in the case of SUS 430, an outer (Fe, Ni)S scale plus an inner CrS scale in the case of Alloy 800, and an outer (Fe, Ni)S scale plus an inner (CrS, Cr2O3)scale in the case of IN 625. This work was supported by New & Renewable Energy R&D program under the Ministry of Knowledge Economy, Republic of Korea.

The Effect of ARB Parameters on Mechanical Properties of Ultra Fine Grained Cu, Al and Fe: *Saeed Tamimi*[1]; Amir Chegini[2]; Mostafa Ketabchi[3]; Nader Parvin[3]; [1]TEMA; [2]Department of Mechanical Engineering; [3]Mining and Metallurgical Eng. Dep.

Present work deals with Accumulative Roll Bonding (ARB) in low Carbon steel, pure copper and Al-1100. A number of passes of ARB were performed at 500ºC for steel, 350ºC for copper and 250ºC for Al-1100, with 50% reduction in area in each rolling pass. The hardness distribution along the thickness was directly dictated by grain size in each point. It was found that both the ultimate grain size achieved, as well as the degree of bonding, depend on the number of rolling pass and reduction in area as a whole. Mean grain size of samples were determined about 225nm for steel, 1-3µm for copper and 500-700nm for Al-1100. The rolling process was stopped when cracking of the edges became pronounced. Finally, the effect of process temperature and wire brushing were investigated. Moreover, the effect of process temperature on the hardness was investigated.

The Effect of Irreversible Losses on the Structure of NdFeB Magnets: Levent Vural[1]; Feriha Birol[2]; *Gultekin Goller*[1]; [1]Istanbul Technical University; [2]Arcelik R&D Center

In recent years, magnet materials having permanent and high magnetic properties are widely used in a wide variety of applications such as white and electronic goods, medical field and automotive industry. Generally NdFeB magnets are used in permanent magnet motors. The magnetic and aging properties of these magnets can be affected by material properties. In this study, the detailed characterization of NdFeB magnet materials was performed and the changes on the material properties after magnetic aging were investigated. The composition of the materials and phase analysis were carried out by using XRF and XRD techniques, respectively. The Curie temperature of the materials was determined by differential scanning calorimetry (DSC) and the magnetic properties determination was carried out by permeagraph device. The additive elements and phases caused different magnetic properties on NdFeB magnets. A great magnetic losses were observed and these losses could be reduced by the existence of some phases.

The Effect of Pressure and Temperature on Densification Rates in Current Activated Densification: *Alexander Dupuy*[1]; Joseph Alaniz[1]; Javier Garay[1]; [1]University of California Riverside

Current Activated Pressure Assisted Densification (CAPAD) techniques have shown great promise in efficiently consolidating a wide range of materials systems. This efficiency manifests itself in the form of a high densification rate, which is influenced by the processing parameters and material properties. To better understand these influences, a wide range of materials (ionic, covalent, and metallic solids) were densified using the CAPAD technique. By calibrating the device, it was possible to eliminate the effects of thermal expansion and determine the true densification rate of the materials. This data was examined in order to determine the effect that pressure and homologous temperature have on densification rate as well as their sensitivity to material bonding type. In particular, the connection between pressure and bonding type on densification rate was investigated by processing zirconia, silicon, and aluminum at a variety of pressures.

The Effect of Sintering Conditions on the Properties WC-Co Hard Metal by Powder Injection Molding Process: *Sung-Hyun Choi*[1]; Dong-Wook Park[1]; Young-Sam Kown[2]; Kwom-Ku Cho[1]; In-Shup Ahn[1]; [1]School of nano and advanced Materials Engineering, I-Cube Center, K-MEM R&D cluster, Gyeongsang National University; [2]CetaTech. Inc

Powder injection molding (PIM) is an advanced technology for processing metal and ceramic powders for forming desired shapes at a relatively low processing cost. Tungsten carbide–cobalt hard materials (WC–Co) are widely used for a variety of applications. The WC-10Co feedstock mixed with wax binder was fabricated by two blade mixer. After feedstocks were injection molded, debinding process was carried by two-steps methods with solvent extraction and thermal debinding. After debinding process, the specimens were sintered at vacuum in difference temperature. The microstructure and phase were observed by FE-SEM. In the case of sintered at 1380° in

vacuum atmosphere, The hardness was 1840Hv, and the relative density of WC-10%Co was 95%. The density of specimen sintered at 1400° in vacuum atmosphere was 96.5% and hardness was 1880Hv. In case of heating rate 3° per minute to 1380°, The hardness and density were observed 1910Hv and 97.5%.

The Effects of Al-5Ti-1B Grain Refiner and Heat Treatment on the Microstructure and Dry Sliding Wear Behavior of a New Developed Super High-Strength Aluminum Alloy: Mohammad Alipour[1]; Masoud Emamy[1]; *Jafar Rasizadeh*[1]; Mostafa Karamouz[1]; Mortaza Azarbarmas[1]; [1]Kargar street

In this study the effect of Al–5Ti–1B grain refiner on the structural characteristics and wear properties of Al–12Zn–3Mg–2.5Cu aluminum alloy was investigated. The optimum amount for Ti containing grain refiners was selected as 2 wt.%. T6 heat treatment, heating at 460°C for 1 h and water quenching to room temperature and aging at 120°C for 24 h, was applied for all specimens before wear testing. Dry sliding wear performance of the alloy was examined in normal atmospheric conditions. The experimental results showed that the T6 heat treatment considerably improved the resistance of Al–12Zn–3Mg–2.5Cu aluminum alloy to dry sliding wear.

The Effects of Be on Mechanical Properties of Al–Mg2Si In Situ Composite: Mortaza Azarbarmas[1]; Masoud Emamy[1]; *Jafar Rassizadehghani*[1]; Mohammad Alipour[1]; Mostafa karamouz[1]; [1]University of Tehran

The influence of Be content on the mechanical properties of Al–15%Mg2Si composite was investigated. The results showed that with the addition of 0.5%Be, the ultimate tensile strength (UTS) and elongation values reached from 252 to 280 MPa and 2.2 to 3.8%, respectively. A study of the specimen's fracture surfaces via scanning electron microscope (SEM) showed that adding Be increase the number of fine dimples that is consistent with results from tensile tests.

The Effects of Cooling Rate on the Microstructure and Hardness of Al–15wt.%Mg2Si In Situ Composite with Boron: Mortaza Azarbarmas[1]; Masoud Emamy[1]; *Jafar Rassizadehghani*[1]; Mostafa Karamouz[1]; Mohammad Alipour[1]; [1]University of Tehran

The effect of cooling rate was investigated by the use of two molds with different section test bars. The results showed an increase in hardness values with reduction in section thicknesses corresponding to increasing cooling rates. This influence was observed in both with and without Boron specimens. Optical and SEM images show that with increasing of cooling rate the size of primary Mg2Si particles decreased. The results demonstrate that the cooling rate affected the amount of alpha phase and the size of pseudo-eutectic cells.

The Effects of Li Additions on the Microstructure and Mechanical Properties of 380 Aluminum Casting Alloys: Mostafa Karamouz Ravari[1]; Masoud Emamy[1]; *Jafar Rassizadehghani*[1]; Mohammad Alipour[1]; Mortaza Azarbarmas[1]; [1]University of Tehran

The effects of Li on the microstructure and mechanical properties of Type 380A aluminum casting alloys have been examined. It is shown that, as the Licontent is increased up to 0.1 wt.pct in the baseline alloy (Al–8.5 wt.%Si–3.5 wt.%Cu–1 wt.%Fe),Li successfully modifies the morphology of the ß-Al5FeSi and eutectic Si phases from coarse intersected and branched platelets into finer and independent ones. The Li-containing alloy exhibits higher strength and elongation to failure, presumably due to both finer ß-Al5FeSi and eutectic Si phases.

The Effects of Ni and Mn on the Solid Particle Erosion Resistance of Austenitic Fe-12Cr-0.4C-xNi/Mn Alloys: *Ki Nam Kim*[1]; Tae Ho Kim[1]; Jun Ki Kim[2]; Seon Jin Kim[1]; [1]Hanyang Univ.; [2]Korea Institute of Industrial Technology

Solid particle erosion implies the removal of material from component surfaces due to successive impacts of hard particles, and has been recognized as a serious problem for many years in various engineering applications such as hydrotransport lines, power plants and gas turbine blades. Recently, it was confirmed that strain-induced martensitic transformation improved abrasive, adhesive wear and cavitation erosion resistance in Fe-base austenitic alloys. The damage was decreased due to the absorption of external energy and the hardened surface formed by the strain-induced martensitic transformation. So, it is considered that the strain-induced martensitic transformation may have significant effect on improving solid particle erosion resistance due to absorbing impact energy of particles. In this study, the effect of Ni and Mn on the solid particle erosion resistance of Fe-12Cr-0.4C-xNi/Mn (x = 5, 10) alloys was investigated in term of the strain-induced martensitic transformation.

The Extended Q-Range Small Angle Neutron Scattering Diffractometer at the SNS: *Yang Gao*[1]; Dazhi Liu[1]; Jinkui Zhao[1]; [1]Oak Ridge National Laboratory

The Extended Q-Range Small Angle Neutron Scattering Diffractometer (EQ-SANS) at the Spallation Neutron Source (SNS) is a high intensity instrument with a wide neutron momentum transfer (Q) coverage and a good wavelength resolution. It has a variable sample to detector distance of ~1.3 to 10 m and an accessible neutron momentum transfer (Q) range of ~0.001 to 1 Å-1. The neutron flux on sample is greater than 106 n/cm2/s/Å at the collimation length of four meters. The standard sample environment equipment on the EQ-SANS is a 45-position automated sample changer with temperature control between -2 and 80°C. The instrument are used to study proteins, polymers, metal alloys, and many other nanocomposites. Experimental results are shown to demonstrate the instrument ability.

The Influence of Li on Properties of 380 Aluminum Casting Alloys: Mostafa Karamouz Ravari[1]; Masoud Emamy[1]; *Jafar Rassizadehghani*[1]; Mortaza Azarbarmas[1]; Mohammad Alipour[1]; [1]university of tehran

This study was undertaken to investigate the influence of Li on the structural characteristics and hardness properties of Al–8.5Si–3.5Cu–1Fe aluminum alloy. A study of the specimen's surfaces via optical and scanning electron microscope (SEM) revealed that in the Li-containing alloys the eutectic Si is well refined and the ß-phase has a finer and individual structure. It was revealed from hardness tests that the addition of Li decreases the hardness values.

The Materials Accelerator: A New Working Model to Promote Commercialization of Multi-Materials through a National Network in Manufacturing Materials: *Karnika De Silva*[1]; Ralph P. Cooney[1]; Mark P. Taylor[1]; [1]Materials Accelerator, University of Auckland, Tamaki Innovation Campus, Auckland, New Zealand

The Materials Accelerator (MA) is a national capability network which seeks to develop transformational multi-material products in cooperative R&D partnership with innovative high-technology companies. MA has teams of researchers drawn from eight NZ research institutions with multi-materials expertise in composites, plastics, conducting polymers, nanotechnology, metals and also expertise in prototyping, virtual manufacturing, materials analysis and characterization, modeling, interfacial analysis etc. MA Network includes contributions from universities and government laboratories with ~100 researchers associated with the network. Some research projects administered by MA that are beneficial to the MA commercial platforms and to NZ generally will be presented. These proposals are interfacial in its materials focus and bridges more than one type of materials and include mechanisms for preserving the knowledge within the MA business model, its strategy, and its aspirations for new product and market development, as well as outlining the technical and research issues raised by potential R&D projects.

The Universality Class of Avalanches in Plasticity: Integrated Exponents from Relaxation Processes: *Stefanos Papanikolaou*[1]; [1]Cornell University

Crackling noise in plastically deformed materials has been suggested to display mean-field behavior, where the histograms of strain jumps show a critical exponent of 3/2. However, there is strong experimental evidence that as the strain-rate decreases, the exponent drifts to higher values, suggesting that the simple mean-field picture is not complete. Here, we present a coarse-grained model of avalanches where an additional slow stress diffusion process takes place in between the fast avalanche events. This model displays the observed rate dependence, which is due to a periodic

integration over hardening levels. Our model suggests that the true universal behavior of avalanches is described by integrated mean-field avalanches, and relaxation processes are important in explaining the experimental behavior.

The Use of the Multi-Axial Parameter for Fretting Fatigue Assessment of Titanium Alloys: *Hyukjae Lee*[1]; [1]Andong National University

Fretting fatigue occurs when two mating components are subjected to oscillating loading and can facilitate crack initiation at very low stresses leading to premature failure in components such as spline joint and blade and disk attachment in dovetail joint. Since its multi-axial nature, fretting fatigue is generally depicted better with multi-axial parameters. In this presentation, a critical plane based fatigue crack initiation parameter is computed from the results of finite element analysis and then used to predict fretting fatigue life of titanium alloys. In addition, the multi-axial parameter is used to understand the different fretting fatigue behaviors of titanium alloys with various conditions, such as different surface treatment, material composition, etc. The results show that the multi-axial parameter is very effective to predict fretting fatigue life of titanium alloys from the conventional fatigue life and it can be a very useful tool for analyzing complex fretting fatigue behaviors.

Thermodynamic Modeling of Chemical Soluble Copper Loss and Liquidus Temperature of High Magnesia Slag: *Pengfu Tan*[1]; [1]Xstrata Copper

Xstrata Copper Smelter at Mount Isa in Australia had experienced the technical issue of high copper losses in the Rotary Holding Furnace (RHF) slag before 2008. The copper losses in RHF slag was more than 3% in 2006 and 2007. The thermodynamic models, viscosity model have been developed to simulate the process control, slag chemistry, slag viscosity, and matt-slag separations. The effect of SiO2/Fe ratio, CaO%, MgO%, and Al2O3% in slag on the liquidus temperature of slag has been predicted. The effect of slag compositions, matte grade, oxygen potential, and temperature on the soluble copper loss in the copper smelting slag has been modeled and discussed.

Thermodynamic Study for Cleaning Water Contaminated with Cu, Pb, and Ni: *Ramiro Garcia*[1]; Francisco Tavera Miranda[1]; Eunice Espinoza[1]; [1]Universidad Michoacana

Flotation devices originally designed for minerals recovery are considered as alternative for waste water treatment (i.e., water contaminated with heavy metals). This work proposes to study the mechanisms of precipitation of lead, cooper, and nickel species in a liquid media, in order to design a procedure of cleaning waste water through a flotation-sedimentation route. Copper, lead, and nickel salts were dissolved into distilled water, and according to the thermodynamic analysis of the corresponding metal-water system, the precipitation of solid species were predicted after changing both the electrochemical potential and the pH of the liquid media. Experimental results show the possibility to remove completely copper, nickel, and lead from contaminated water, and to establish a sedimentation procedure for cleaning waste water.

Thermoelectric Properties of ß-Zn4Sb3 Synthesized by Mechanical Alloying and Vacuum Hot Pressing: *Pee-Yew Lee*[1]; [1]National Taiwan Ocean University

Theß-Zn4Sb3 compound has become the focus of attention as a thermoelectric material applicable to thermoelectric power generation around 700 K. It has a relatively low cost and can potentially substitute for high performance lead tellurides which contain toxic lead. In this research, a method combining the mechanical alloying with the vacuum hot pressing was adopted to obtain the bulk sample ofß-Zn4Sb3. It is found single-phaseß-Zn4Sb3 were successfully prepared by mechanical alloying of elemental powders containing 0.6 at.% excess Zn. Thermoelectric properties as a function of temperature were investigated from room temperature to 600 K and compared with results of other studies. Transport properties at room temperature were also evaluated. Thermoelectric properties of single-phase ß-Zn4Sb3 materials produced by present method were measured and are comparable to the published data. Synthesis by mechanical alloying and vacuum hot pressing provides an optional processing route in this material.

Thermographic Analysis of Braking in Railway Brake Disc: *Jeongguk Kim*[1]; Sung-Tae Kwon[1]; Sung Cheol Yoon[1]; Byung Choon Goo[1]; [1]Korea Railroad Research Institute

The damage evolution due to generation of hot spots on railway brake disc has been considered the main degradation mechanism in brake disc. Therefore, the understanding of hot spots, also called hot judder, which is undesirable low frequency vibrations developed by non-uniform contact area between brake pad material and brake disc, is important for a better understanding of material design as well as enhancement of materials properties in railway brake disc. In this investigation, during braking, the thermographic temperature analysis of railway brake disc was quantitatively performed to investigate the degradation mechanism of brake disc. The analysis of surface temperature changes on railway brake disc was conducted using a high-speed infrared camera. Through the analysis of thermographic monitoring images, the temperature evolution with different braking speeds was qualitatively evaluated. In this paper, the qualitative investigation results on the temperature evolution of railway brake disc was summarized and presented.

Thermographic Monitoring of Fracture Behavior in Railway Steels: *Jeongguk Kim*[1]; [1]Korea Railroad Research Institute

The tensile failure behavior of different types of railway steels, which are used for railway vehicle components such as wheel and axle, was characterized using high-speed infrared camera. The tensile specimens were obtained from the actual railway vehicle parts, which were used for over 20 years. An infrared camera was used to monitor damage evolution in terms of surface temperature measurements with the camera speed of 100 Hz. A qualitative image analysis was conducted to explain failure mode and mechanisms in different railway steel samples based on infrared thermographic images obtained during tensile testing. Moreover, the microstructural characterization using scanning electron microscope (SEM) was performed to correlate the mechanical failure mode with thermographic results. In this investigation, an IR camera and SEM characterization method were used to facilitate a better understanding of fracture behavior of different types of railway steels during tensile testing.

Three-Dimension Electrode Device Assembled from Bamboo Char Loaded Nano Ferric Oxide for Catalytic Treatment of Organic Wastewater: *Li Dan*[1]; [1]Central South University

Three-dimension electrode device assembled from foam nickel and bamboo char loaded nano ferric oxide electrode was investigated for catalytic treatment of organic wastewater. The influence of the following parameters, namely calcination temperature, organic pollutant concentration, voltage, amount of electrolyte, was the main focus. The optimum value of calcination temperature (400°), organic pollutant concentration(5mg/L), voltage (1V), amount of electrolyte (0.7g/L), were obtained, corresponding to the best elimination rate of 96.5% with good durability. The order of the treatment effect for different organic wastewater is as follow: basic fuchsine > Methyl orange > Rhodamine B > Acid fuchsine.

Three-Dimension Electrode Device with Bamboo Char Loaded Nano-Cobalt Oxide for Catalytic Degradation of Organic Pollutant in Wastewater: *Zhang Ling*[1]; [1]College of Chemistry and Bioengineering, Changsha University of Science and Technology

Bamboo char loaded nano-cabalt oxide catalyst was prepared by sol-gel method from bamboo char, cobalt nitrate, and citric acid. The catalytic performance of the obtained catalyst contained in three-dimension electrode device for catalytic degradation of organic pollutant in wastewater was investigated . The prepared catalyst with uniform particle size was fine. Orthogonal experiments were performed to achieved the optimum conditions, namely calcination temperature of 600°, voltage of 7V, and amount of electrolyte of 0.7g/L. The order of the degradation effect for different organic pollutant was as follow: methyl orange > basic fuchsine > rhodamine B > acid fuchsine > phenol. The test of the effect of catalyst under the optimum conditions indicates that the catalyst exhibited best degradation rate to acid fuchsine (91.36%) with catalyst concentration of

1.0g/L, calcination temperature of 600°, catalytic degradation time of 5h, and acid fuchsine concentration of 1mg/L.

Toughened Poly (Acid Lactic): Mechanical and Morphological Characterizations: Gustavo Brito[1]; Tomas Melo[1]; *Pankaj Agrawal*[1]; Carlos Cunha[1]; Edcleide Araújo[1]; [1]Federal University of Campina Grande - UFCG

The poly (acid lactic) has attracted great attention of researches due to it come from renewable source, and possess characteristics like biodegradability and good processability. However, the PLA presents some drawbacks, like brittleness, that should be overcome to make possible its wide application. In this work, PLA was blended with an impact modifier. The blends were tested by impact and tensile tests. Scanning Electronic Microscopy was realized in the fracture surface of the impact samples. Results showed that a thoughened PLA was obtained.

Toughening of ADI Austenitized in Intercritical Region: *J.K. Chen*[1]; B.T. Chen[1]; J.S. Tsai[1]; [1]National Taipei Univ. Technology

The current article investigates the influences of intercritical austenitizing temperatures on microstructures and mechanical properties of austempered ductile irons. A series of intercritical austenitizing temperatures ranging from 775 to 900°C are used and austempering is performed at 400°C on a conventional FCD700 ductile iron. Experimental results show that mechanical properties, including strength, ductility, and the toughness, all increase with intercritical austenitizing temperatures till an optimum austenitizing temperature of 830°C. At this optimum processing condition, strength of 974MPa, impact energy of 166 J, and 16.4% ductility is achieved which is compared with the non-treated ductile iron with 790MPa strength, 42J impact energy, and 8.2% ductility. Microstructure refining via well distributed sub-micron ausferrite structure is essential for the increase of strength. Furthermore, the increased carbon content of retained austenite and austenite volume fraction combines to increase toughness through martensitic transformation and gives rise to transformation induced plasticity (TRIP) effect.

Ultrasonic-Assisted Soldering of Aluminum Alloy under Liquidus Temperature of Zn-Al Alloy: *Toru Nagaoka*[1]; Yoshiaki Morisada[1]; Masao Fukusumi[1]; Tadashi Takemoto[2]; [1]Osaka Municipal Technical Research Institute; [2]Joining and Welding Research Institute, Osaka University

To obtain butt-joints of aluminum alloy containing 4.5 to 5.6 mass % magnesium, an ultrasonic-assisted soldering process using Zn-xAl (x = 5, 13, and 38 mass %) solder alloys was investigated. Each solder foil was inserted between faying surfaces of the aluminum rods. Ultrasonic vibration was propagated to the solder foil through the aluminum rod for 4 seconds at soldering temperatures. As the results of tensile tests for obtained joints, the joint strength increased with decrease of soldering temperature and with increase of Al content of Zn-Al solder alloy. The results of XRD on the fracture surface and SEM-EDX analysis of the solder layer revealed that the improvement of joint strength was due to the decreased amount of $MgZn_2$ phase in the solder layer. The generation of $MgZn_2$ phase should be decreased by suppression of the dissolution of 5056-Al substrates during the soldering process.

Use of Polymeric Residues from the Footwear Industry in Layers of Asphalt Composites: *Ariosvaldo Sobrinho*[1]; Fábio Rios[1]; Karine Santos[2]; Marcos Baracho[2]; Luiz Pontes[3]; José Nascimento[1]; [1]UAEMA / UFCG; [2]UAEC/UFCG; [3]LMPC / DTM / UFPB

Technological innovation, analysis of the life cycle of materials, development of new alternative products such as composites and asphalt blanket, using materials from industrial waste for use in construction, are constant challenges for researchers. In general, the reasons that motivate these researchers are: reducing the environmental impact, gradual reduction of deposit areas, depletion of non-renewable raw materials, reducing costs and energy consumption and improvement in quality of life. The demands of current management, and proper management of waste and tariffs imposed by environmental legislation, and bring great concern and cost to entrepreneurs, have also motivated research on recycling and reprocessing.

Utilizing SST and Ultrasonic NDT for Microstructure Analysis of the Irradiated Steel Structure: *Mohammad Allazadeh*[1]; [1]University of Pannonia

The radiation, particularly neutron radiation, can have deleterious effects on material properties such as formation of internal voids or bubbles. Modification of microstrutural configuration may cause catastrophic results in the soundness of the irradiated heavy section ferritic-martensitic steels structure (e.g. nuclear pressure vessels). The small specimen technique (SST) method is a technique used to predict the standard mechanical properties of heavy section components and structures under operational loading conditions. Defect distributional map provided by the ultrasonic nondestructive testing (NDT) can be analyzed to specify the type of the defect and to assess the level of the defects in the microstructure. A microstructural analysis method is suggested to study the microstructural variability based on a combination of SST and signal processing analysis of ultrasonic NDT. This method can be applied to monitor catastrophic flaw formation and crack propagation in large steel structure due to microstructural degradation by irradiation.

Water Modeling of Optimization of Two-Strand Tundish Configuration for Slab Continuous Casting with Gas Bubbling: *Shu-guo Zheng*[1]; [1]Northeastern University

The effects of various flow control devices on melt flow in a two-strand tundish with gas bubbling were investigated in water modeling experiments. The results showed that the bubbling flowrate had an effect on the melt flow in the tundish. And within a reasonable range of bubbling flowrates, the melt flow was improved. While too large bubbling flowrates not only seemed to be inefficient in the improvement of melt flow, but also lead to reoxidation by exposing the metal to air. For the present research, the optimal bubbling flowrate range is from 1.18 to 2.36 Nl/min. With reasonable arrangements of turbulence inhibitor with gas bubbling curtains, weirs and dams or without dams showed good control on the melt flow. While the arrangement of turbulence inhibitor with gas bubbling curtains was poor in the improvement of melt flow. In present study, an optimal proposal was presented by physical modeling.

WCLES: An Innovative Environmental Friendly Combustionless Engines For Marine Applications Based On Low-Current Electrolysis Technology: *Saad Sharaf*[1]; [1]MOMCO

A new innovative engine design is proposed. The design offers a radical solution for the design of safe, environmental friendly, energy efficient engines. The engine is based on water power. The poster discusses aspects related to energy generation, retrieval and storage. The discussion emerges from a designer point of view, offering design formulas and qualitative comparisons with existing fuel technologies. Case studies are used to demonstrate the advantages and challenges associated with the proposed solution. The concept behind water power generation is based on the following arguments. When water electrolyzed, it converts to hydrogen and oxygen.For the same mass, the volume of generated gases is higher than the original amount of water. This large increase in the pressure can work as a power stroke in internal combustion engine.

Wettability Testing for Ni/Ti(CN) System in High Temperature: *Koji Shimojima*[1]; Hiroyuki Hosokawa[1]; Kiyotaka Kato[1]; Akihiro Matsumoto[1]; [1]AIST

The titanium carbide (TiC) based cermet is one of the candidacies for the alternative material of WC-Co cemented carbide and has been known its higher resistance to wear than that of WC-Co cemented carbide in the use of tools for working steels. Cermet was made from hard particles such as TiC or Ti(CN), metal binders, such as Ni / Co and some additives such as Mo. For improve of strength and toughness of the cermet, it is important to know the wettability of the hard particles with the binder materials, In this paper, we show the wettability testing equipment with HDTV system under high temperature in Ar / N2 / vacuum atmosphere. We also show some experimental results of the wettebility test for various Ti(CxNx-1) with Ni at 1727 K and they showed that substrate materials affects the wet angle.

Work of Adhesion and Thermodynamic Stability of Metal/Oxide Interface: Hongmei Jin[1]; *Ping Wu*[1]; [1]Institute of High Performance Computing

By using density functional theory (DFT) and semi-empirical approach, the thermodynamic stability of metal/oxides interface including Ni/ZrO2, Cu/ZrO2 and Au/TiO2 were evaluated. The work of adhesion and stability of Ni/ZrO2 and Cu/ZrO2 which are the function of the total energy of the interacted system and the oxygen partial pressure were calculated. An empirical model for work of adhesion and interfacial stability was developed by using DFT calculations results as a reference. The developed empirical model was further extended to Au/TiO2 system and the stability of different crystallographic orientations of Au/TiO2 was predicted.

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