Countries Participating at the 12th International Symposium of Croatian Metallurgical Society “Materials and Metalurgy“:

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TOTAL ABSTRACTS: Σ 546

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Organizer

Šibenik, CROATIA, June 19 – 23, 2016
HOTELSKO NASELJE SOLARIS HOLIDAY RESORT
ORGANIZER: CROATIAN METALLURGICAL SOCIETY (CMS)

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The state of art and foresight of world’s casting production. The casting production is considered as one of the main factors influencing the development of World economy. Actual capacity of the world’s casting production, which is about 110 mln metric ton per year (2014), is strongly diversified. The last decade brought significant changes in the World map of the greatest casting producers. Globalization and transformation of economic systems is reflected by variations of foundry production in different countries, moreover the globalization of the economy is regarded not only as a chance but also as a menace for European foundries. The most important research directions leading to further development of the foundry industry: - development of new technologies of molding sands – implementation inorganic binders; - development of new casting alloys and casting composites; - save energy and materials; - reduction of the emission of dangerous gases and dust; - reclamation of the used sands.

Fast numerical simulation of heavy plate hot rolling processes using a multiscale layer model. The simulation tool LaySiMS provides new insight for inhomogeneous material flow and microstructure evolution e.g. for heavy plate rolling or rolling conditions of low roll gap ratios $L/R < 1$. A deepened understanding of the influence of inhomogeneities in initial material state, temperature profile and material flow and their impact on the finished product can be reached e.g. by allowing for variable layer thickness distributions in the roll gap. Coupling temperature, deformation work and work hardening/recrystallization phenomena accounts for covering important effects in the roll gap. The underlying concept of the LaySiMS approach will be outlined with special emphasis on shear stress gradients and their effect on microstructural evolution, stress and strain state. Due to the used computational approach, the origin of local residual stresses can be investigated as well. For selected cases of heavy plate rolling a comparison between computation and experimental data will be given. Special emphasis is put on the derivation of dedicated rolling schedules for thicker gauge pipe grades with special focus on through-thickness homogeneity of the final product.

Advanced forming technology. Forming is usually the final stage of metallurgical production of steel (about 90% of the 1.7 billion tons of total steel production in the world) and traditionally largely in the products of non-ferrous metals. Procedures and methods are many and we will remark only some of them. Hot and cold deformation, flat rolling, plate mill, superplastic deformation, rolling of sheet pile, slitting rolling, cold roll bonding of alloy / steel bimetal strips, drawing process of the inner layers of copper and aluminum, drawing of sheets, seamless tube and tube bending, sheet metal forming, stamping, forging, extrusion, deformation in semi-solid state with rapid solidification, high-rate plastic deformation, equal channel angular pressing (ECAP), the severe plastic deformation (SPD), continuous extrusion of metals using Conform ™, and other. The aim is usually to achieve ultra-fine grained structure, the proper microstructure and (mechanical / electrical) properties on innovative materials. The presented article mentions only examples.

Modern materials used in construction of thermal power plants. Energy production with waste incineration in thermal power plants is also becoming increasingly popular, especially in big cities as it serves as a great solution for garbage accumulation. Efforts to increase the operating parameters of thermal power plant (temperature, pressure) are leading to development of materials appropriate for high temperature service in conditions of different aggressive corrosion media. This paper presents the characteristics of modern low-alloyed and high-alloyed steels and Ni-base alloys that are used in construction of modern thermal power plants for the purpose of increasing their service parameters and their overall efficiency. Welding technology is unavoidable for joining of these materials, and it is also crucial from the viewpoint of thermal power plant reliability. Therefore, this paper presents existing experience related to welding technology of modern materials used in construction of thermal power plants.

Advances in mechanics and its influence on science, technology and society. The development and progress of mechanics strongly influenced many human activities from philosophy and science to technology and engineering. Its progress particularly enhanced technology and engineering such as metallurgy and metalworking. Mechanics is unavoidable and indispensable in analysis of metal forming and metal cutting processes. Generally the development of mechanics can be divided in the three periods. The first one form Aristotle and Archimedes to da Vinci. In this period mechanics is dominated by Aristotelian or peripatetic mechanics which considers the universe as a sphere with its center at the Earth. The second period from Galileo and Newton to Einstein and Planck is the period of classical mechanics which is strongly deterministic. The classical mechanics rests on the three laws of motion, the law of gravity and the parallelogram of forces. All other laws can be deduced from them. At the beginning of the 20th century Einstein pronounced relativistic mechanics. According to Minkowski space by itself and time by itself are doomed to fade away into mere shadows and only a kind of union of the two will preserve an independent reality.
1. A. Milinović, V. Marošić, I. Samardžić

**Research into boride layers growth kinetics on C45 carbon steel.** This study focuses on evaluation of borides formed on C45 steel. Pack boronizing is carried out at a temperature range of 870 – 970 °C in durations of 4 to 8 h. Values of frequency factor (4.51·10^10 m^2·s^{-1}) and activation energy (199.63 kJ·mol^{-1}) are determined by means of Arrhenius equation. Analysis is also performed to assess the change in volume share of boride phase and the surface microhardness in the layer cross section. Results indicated that cross sectional changes of volume share of boride phase depends on boronizing temperature and duration. In addition, empirical expression showing functional relationship between them has been obtained.

2. M. Zuk, J. Gorka, A. Czupyński, M. Adamiak

**Properties and structure of the weld joints of quench and tempered 4330V steel.** This work outlines the research on welding of heat treated 4330V steel using the flux core arc welding process. The research describes the effect of preheat temperature, interpass temperature, heat input, and post weld heat treatment on strength, hardness, toughness, and changes of microstructure in the weld joint. Welding with the lower heat input and without post weld heat treatment results in optimal mechanical properties in the weld metal. Austempering at 400 °C results in optimal mechanical properties in the heat affected zone (HAZ). Increasing preheats and interpass temperature from 340 to 420 °C did not improve Charpy V-notch values or ultimate tensile strength in the weld metal or heat affected zones.

3. V. Pepel, Á. Zerovnik, R. Kunc, I. Prebil

**Crack growth through low-cycle fatigue loading of material Armoxx 500T.** This paper presents microstructure analysis of the creation and growth of cracks in uniaxial load. Analyse were done for steel Armoxx 500T (armour sheet). Results show that cracks are present quit early in steel lifetime. First micro cracks occur before the 200th cycles, whereby crack growth is progressive during further loading. Also it can be seen that after a certain number of cycles there are more longer cracks then shorter ones.

4. I. Matin, M. Hadžištević, D. Vukelić, B. Trifković, M. Potran, T. Brajliš, I. Drstvenišek

**Advanced procedure for fabrication of substructure in dentistry.** The paper presents some aspects of the novel integrated system, procedure for fabrication of metal substructure of metal-ceramic crowns. The results been shown that the CAD/CAM/RP technology integration presented in this paper can be fully applied to metal casting substructures. The substructure fabricated in this way, confirm the reduction of the total manufacturing time, with an increase in the percentage of high quality castings that use integrated system.

5. A. Vaško, J. Belan, L. Kucharíková, E. Tílová

**Low and High Frequency Fatigue Tests of Nodular Cast Irons.** The paper deals with the influence of charge composition on microstructure of nodular cast iron and its fatigues properties at low and high frequency loading. The basic charge of experimental melts was formed by a different ratio of pig iron and steel scrap. Chemical composition of individual melts was regulated alternatively by metallurgical silicon carbide or ferro-silicon and carbonates. Fatigue tests were realised at low and high frequency sinusoidal cyclic push-pull loading (stress ratio R = -1) at ambient temperature (T = 20 ± 5 °C). Low frequency fatigue tests were carried out with frequency f = 100 Hz, high frequency fatigue tests with frequency f = 20 kH.

6. E. Tílová, M. Chalupová, L. Kucharíková, J. Belan, A. Vaško

**Influence of laser surface hardening on corrosion properties in Al-Zn-Si cast alloy.** Advanced automotive applications require materials with special surface properties such as high corrosion and wear resistance. This work is focused on the effect of the laser surface treatment (laser power 50 and 80 W) on microstructure and corrosion properties of self-hardened AlZn10Si8Mg cast alloy used for engine and vehicle constructions. Electrochemical impedance spectroscopy (EIS) technique and Tafel’s plots in a 1M NaCl test solution at 20°C were carried out. A detailed corrosion study showed that corrosion resistance samples with laser layer were marginally less; probably presence of chloride ions significantly damaged the Al2O3 film and caused the formation of NaAlO2.

7. L. Kucharíková, E. Tílová, J. Belan, M. Chalupová, A. Vaško

**Quantitative assessment of structural parameters in aluminium cast alloy with NIS elements software to optimize the properties of aluminium materials.** The present work deals with evaluation of eutectic Si (its shape, size, and distribution), dendrite cell size and dendrite arm spacing in aluminium cast alloys which were casted into different mould. The morphology, size and distributions of eutectic Si and dendrite cell size, dendrite arm spacing effect on all of aluminium cast alloys properties. Structural parameters were evaluated with using NIS-Elements software. This software is imaging analysis software for the evaluation, capture, archiving and automated measurement of structure parameters. The control of structural parameters by NIS Elements shows that optimum mechanical properties of aluminium cast alloys are strongly dependent upon the distribution, morphology, size of eutectic Si and matrix parameters.

8. J. Belan, L. Kucharíková, E. Tílová, A. Vaško

**The Inconel’s alloy 718 is iron-nickel base superalloy with working temperature up to 650°C.** Presented phases such g¢¢ (Ni3Nb), g¢ (Ni3Al), and δ (δ = Ni-δNb) are responsible for alloy’s unique properties. The δ –delta phase is profitable when situated at grain boundaries in small quantities due to increasing fatigue life. However, at temperatures close to 650°C is g¢¢ transforming to δ – delta and causes decreasing of fatigue life. Heat-treatment (800°C for 72 hours) and its influence on fatigue life are discussed in paper. The fatigue tests were provided at room temperature. After the test the S-N curves for both stages were plotted. The SEM fractography was carried out as well.

9. J. Tuček, D. Klokočar

**Tungsten inert gas welding of aluminum alloy 7075-T6.** A study of tungsten inert gas (TIG) welding of aluminum alloy 7075-T6 in the butt joint was done. The welding was done with 2.4 mm diameter filler wire made of AlMg5 at five different preheating temperatures. During the welding a temperature was measured at six locations with thermocouples. The tensile tests were done and microstructure of base metal, heat affected zone (HAZ) and weld were analysed. The welds brake at HAZ between base metal and the weld. The optimal preheating temperature was at 180 °C.

10. M. Mihališkova, A. Lišková

**Dynamic characteristics of automotive steel sheets.** This work deals with the influence of the strain rate on the properties of automotive steel sheets. Two different types of steel: IF steel, and micro – alloyed steel were used. According different measured values as well as according the analysis of literary knowledge it can show the hardness of all tested materials had a higher level in dynamic loading conditions by slow rate of deformation. The higher strain hardening of materials was recorded too that was confirmed by distribution of dislocation.

11. S. Sawicki, H. Maroš, A. Kawalek, M. Knapiński, M. Kwapisz, K. Lober

**High temperature characteristics of 20MnB4 AND 30MnB4 micro-addition cold upsetting steels and C45 and C70 high-carbon steels.** The paper analyzes the high-temperature plasticity characteristics of 20MnB4 and 30MnB4 with micro-additives, intended for cold upsetting and high-carbon steels C45 and C70 in the “solid phase-liquid” during heating and cooling. The investigation was conducted to determine the plastic formability of the examined alloy under hot plastic working conditions. Experiments were carried out on the simulator Gleeble 3800 with the aim of determining the susceptibility of 20MnB4, 30MnB4, C45 and C70 steels to cracking at high temperature. The nil strength (NST), nil ductility (NDT) and ductility recovery temperatures (DRT), and the fracture toughness factor and the BRT (brittleness temperature range) have been determined.

12. T. Dembiczaż, M. Knapiński, B. Garbarz

**Mathematical model of dynamic and metamdynamic recrystallisation in highcarbon bainitic steel during hot plastic deformation.** The article presents the results of physical simulation aimed at determination of the coefficients of constitutive equations for describing the kinetics of dynamic and
metadynamic recrystallization for a new class of steel. Based on the tests results the coefficients were calculated in the constitutive equations describing the kinetics of dynamic and metal of metadynamic recrystallization of high-carbon bainitic steel during hot plastic deformation. The mathematical model shows the relationship between the kinetics of structural changes and the size of initial austenite grains, the plastic strain, the strain rate, temperature and time.

13. J. Kuthánek, P. Tomšík, R. Trojan, M. Juránek, P. Klaus
Experimental Modeling of Weld Thermal Cycle of the Heat Affected Zone. Contribution deals with experimental modeling of quick thermal cycles of metal specimens. In the introduction of contribution will be presented measured graphs of thermal cycle of heat affected zone of weld. Next will be presented experimental simulation of measured thermal cycle on the standard specimens, useable for material testing. This approach makes possible to create material structures of heat affected zone of weld, big enough for standard material testing.

Influence of selected non-ferrous metals on structural characteristics of 42CrMo4 steel. The influence of rare-earth (RE) metals addition on solidification structure of the low-carbon 42CrMo4 steel was investigated. Alloys were prepared by means of a centrifugal casting. The addition of cerium, praseodymium or mischmetal in the steel produced greatly improved solidification structure with a suppressed columnar grain zone, finer grain size in the equiaxed grain zone, and zero area fraction of casting shrinkage cavity. The added RE metals occurred in the steel bath in the form of RE oxide and/ or oxo-sulphide inclusions and as dissolved atomic RE segregated along with other elements at prior grain boundaries and inter-dendritic spaces. Microstructure (light optical microscope, SEM), X-ray EDX chemical microanalysis, and TOF-SIMS analysis – mapping of elements in the structure of alloys were obtained.

15. M. Losertová, M. Štamborská, J. Lapin, V. Mareš
Comparison of deformation behavior of 316L stainless steel and Ti6Al4V alloy applied in traumatology. The comparative analysis of mechanical properties was performed for AISI 316L stainless steel and Ti6Al4V alloy using digital image correlation (DIC) method. Both types of materials are commonly used for implants in traumatology. The room temperature tensile tests of the cylinder tensile specimens were performed at initial strain rate of 2.5 x 10^-3 s^-1. The strain analysis during tensile tests was carried out by means of Vic 2D image correlation software. Ti6Al4V alloy showed higher yield strength and ultimate tensile stress. The differences in the strain localization zones were observed.

Numerical simulation of the heat treatment for steam generator. Heat treatment of the weld of the steam generator is investigated in this paper. Annealing is realized by system of heating elements that are placed on casing of the generator. An experiment using real parameters and a computational fluid dynamics analysis using COMSOL Multiphysics software were performed. Experimental data were compared with results of the analysis. Boundary conditions for numerical prediction had been derived on basis of results obtained from a supplementary calibration experiment. There was good correlation between predicted and measured data. Based on results it can be stated that 67 heating elements with heating output of 66-70 % of maximum range is sufficient number for required heat treatment.

17. S. Rusz, I. Schindler, P. Kawanuki, R. Kawulok, P. Opita, J. Klíber, Z. Šolsovič
Phase transformation and cooling curves of the mild steel influenced by previous hot rolling. Rods from mild steel S235JR were intensively rolled in the laboratory continuous mill. Specifically defined temperature of phase transformation Ar3 was determined from the free cooling curves measured by the temperature scanner. The Ar3 value increased from 763 to 786 °C with rolling temperature descending from 1 200 to 800 °C. Value Ar > 730 °C was obtained at free cooling of the non-deformed rod at the distance from 9.8 mm from heating temperature 1 000 °C. The obtained results were compared with CCT and DCCT diagrams based on the dilatometric tests.

18. L. Ďeváčková, R. Dudek, S. Rosypaliová, D. Matyšek, J. Dobrovský
Comprehensive study of rheological and surface properties of the selected slag system in the context of its internal structure. Rheological (dynamic viscosity, flow curves) and surface properties (tensile property) of real slag system were experimentally investigated. Measurements of dynamic viscosity were performed with use of the high-temperature viscometer Anton Paar FRS 1 600. The method of sessile drop was used for measurement of surface tension. Surface tension and dynamic viscosity were measured in the temperature interval from 1 200 to 1 600 °C. The structural characteristics of the selected samples were determined by X-ray diffraction (XRD). The samples for given analysis were prepared by quenching experiment. Experimentally determined values of dynamic viscosity and surface tension were compared with the results of X-ray diffraction phase analysis.

Influence of heat treatment on the structural and magnetic characteristics of (Nd,Pr)_xFe_12B-based magnetic material for low-temperature application. Sintered PrNdFe-Fe-base permanent magnets with 10 and 13 wt.% Pr were prepared by traditional technology and then subjected to various heat treatments. Their microstructure, phase composition and magnetic properties were studied. The stoichiometric composition of the matrix grains corresponds to (PrNd)xFe12B and (PrNd)xFe12B compound, respectively. According to the literature, these compositions have a spin reorientation temperature in the boiling temperature of liquid nitrogen. This makes these magnets are potentially applicable to low temperatures.

20. L. Ambrüsko, M. Cehlar, D. Marasova
The rate of stable crack growth in automotive steels. The main aim of this paper is determining the stable crack growth (SCG) rate for automotive steel in real sheets. The SCG was monitored by means of the Compact Tension (CT) specimen. The SCG rate in low-carbon microalloyed steels was found to depend on the third power of C. The results were compared to the SCG rate of WC-Co coated cutting tips, and linear regression was fitted to the data. The SCG rate was found to be a function of the C content in the matrix and the applied load.

21. W. Matsiakia, D. Bartkowska, A. Myszkowski
Microstructure and selected properties of sintered tool materials after thermal drilling process. The paper presents the study results on the selected properties of sintered tool materials used for thermal drilling process. The studies were carried out on a series of the commercial tools. Microstructure, chemical composition, microhardness and surface roughness were investigated before and after thermal drilling process. The content and kind of phases and porosity in sintered material were determined on the base of microstructure and the chemical composition study. Additionally, in the case of WC-Co based tools which have been damaged during the process, the type of fracture was determined. On the fracture surfaces the beach marks were observed, thus confirming that it was fatigue crack. The possibility of applying the thermal drilling method were also described in this paper.

22. D. Bartkowiak, W. Matsiakia, A. Bartkowska, J. Koper
Co-based alloy coatings reinforced with tungsten carbide particles produced on low carbon steel using laser cladding. This paper focuses on the selected properties of coatings produced on low carbon steel using laser cladding with powder. The power of laser beam 550 W and feed rate 340 mm/ min were applied. The aim of this study was to obtain the microstructure similar to sintered carbide. Microhardness, microstructure studies using optical microscopy as well as phase analysis and corrosion resistance tests were carried out. It was found that the presence of WC particles in metal matrix had a negative impact on corrosion resistance of coating compared to the unreinforced coating. Phase analysis confirmed the presence of the hard interstitial phases (WC, W2C, M7C3 and M23C6) in the matrix.
of the casting powder by forming a liquid slag lubricating steel strand in its slip in the mold and steady heat transfer, we need to achieve high in

Changes in physical properties of the casting powder during the continuous casting of steel with increased Al content. Therefore the aim of our work was to study the role of size and distribution of carbide particles on creep rate. With different heat treatments distributed in the matrix of the steel. Carbide particles are obstacles to dislocations movement, with the creep rate strongly depending on their size and distribution. At elevated temperatures the creep resistance of the steel is improved, thus changing the creep resistance of the steel. Therefore the aim of our work was to study the role of size and distribution of carbide particles on creep rate. With different heat treatments of the prepared materials were evaluated by means of indentation. Propagation of indentation cracks was analyzed using light microscopy and SEM. The electric conductivity as a function of fraction of additives was determined.

Effect of carbide size and distribution on the creep rate. In creep resistant steels one of the most influencing constituents are the carbide particles distributed in the matrix of the steel. Carbide particles are obstacles to dislocations movement, with the creep rate strongly depending on their size and distribution. At elevated temperatures the creep resistance of the steel is improved, thus changing the creep resistance of the steel. Therefore the aim of our work was to study the role of size and distribution of carbide particles on creep rate. With different heat treatments of the prepared materials were evaluated by means of indentation. Propagation of indentation cracks was analyzed using light microscopy and SEM. The electric conductivity as a function of fraction of additives was determined.

Incorporation of tungsten metal fibers in metal and ceramic matrix. Tungsten fibers have high tensile strength but a poor oxidation resistance at elevated temperatures. Using this first characteristics and prevent oxidation of tungsten armored composite materials in which the primary requirement reinforcement against destruction or deformation was studied on tungsten fibers and tungsten wires which were coated by applying the metal and ceramic powders by plasma spraying device in plasma generator WSP®. Deposition took place in an atmosphere of Ar + 7.5% H2, sufficient to reduce the oxidized trace amounts of tungsten. Short tungsten filaments were consolidated into the same matrix by Spark plasma sintering method at temperatures of 1400 – 1900°C and pressures up to 80 MPa.

Effect of carbide size and distribution on the creep rate. In creep resistant steels one of the most influencing constituents are the carbide particles distributed in the matrix of the steel. Carbide particles are obstacles to dislocations movement, with the creep rate strongly depending on their size and distribution. At elevated temperatures the creep resistance of the steel is improved, thus changing the creep resistance of the steel. Therefore the aim of our work was to study the role of size and distribution of carbide particles on creep rate. With different heat treatments of the prepared materials were evaluated by means of indentation. Propagation of indentation cracks was analyzed using light microscopy and SEM. The electric conductivity as a function of fraction of additives was determined.

Evaluation of Strength Properties of Composite Materials Using Additive Technologies. This paper deals with the strength properties of composite components created by FDM technology. Examined samples were sequentially formed directly from a multicomponent operating medium with an admixture of different additives and composite material created during the 3D printing process. Test samples will be printed according to the relevant technical standards. The samples will be then determined to mechanical, static, strength properties, and Brinell hardness tests. The impact of various additives on the strength properties of printed composite materials will be assessed. Based on the results can be prepared conclusions and recommendations for future reference additions. Reciprocal Linking of various materials enables to extend the range of applications of 3D printing and helps to the development in given field.

Precipitation of sigma phase in superaustenitic stainless steel UHB 904L. Superaustenitic stainless steel UHB 904L with high Mo concentration widely used in applications that require good toughness and corrosion resistance. Given certain thermal histories, UHB 904L may be susceptible to the formation of potentially detrimental intermetallic phases, such as the sigma phase. The formation of sigma phase is promoted by high concentrations of Cr and Mo, while elements such as carbon and nickel retard its formation. Samples of UHB 904L were exposed to isothermal annealing within the temperature range between 800–1050 °C, with ageing times varied between 0.5 h and 8 h, followed by water quenching. Microstructural analysis showed that sigma phase forms up to 1000 °C. Optical and electron microscopy and Auger electron spectroscopy were used.

Verification of Mechanical Properties of Carbon Base Composite Materials. There is wide variety of composite structures achieved by hand-layup technology. These materials are diverse in their attributes. The paper will verify the influence of chemical constitution, physical construction and also of specific technological procedures realized in production process of composite materials. Present experimental testing focuses to the properties of diffusion...
different composite materials made of carbon based structures. The samples from different composite materials will be created using the milling technology according to the dimensions determined in international standard. Samples will then be tested accordingly to verify their mechanical properties, such as tensile testing, toughness, hardness etc. In the end, the results and relevant reasons will be published while describing the mechanical properties of selected composites.

36. Y. Bozkurt

Dissimilar friction stir welding between Al based SiC particle reinforced metal matrix composite and AlMn1Cu alloy. In the present study, aluminum based SiC particulate reinforced MMC and AlMn1Cu aluminum alloy sheets were successfully friction stir welded by offsetting the high tensile strength sheet to retreating side of the tool. Scanning electron microscopy with energy dispersive spectroscopy were used to characterize the effects of the welding parameters on the microstructural properties. The joint exhibited a typical ductile mode of failure characterized by the presence of dimples known as microvoid coalescence. The highest tensile strength value was obtained to be approximately the same that of the aluminum alloy base metal. This study represents that FSW is a good candidate for joining of dissimilar alloys.

37. I. Stojanović, A. Alar, V. Šimunović

Study of corrosion performance of polymer and epoxy-polyester powder coatings. If the construction material isn’t corrosion resistant enough in the foreseen conditions, either the conditions should be changed, or a protective coating should be applied. Many currently used anticorrosive coatings are not environmentally acceptable because of their high solvent emissions in the air. One of the environmentally friendly anticorrosion solutions are powder coatings. In this study, the corrosion performance of polyester and epoxy-polyester powder coatings was evaluated using electrochemical impedance spectroscopy (EIS), salt spray and humidity chamber, and Scanning electron microscope (SEM) with Energy-dispersive X-ray spectroscopy (EDX) analysis. Study revealed that the epoxy-polyester powder coating demonstrated a better performance than polyester powder coating. The influence of surface texture on thickness and barrier properties of the coating was also determined.

38. I. Juraga, V. Šimunović, I. Stojanović

Influence of surface and structural changes in stainless steels weld joints area on their properties. High alloyed Cr-Ni steels are important group of structural materials and their use in various industrial fields are almost irreplaceable for example in food industry, pharmaceutical and petrochemical industry. Structures made of these steels are almost always made as welded, and because of heat input during welding processes surface and structural changes occurs which may have negative influence on weld joint properties particularly corrosion resistance and mechanical properties. In this paper real cases of damages, which were caused by surface and structural changes in weld joint areas, on various welded structures made of stainless steel are analyzed and recommendations for their avoiding are presented.


Influence of different treatments on corrosion behavior of Fe-based biodegradable alloy. Traditionally, the most commonly used biodegradable materials for biomedical applications are Mg and Zn-based alloys. The limitations of those alloys are too fast degradation of metal parts and too high amount in relatively short time of the elements and compounds released during the degradation in the body. Nowadays, the research is extended also on Fe-based alloys. The benefits of these alloys are longer lifetime in the body, when this is urgent for some treatments and healing. When served the material also decompose in the body and no additional operation is needed to remove the implants. The limitation of such a material is the time could be too long. In the present study we focused on synthesis of Al-Mn alloys by commonly used producing steps. The aim was to produce the material with faster degradation. The study was focused on corrosion testing. Characterization of the material was performed by SEM/EDS, LM and mechanical testing.

40. P. Mikolajczak, L. Ratke

ThermoCalc prediction of solidification front in aluminum alloys with Mn-rich intermetallics. Solidification of AlSiMn alloys was studied using directionally solidified facility and the ThermoCalc software was applied to calculate phase diagrams and to predict occurring phases. The ternary phase diagrams presented different solidification paths caused by segregation in each selected specimen. The property diagrams showed modification in the segregation and properties of the phases. In this study application of thermocapable pixels in the study on microstructure of the phases. It is proposed that the manganese zone in directional solidification. 2D maps based on property diagrams show a mushy zone with a channel in the AlSi7Mn1.0 specimen center, where Mn-rich phases may precipitate separately to α-Al dendrites.

41. P. Mikolajczak, J. Janiszewski

Morphology in slowly solidified AlSi9Fe0.3Mn0.3Mg0.3 alloy by various stirring speeds. The paper present the effect of the intensive stirring on the microstructure of aluminum alloys AlSi9Fe0.3Mn0.3Mg0.3 slowly cooled in uniform volume solidification. The stirring generated by rotating magnetic field caused changes in precipitation of α-Al dendrites and occurring phases. The measured chemical composition measured across specimens showed good mixing of the components. The modification of the microstructure was studied as effects of the different rotation speeds and strength of the electromagnetic field.

42. P. Mikolajczak, L. Ratke

Effect of solidification velocity by forced convection on microstructure and Fe-rich intermetallics in AlSi alloys. The current study aims to identify the role of forced convection on the alloy microstructure and formed intermetallics in Al-5 wt.% Si-2.0/3.0/4.0/5.1% Fe alloys directionally solidified under definier thermal and flow conditions in Artemis-3 facility. The experiments were carried out by various solidification velocities from 0.02 to 0.12 mm/s. The results showed the effect of solidification velocity by forced flow different on the length and number density of Fe-rich needles to gather with modification in microstructure characterised by changes in primary and secondary dendrite arm spacing and specific surface of the dendrites.

43. P. Schlaffke, A. W. Bydalek, M. Holtzer, W. Woćzyński

The influence of the ion reactions on the refining secondary raw materials. The article presents the concept of refining with the use of slag activated with carbide coating. It pointed out the important role of stimulators of ionic reactions. The results of research from the meltings of the CuAl10Fe4Sn alloy obtained from recycled materials in metallurgical conditions were shown. The changes in the structure of the alloy depending on the nature of the used stimulators were indicated. Chemical reagents used and the stimulants in the form of carbides helped to improve the melting sand exchange process. The use of chemical reagent in the form of calcium carbide and stimulants has also contributed to the formation of a protective atmosphere in the furnace bottom.

44. A. Z. Issagulov, A. B. Akhmetov, Ye. P. Naboko, G. D. Kusainova, A. A. Kuszhanova

The research of modification process of steel hadfield integrated alloy ferroaluminicoaluminate (Fe-Al-Si-Ca/FASC). There is article discusses the process of modification of high-manganese steel, Hadfield, which will significantly increase the yield of the casting at the stage of melting and casting the steel. The steel modification performed integrated alloy FASC (ferroaluminicoaluminate) in an amount of 0.3 - 0.5% by weight of the metal. The integrated alloy unlike traditional methods of modification leads to globalisation and purification of steel from nonmetallic inclusions and for grinding grains of austenite, thereby greatly increases its mechanical properties.

45. J. Barglik, K. Ducki A. Smalerz, D. Kuc

The analysis of the influence of continuous induction hardening on the structure and properties of steel 38MN6 grade. The paper presents tests which were aimed at the assessment of the influence of surface heat treatment on the mechanical properties and microstructure of the chosen element of the steering gear which was the toothed bar. The material for tests was special unalloyed steel type 38Mn6 for toughening and surface hardening. This steel type is used to produce steering gears and other components of wheels and suspension system. The influence of induction hardening on the thickness of hardened layer with the use of various parameters of the process was analysed. Tests were conducted on the multi-functional station for induction hardening on the Faculty of Materials Engineering and Metallurgy at Silesian University of Technology.
The effect of Ca in biodegradable Mg-Zn-Ca magnesium alloys on grain refinement by HPT. The paper presents a brief study of selected properties of nanocrystalline WC-Co Infralloy S7412 coating HVOLF sprayed. The paper shows the results of successful studies on the creation of miniature dental implants and implants for osteosynthesis in the cranio-facial areas from Ti Grade 4 rods nanostructured by ECAP via the Conform treatment method dedicated to blood-contacting stainless steel implants.

Cellular automaton method applied for microstructure prediction of Al-Si casting treated by laser beam. The paper presents the results of tests related to modification of the surface structure of aluminium alloy casting treated by laser beam and the rapid remelting and solidification of the super-ficial remelting zone. The microstructure of the casting (remelting zone) was characterized by decrease of the DAS (Dendritic Arm Spacing) value to a few microns (one order of magnitude lower with respect to the origin casting structure). The simulation tests of this laser process allowed to predicting the modified microstructure formation in the remelted zone. The Calcosoft CAFE (Cellular Automaton Finite Element) simulation code was applied. The CAFE database and predicted microstructure were validated experimentally.

The interaction between diamond like carbon coatings and ionic liquids under boundary lubrication conditions. The aim of the study was to analyze the anti-wear-like diamond-like carbon coatings produced by Physical Vapor Deposition. The anti-wear-like diamond-like carbon coatings were deposited on steel elements operating under friction conditions. The coating structure was studied by observing the surface topography using a scanning electron microscope and a profilometer. The coatings were examined and wear properties of DLC-coatings were studied by ball-on-disc tribotester. The lubricants tested were two types of ionic liquids (1-butyl-3-methylimidazolium tetrafluoroborate and trihexyltetradecylphosphonium bis(trifluoromethylsulfonyl)imide). The experimental data was used to select the ionic liquids with the best tribological properties to operate under lubricated friction conditions with a DLC coatings.

The structure and mechanical properties of oxide films of zirconium alloys. The structure and mechanical properties of oxide films (thickness 7-10 μm) of Zr-1Nb and Zr-1Nb-0.8Sn-0.3Fe zirconium alloys formed in autoclave corrosion tests in water under conditions of T=360 ºC, P=18,6 MPa were investigated. The macrostructure of the oxide films in Zr-1Nb samples consists of layers of elongated and equiaxed grains. Structure of the film in Zr-1Nb-0.8Sn-0.3Fe samples mainly consists of elongated grains. The film structure defines the resistance and mechanism of fracture of films during mechanical loading. Fracture of the oxide films in Zr-1Nb samples occurred through the formation of longitudinal cracks and delamination. In the films of Zr-1Nb-0.8Sn-0.3Fe sample transverse cracks were formed perpendicular to the film surface.

Effect of chemical composition on the hot hardening of die steel with regulated austenitic transformation. A new class of die steels for hot deformation, namely, steels with regulated austenitic transformation realized during exploitation (RATE) have been developed in Russia. These steels are characterized by the technological advantages of traditional n-solid solution-based steels and, when working in the austenite state, assure the enhanced tool life. RATE steels have a tendency to hot hardening during operation. The nanophase hardening occurs in RATE steel s being in the austenitic state, during multiple plastic deformation at temperatures of 450–750 ºC. Effect of chemical composition (replacement of nickel by manganese) on the microstructure, phase composition and hardening of RATE steel is analyzed.
a range of sectors including the tool manufacturing, automobile, food, and medical industries. Remarkable mechanical properties, high surface smoothness, corrosion, friction and wear performance of diamond like carbon coatings.

Structure and mechanical properties of high-temperature three-layer material “stainless steel/vanadium alloy/stainless steel”. Vanadium alloys are promising materials for the fuel cladding of fast nuclear reactors due to their high thermal conductivity, high-temperature tensile strength, high temperatures creep resistance (at temperatures up to 800°C) and radiation stability. However, oxygen and nitrogen are highly soluble in vanadium at temperatures up to 400°C. We propose a three-layer material based on high-temperature V-4Ti-4Cr alloy that is protected by corrosion-resistant ferritic stainless steel from the surface. It is shown that “transition” layer with monotonically changing chemical composition is formed in the three-layer material due to the joint hot deformation and annealing. Tensile tests demonstrate that three-layer sample behaves as a monolithic material.

Structure and mechanical properties of vital parts of railway transport after the volume-surface hardening. Using the volume-surface hardening for hardening of vital parts of rail transport from low-carbon cast steel improves the mechanical properties: tensile strength at 1.6-2.0 times; the yield strength at 1.3-1.6 times; the bearing capacity at 1.4-2.6 times; the fatigue strength to 10%. The volume-surface hardening by fast-moving flowing water provides the surface hardened layer (with thickness of 5-8 mm) in the wall of the fragment with the tempered troostite structure. In this case the gradient of strength and hardness over the cross section of the wall of the solfer steel (from 21 HRC in the core to 36 HRC on the surface) is achieved.

Composite coatings based on electroerosion resistant and wear resistant systems. Composite coatings based on electroerosion resistant (W-Ni-Cu, Mo-Ni-Cu, Cr-Cu) and wear resistant (TiC-Ni, TiC-Ni-Mo) systems and their modification was implemented in two stages. At the first stage the electroerosion coating deposition with a layered filled structure was conducted. At the second stage irradiation of the coatings formed by high-intensity pulse electron beams was performed in order to reduce the degree of surface roughness, homogenization and nanostructuring, improve electroerosion resistance, hardness and wear resistance.

Experimental Investigation of 30HGS A Steel Acoustic Properties. The results of experimental studies of speed and ultrasonic attenuation, as well as the relative thermal expansion of 30HGS A steel relating to the class of structural alloyed steels in the temperature range 20–1100 °C are lead. It is noted the peculiarities in the behavior of the investigated properties when heated in the temperature range 735–850°C and cooled 1020–990 °C. Approximating equations for the temperature dependence of the investigated (speed, ultrasonic attenuation and relative thermal expansion) and calculated on their basis (density and Young’s modulus) properties are given. Constructed a table of values of these properties in the entire temperature range of study.

Microstructures, texture and mechanical properties of Mg-Al-Zn-Mn alloy processed by rotary swaging. The Mg-4.4%Al-0.9%Zn-0.4%Mn(wt.%) alloy was processed by rotary swaging with decreasing deformation temperature from 400°C to 200°C up to a logarithmic deformation strain of ε=2.77. Microstructures, texture and tensile properties of the alloy was investigated using optical microscopy, TEM, EBSD, X-ray analyzes and tensile tests. It is shown, that the microstructure evolution in the alloy is strongly influenced by twinning. Twinning leads to fragmentation of the initial grains from 16.8 μm to 2-6 μm. Inside the primary twins grain refinement takes place by dynamic recrystallization and twinning. The alloy swaged at 200°C (ε=2.77) is characterized by UTS=360 MPa and YS–320 MPa at elongation of 7.5%.

Composite coatings based on electroerosion resistant and wear resistant systems. Composite coatings based on electroerosion resistant (W-Ni-Cu, Mo-Ni-Cu, Cr-Cu) and wear resistant (TiC-Ni, TiC-Ni-Mo) systems and their modification was implemented in two stages. At the first stage the electroerosion coating deposition with a layered filled structure was conducted. At the second stage irradiation of the coatings formed by high-intensity pulse electron beams was performed in order to reduce the degree of surface roughness, homogenization and nanostructuring, improve electroerosion resistance, hardness and wear resistance.

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Acoustic emission analysis of diamond like carbon coatings by bending. The delayed fracture resistance to hydrogen embrittlement in 35KGM (Russian standard - 35XTM) and 33 KhMIF (Russian standard - 33XM10) steels was investigated. Based on the results of a comparative analysis of the mechanical behavior of materials with four-point bending and uniaxial tension by measuring the acoustic emission and fractography, the differences in the mechanism and kinetics of fracture of steels were shown.
68. J. Kasinska
Modification influence of mischmetal on fractography fracture of G17CrMo5-5 cast steel samples after the three-point bending test. The article presents an analysis of fracture of the samples after the three-point bending test at temperature range from +20 °C to -80 °C. The author shows a beneficial effect of mischmetal on the cracking mechanism and on the character of samples fracture. It has been shown that the width of the ductile fracture zone under the bottom of the notch and the nature of the cracking mechanism changes with decreasing test temperature.

69. K. Semrád, K. Dragovanov
Methodology for repeated load analysis of composite structures with embedded magnetic microwires. The article processes issue of strength of cyclically loaded composite structures with the possibility of contactless stress measuring inside a material. Implementation of the magnetic microwires into the composite structure gives the possibility to create a build-in sensor inside the material without its structure violation and to measure induced stresses. The practical application of the solution is designed for the repeated load of the wing hinge connection, including FEM fatigue strength analysis. It covers history and physics of fatigue, the E-N approach - strain cycles, which involves effect of mean residual stresses, hysteresis loop capture and rainflow cycle counting. Factors affecting fatigue life include component size, loading type, surface finish, surface treatment and effect of surface treatments on the endurance limit.

70. L. B. Zuev, S. A. Barannikova, Yu. V. Li
Research of the plastic deformation localization of electrolytically saturated with hydrogen aluminum alloy by the digital image correlation method. The paper presents investigations of the effect of hydrogen embrittlement on the plastic flow. It is found that the mechanical properties and plastic flow curves of aluminum alloy are affected adversely by hydrogen embrittlement. These are found to show all the plastic flow stages: the linear, parabolic and pre-failure stages would occur for the respective values of the exponent n from the Ludwik-Holomon equation. Microhardness tests were performed for as-treated aluminum alloy. Using scanning electron microscopy method, the changes in the fracture surface were investigated.

Improving sliding wear resistance of Mg parts by plasma spraying. Durable coatings, which would combine good technological properties, high hardness with excellent tribological characteristics, are of great interest for engineering fields where working parts are produced from aluminum and its alloys. In present work, plasma spray technology was used as a means to increase durability of Al-Mg alloy parts. NiCrSiBFe coatings deposited on aluminum alloy substrate at different thickness were studied. Before spraying, the surfaces of aluminum alloy were modified using different surface pretreatment methods. The phase composition, microstructure, microhardness, porosity and adhesion of deposited coatings were characterized. Ball-on-plate wear tests with NiCrSiBFe coatings were carried out in dry and lubricated conditions, using SEM to characterise the worn track and the wear mechanism.

72. J. Čerkč, M. Ćutová, K. Ratkovská, F. Adamčík
Effect of the thermal barrier coating on heat transfer into nickel based refractory alloy. The aim of experiment is evaluate an effect of industrially used plasma sprayed coatings of TBC on transfer of heat into refractory material designed for aeronautical applications. This study uses basic structural material of combustion chambers - components of turbine engines during operation highly termally stressed by flow of hot gasses. Using the hot gasses from gas burner, the operational conditions inside the combustion chambers are simulated. The use of TBC coating shows positive effect on alloy overheating reduction. The results demonstrated decrease of temperature with values in extent of hundreds of °C for materials covered with TBC. This phenomenon can contribute to development of a new types of aircraft engines with higher operational temperature and better fuel economics.

73. M. Grygorowicz, P. Wasilewicz, W. Matysiak
Microstructure and mechanical properties of commercially pure titanium foam with varied cell size fabricated by replica impregnation method. The paper deals to structural and mechanical properties of aluminum alloy foams. That kind of structures are commonly used in civil and mechanical engineering i.e. as medical implants or parts of the vehicle frames. The aim of presented investigations was to compare mechanical properties of three-layer sandwich structures with the aluminum foam core. The structures were treated forging. After forging the microstructure, microhardness and surface roughness were observed. The structures were also cut into the pieces using laser and the heat affected zone was investigated. Decrease of the microhardness values was observed in locations set further from the rim edge – inside the material, which may additionally improve the thread properties – it will keep a durable surface and a malleable core.

74. K. Gawdzinska, L. Chybowski, J. Grabian, A. Beiger, S. Krile
Determination of technological parameters of saturated composites based on SiC by means of a model liquid. The paper describes a method for determination technological parameters of the formation process of saturated composites based on SiC by applying the theory of dynamic similarity. The Rayleigh number is used as a similarity index in the proposed method. Basic mathematical relations have been presented in terms of hydraulic analysis of the saturated liquid flow (liquid metal) and determination of the saturated composite density depending on the technological parameters of its formation process: saturation time and pressure. Adopting the method for determining the density of silicon composites reinforced with silicon carbide by means of Wood’s metal as a model liquid has been described. Microscope images of the composite structure have been shown after filling it with the model liquid. The results have been used on the application of the method.

75. N. Radek, J. Pietraszek
The bootstrap-based analysis of uncertainty for the RSM model of the friction properties after laser texturizing of the silicon carbide surface layer. The surface coated by SiC through the electrospray deposition (ESD) has been treated by the laser beam machining (LBM) to lower roughness. The elements coated by ESD have been tested to determine tribological properties and they were compared before and after LBM. The relation between two controlled quantitative factors – a blackening and a diameter of a cavity – and a coefficient of friction was identified. The obtained data violated normality test and it was a reason that a classic methods of uncertainty estimation were not appropriate. This paper presents a specific estimation of uncertainty based on a bootstrap approach. Details of the solution and the discussion of results are presented also.

76. G. Galuszka, M. Madej, D. Ozimina, J. Kasinska, R. Galuszka
The characterisation of titanium alloys for biomedical applications. The paper presents results of research on the use of pure titanium medical implants, dental and orthopedics - as pins hip replacements. The properties of metal biomaterials, including their hardness, determine the usefulness of the material in the region of wear and the deformation of the microstructure and mechanical properties of pure titanium. The observations surface were carried out using a scanning electron microscope SEM. The optical profiler was used to depict the geometric structure of the surface, and to carry out the nanindentation tests a nano hardness tester was used.

77. F. Tehovnik, J. Burja, F. Vode
The recrystallization of austenitic stainless steels alloyed with molybdenum. The poor hot workability of austenitic stainless steels alloyed with molybdenum depends on the numbers of factors. The most probable explanation is connected with a retardation of the softening processes. The relationship between the softening and the hot-ductility phenomena was investigated using hot rolling experiments with wedge specimens. The fraction of the recrystallization was determined by metallographic investigation and the degree of mechanical softening.

78. J. Burja, F. Tehovnik, M. Godec, J. Medved
The recrystallization of austenitic stainless steels alloyed with molybdenum. The poor hot workability of austenitic stainless steels alloyed with molybdenum depends on the numbers of factors. The most probable explanation is connected with a retardation of the softening processes. The relationship between the softening and the hot-ductility phenomena was investigated using hot rolling experiments with wedge specimens. The fraction of the recrystallization was determined by metallographic investigation and the degree of mechanical softening.

79. J. Burja, F. Tehovnik, M. Godec, J. Medved
Formation of chrome spinel inclusions in stainless steel melt during decarburization in the cafl. Decarburization in the cafl is one of the most important phases in stainless steelmaking. During this phase oxygen is blown into the steel melt to reduce the carbon content, but unfortunately chromium is also oxidized in the process. The two competitive reactions of carbon and chromium oxidation are crucial for control of the decarburization process. Laboratory experiments of oxygen blowing into Fe-Cr-C were carried out and the results were thermodynamically analyzed, with supporting microscopic analysis. The mechanism of stainless steel melt oxidation trough chrome spinel inclusions was proposed, explaining the thermodynamic calculation results.

MATERIALS – SECTION “A”
M. Važko, M. Blatnický, P. Kopas, M. Sága
Research of weld joint fatigue life of aluminium alloy AlMgSi07.F25 under bending-torsion cyclic loading. The contribution deals with a research of fatigue lifetime of weld joint of aluminium alloy AlMgSi07.F25. The paper will present unique biasial testing equipment, process of preparation of specimen rods for fatigue test and results of fatigue life for aluminium alloy during cyclic bending-torsion loading. Fatigue tests under constant amplitude loading were performed in a special electromechanical machine with a suitable gripping system. Obtained fatigue curves were compared to most widely known fatigue criteria as LIU, F-S and B-M.

P. Kopas, M. Blatnický, M. Sága, M. Važko
Identification of mechanical properties of weld joint of aluminium alloy AlMgSi07.F25. The aim of the contribution will be a presentation of an analysis of chosen mechanical properties of weld joint of aluminium alloy AlMgSi07.F25. The focus of attention will be on an influence of a shape of the weld surface of specimen rod neck over a tensile strength characteristic and over a distribution of hardness in a weld joint cross-section. An additional material in a TIG technology welding process was AISi5 under the consideration. A part of the contribution will be a brief study of a numerical modelling of specimen rod welding.

P. Pastorek, P. Novák, P. Kopas, M. Močišan
Finite element analysis of bond behavior at steel-reinforced concrete structure strengthened by CFRP strips. The article deals with analysis of influence of carbon-fiber reinforced polymer (CFRP) on stress distribution in steel reinforced concrete beam loaded by the four point bending flexural test. Simulation of the delamination is modeled by cohesion zone material model. Distribution of cracks on models with and without CFRP strengthening is compared. Along the analysis was executed fatigue test of steel sample (W-Nr. 1.0429 - concrete steel), which was used in the concrete beam. From the fatigue test results was constructed the fatigue life curve.

M. Sapjeta, V. Děkýš, A. Sapietová
Comparison of expression thermoelastic phenomenon of stainless steels during cyclic loading. The main aim of this paper is to compare the thermelastic stress on the specimens of stainless steel. Materials specimens were chosen stainless steel of type AISI 304, AISI 316Ti and AISI 316L. The specimens were cyclically loaded with three-point bending. The whole process was recorded using an infrared camera. Thermal difference that occurred during the test was evaluated based on the relationship of thermo-elastic stress. Subsequently stress distribution on specimens was compared for different types of stainless steel.

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Studying laser radiation effect on steel structure and properties, Metalurgija, 55 (2016) 3, 411

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1. A. Kojawinska, M. Rogalewicz, M. Pilacinska, A. Koszalinski, A. Hanerud, M. Diering
Application of dominance-based rough set approach (DRSAs) for quality prediction in a casting process. The main subject of the paper is a problem of capability assessment of a production process for manufacturing products fulfilling certain requirements. The paper presents theoretical assumptions of the DRSAs method for classification of a process state based on so-called process state measures (e.g. process parameters, diagnostic signals, events). In the paper, results of application of the proposed methodology for assessment of capability of the nodular cast iron casting process are presented.

2. V. Marsuic, I. Samardzic, I. Opacic, L. Marsuic
Influence of induction hardening parameters on the GS30Mn5 weld properties. This study examines parameters of post-weld heat treatment on the test specimens made of cast steel GS30Mn5. The welding is performed with shielded metal arc welding (SMAW) process. The aim is to obtain the surface without illicit cracks, with hardness ranging from 320 up to 400 HB. After induction heating, the specimens are cooled alternately with air and water. Decreased speed of quenching results in avoiding the occurrence of illicit splashes, while the hardness is maintained within the prescribed limits.

3. M. Jodkowski, J. Labaj, J. Brzoska, D. Jama
Binder fraction reduction in non-ferrous metals concentrates briquetting process. The research results on a method of reducing the amount of binder applied during formation of metal concentrates are presented. Research was done on a model copper concentrate, which was mixed in assumed mass fraction with binder, as well as binder with addition of waste polyls. Such mixtures were formed and tested using static compressive strength, both immediately after forming and after the assumed seasoning times: 24, 96, 192 and 336 hours. The results confirm the possibility of binder dose lowering using high-efficiency system of binder dispersing with small addition of waste polyls and by homogeneous mixing of the binder with the material. In all examined cases increase in seasoning time influenced mechanical strength of the formed shapes advantageously.

4. J. Korol, M. Kruczek, M. Pichlak
Material and energy flow analysis (MEFA) – first step in eco-innovation approach to assessment of steel production. The main goal of the study was to evaluate material and energy flow analysis (MEFA) of steel production. The application of umberto universal software to devise MEFA for the steel production was presented. The material and energy flow analysis of steel production includes a range of technologies through each unit process in integrated steelmaking route in Poland. Modelling MEFA helps a high level of technology to be reached through the effective use of resources and energy.

5. J. Luczak, R. Wolniak
Integration of quality, environment and safety management systems in a foundry. The management systems in the Foundry in question were integrated by means of a quality management system according to ISO 9001 standard. This means that the quality management system is a basic management structure in the enterprise, into which elements of environment management and work safety management have been incorporated. In presented paper we describe some problems of management system integration in metallurgical industry.

6. S. Gil, W. Bialik, J. Ochman
Analysis of fuel savings in metallurgical furnaces with protective atmosphere. In the paper, a case of improvement in energy efficiency of a rollway-continuous furnace used for heat treatment in production of cold-drawn tubes as well as gas savings resulting from application of modern burners for radiant tubes was considered. For the investigated furnace, energy balance calculations were performed for the currently operating status as well as following replacement of burners for modern devices with better parameters of combustion and recuperation, which showed a significant reduction in fuel consumption. The burners ensure uniform temperature distribution along the radiant tube, stable operation, high energy efficiency (also in high temperature furnaces) and low emissions.

7. D. Klobar, J. Tulek, M. Bizjak, S. Simoncic, V. Leiser
Active flux tungsten inert gas welding of austenitic stainless steel AISI 304. The flux assisted tungsten inert gas (A-TIG) welding of 4 (10) mm thick austenitic stainless steel AISI 304 in the butt joint was done using commercially available active flux QuickTIG. The influence of welding position and weld groove shape was analysed regarding penetration depth. A comparison of microstructure formation, grain size and ferritic number between TIG welding and A-TIG welding was done. The A-TIG welds were subjected to bending test. A study shows that A-TIG welding increases the weld penetration depth.

8. E. Kardasz, Z. Skuza
The assessment of the efficiency of the use of raw materials in the blast furnace department of steel mill. The quality analysis of raw materials used in pig iron production is presented in this paper. Two kind of raw materials containing Fe are used in this process: sinter and pellets. Then, the influence of the quality of these materials on the efficiency of blast furnace process is presented. The efficiency of the process is determined by selected parameters of the process.

9. C. Kolmasiak, E. Staniewska, A. Kisielek
The concept of using selected output elements of the metallurgical process. Modern metallurgical plants work in the environment conditioned by a number of factors. First, the economic effect, that leads to the use of optimal technological solutions and process to achieve the maximum productivity at the lowest cost is important. On the other hand, obtaining of appropriate quality of products with optimum profitability should be taken into account. In addition, metallurgical company should take into consideration the impact of factors on the work environment and natural environment at each stage of production. In the paper the classification of the waste stream in selected metallurgical process is presented. In addition, an attempt to determine how to use the selected items was made.

Research methodology of inclusions removing from steel flowing through the tundish. Obtaining high quality steels mainly depends on the quantity of non-metallic inclusions contained in it and this, in turn, to a large extent on the structure of the flow in the tundish. Optimisation of the flow of liquid steel through the tundish makes it possible to control the trajectory of inclusions and thereby to improve the conditions of their outflow into the slag layer. The following article presents an analysis of research opportunities of the inclusions removing process in the tundish resulting in reconstruction of the own research facility.

11. L. Čamek, P. Lichý, I. Kroupová, J. Duda, M. Korbáš, J. Beňo, F. Radkovský, S. Bíliznyukov
Effect of cast steel production metallurgy on the emergence of casting defects. The paper documents metallurgical possibilities of high alloy cast steel production in open induction medium frequency furnaces and an electric arc furnace in a gravity die casting foundry. The observation was focused on the emergence of gas defects in steel castings. The content of gases achieved during the metallurgical processes was evaluated for every unit of the production equipment and the casting ladle before casting into disposable sand molds. The sand mold area was considered to be constant. The aim was to evaluate the current metallurgical possibilities of affecting the content of gases in high alloy cast steel in the current technical conditions of the foundry.
12. V. Pečinková, Z. Lenček, Z. Joníta
Gas pressure sintered Si₃N₄ – MgSiN₂ composites. Si₃N₄ and MgSiN₂-based ceramic composites have excellent thermo-physical and mechanical properties, however with limited industrial applications. In this paper the preparation of Si₃N₄/MgSiN₂ composite by gas pressure sintering (GPS) is described and some of the mechanical properties like Vickers hardness and indentation fracture are characterised and compared with hot pressed (HP) samples. The 15.3 GPa hardness and 7.6 MPa m¹⁄₂ fracture toughness of GPS composites was slightly lower compared to HP samples (16.5 GPa, 8 MPa m¹⁄₂).

13. K. Kaczmarska, B. Grabowska, D. Drużyński, A. Bohrowski, Ż. Kurelo, L. Szymański
Modified polysaccharides as an alternative binders for foundry industry. Polysaccharides constitute a wide group of important polymers with many commercial applications, for example food packaging, fibres, coatings, adhesives etc. This review is devoted to the presentation of polysaccharide application in foundry industry. In this paper the selected properties of foundry moulding sand and core sand containing different polysaccharides as binders are presented according to foreign literature data. Also, author’s own research about effect of using moulding binder consisting of modified polysaccharide (modified starch) or its mix with non-toxic synthetic polymers are discussed. Based on technologies taken under consideration in this paper, it could be concluded that polysaccharides are suitable as an alternative for use as binder in foundry moulding applications.

14. A. Issagulov, N. Ospanov, A. Bayysanov, Ye. Makhambetov, D. Issagulova
Studying possibility of smelting refined ferromanganese grades using silicon aluminium reducer. In the given article there are presented the results of smelting refined grades of ferromanganese using silicon aluminum reducer. There is established the possibility of smelting medium – carbon ferromanganese of the FeMn80C20LP grade ( ISO 5446-80 ). The extent of extraction and effective use of basic elements reaches 51,1 – 51,2 % of manganese, 54,5 - 59,8 % of silicon and 82,5 - 89,5 % of aluminum.

15. A. V Todurut, L. Palis-Popa, D. Cirnu, V. S. Telenits
Interdependence between iron ore production and the maritime transport. The maritime industry plays an important role in international trade, transporting a total of 9,84 billion tons of merchandise in 2014, representing over 80 % of all global trade, with dry cargo estimated to account for over two thirds of the total seaborne trade. Bulk carriers supply the raw materials needed by the steel industry and container ships transport the steel products. Demand and supply for seaborne transport is influenced by trends in global economy and worldwide demand for commodities. The paper analyzes the most important economic determinants in the supply of metallurgical raw materials, highlighting the importance of the shipping sector.

Improving production technology of tube steel grades in converter process. There is studied the nature of formation and features of evolution of nonmetallic inclusions in the course of steel-smelting processing of converter steel of the tube grades (22G15, 10G2F, 09G2F). There are defined the critical parameters and developed technological recommendations on decreasing impurity of metal by nonmetallic inclusions: there is increased the calcium to aluminum ratio that are introduced for deoxidation and modification, there is recuced the time interval between addition of aluminium and calcium in the melt, there is corrected the total time of secondary refining and taken the measures for decreasing the secondary oxidation of the melt in pouring.

17. S. Medi, J. Gröf, A. Horvatči, Ž. Kondić, L. Maglić
Measurement of casting parameters in ZnAlCu₃, molds created by additive technology. This paper examines the parameters of casting ZnAlCu₃ alloy (volume, castability, density and occupancy of the mold) in mold made additive technology. Molds made by additive technology are: cheaper in production of a small number of castings, geometrically more accurate and faster made. From obtained results of this paper it is clearly seen that printed mold must be protected with thermal coating because liquid adhesive of powder otherwise evaporates during casting and creates additional moisture in the mold, as it was noted.

18. S. Gil, J. Ochman, W. Białik
A thermal study of pipes with outer transverse fins. This paper provides results of thermal investigations on pipes with outer transverse fins produced by placing a strip, being a form of helical spring which functions as a radiator, on the basis pipe. The investigations were carried out at the facility that enables measurements with respect to both natural and forced convection. Performance of the investigated pipes was assessed in relation to a non-finned pipe and a pipe welded with the use of Metal Active Gas (MAG) technology. The experiments have shown that the finned pipe welding technology does not markedly affect their thermal efficiency, which has been confirmed by performed model calculations, while the welding technology has a crucial impact on their operating performance.

Ecological water-based protective coatings for moulds and cores of iron castings. The aim of the investigations was the development of the protective coating and the method of its preparation intended for foundry moulds and cores. The selection of the proper surface-active agent, allowing graphite wetting by water in order to form homogenous water composition with the remaining components of the coating, was especially important.

20. T. Lin, K. Nowacki, H. Kania
Determination of physico-chemical properties of fine-grained waste from the cleaning of iron casting. In the European Union one of the most important activities are the recovery and recycling of waste including foundry waste. In the article waste arising from production of iron casting were presented. Selected physico-chemical properties of iron-bearing waste were defined. Opportunities of waste management are related to their chemical constitution as well as some physical properties. On the basis the results of research the solutions of foundry waste management were proposed.

21. A. Kmita, A. Rocznik, M. Holtzer
The identification of pyrolysis products of the alphaset binder with gas chromatography/mass spectrometry. Pyrolysis-gas chromatography-mass spectrometry (PyGC/MS) was used to identify the major organic products created by pyrolysis of the components at 700, 900 and 1100 °C. This review is devoted to the presentation of polysaccharide application in foundry industry.

22. R. Radoń, Ž. Milošević, S. Jurčič, S. Ćudić
Flootation of ores and waste waters. World generally requires a very high standard of pollution control, and mining companies pride their organisations as being examples of excellence in this field. Hydrometallurgical mining processes decrease the production of gas and solid pollutants into the atmosphere and maximize the recirculation of solvents at every level of waste waters treatment. The extra electrowinning of metal using the circular hydro-metallurgical process ensures that the maximum amount of mined metal is recovered. Reducing pollution helps to improve company profitability.

23. I. Špíčka, M. Heger, O. Žímovy, Z. Janěčková, T. Tykva
Artificial intelligence based model for optical control of heating furnace. In practice, however, a certain level of downtimes causing deterioration in economic indicators cannot be avoided. The article demonstrates how one can use elements of artificial intelligence for the creation of suitable simulation models that would work in real time. These models could be used to reduce the negative impact of downtimes by correcting the temperature in each zone of the furnace. The corrections could be then calculated on the basis of predictions of heat curves of the processed material and subsequent optimization, along with using the elements of artificial intelligence.
Thermal analysis and kinetics of the chalcopyrite-pyrite concentrate oxidation process, Metalurgija, 54 (2015) 2, 311

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Effect of alkaline elements on the reactivity, strength and structural properties of blast furnace cokes, Metalurgija, 54 (2015) 3, 503

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55. Š. Vilamová, P. Besta, R. Kozel, M. Piecha, M. Vaničk, A. Samelejová, K. Janovská, M. Čech
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56. R. Frischer, O. Krejcic, J. David
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57. P. Švec, J. David, R. Garzinová
The evaluation system of surface inequalities and defects of mold’s plates, Metalurgija, 55 (2015) 4, 657

58. J. L. Gao, Y. Zhi, X. F. Ren, Y. H. Liu
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59. J. Wang, G. Z. Wang, C. M. Wang
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60. A. K. Serikbayeva, A. A. Suleyberganova, F. A. Berdikulova
Review of technologies of processing of technogenic products of copper production, Metalurgija, 55 (2015) 4, 715

61. D. Wilk-Kolodziejczyk, G. Różej, K. Reguś, S. Kluska-Navarecka, M. Adrian
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62. J. Behe, P. Ličý, I. Kroupová, F. Radkóvský
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63. D. Cirjina, O. Chivu, L. M. Cirjina
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64. K. Kaczmarska, B. Grabowska, D. Drożyński
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65. J. Kulasa, W. Malec, B. Juszczyk, S. Malara, B. Cwołek
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69. D. Dobrotá, V. Petrescu
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76. V. Petrescu, G. Paraschiv, D. Dobrotă
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77. O. Chivu, D-T Cîciec, C. Rontescu
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78. J. Winczek, E. Gawrońska
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79. Z. Dadić, Ć. Živković, N. Čatićović
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81. Z. Glavas, A. Strkalj, A. Stojaković
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82. J. Hampl, J. Odehnal, B. Smetana
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83. A. Isagulov, A. Akberdin, R. Sultanгазиев, D. Isagulova
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84. A. Isagulov, A. Akberdin, R. Sultanгазиев, A. Kim, V. Kuslikov, D. Isagulova
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85. C.X. Li, H. Li, H. Lu, W.W. Mao
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86. A. Akberdin, U. Konurov, A. Kim, A. Isagulov, R. Saitov, R. Sultangaziyev
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88. M. Mihailović, A. Patarić, K. Raič, Z. Gulijia
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89. Š. Vilamová, P. Besta, R. Kozel, K. Janovská, M. Piecha, A. Levit, M. Straka, M. Šanda
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92. K. Major – Gabryś, A. Grabarczyk, St. M. Dobosz, J. Jakubski
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98. N. Luptáková, P. Dymáček, F. Pešlová, Z. Jurković, O. Barborák, J. Stodola
99. V. P. Karasyov, P. V. Kovalev, A. Z. Issagulov, V. Yu. Kutikov, Y. P. Chsherbakova
Iron loss in high-power arc steelmaking furnaces, Metalurgija, 55 (2016) 3, 503
   **Plasticometric study of hot formability of hypereutectoid C – Mn – Cr – V steel.** Formability of hypereutectoid C-Mn-Cr-V steel in hot condition was investigated with use of plasticometric methods. A wide range of deformation temperatures 1 300 - 640 °C for hot tensile tests was proposed with use of nil-strength temperature (NIST), determined by special plasticometric method, and as well as with use of the calculated temperatures of phase transformations during heating of the investigated steel. Ultimate tensile strength of the investigated steel was increasing exponentially with the decreasing deformation temperature. Ductility of the investigated steel in hot condition increased with the increasing deformation temperature up to the temperatures ranging from 1 150 to 1 250 °C, after which a sharp decline of formability took place in investigated material.

   **Transformation kinetics of selected steel grades after plastic deformation.** The aim of this article was to assess the impact of previous plastic deformation on the kinetics of transformations of four selected steels. The research was conducted with use of the universal plastometer GLEEBLE 3800, when Continuous Cooling Transformation (CCT) and Deformation Continuous Cooling Transformation (DCCT) diagrams of selected steels were constructed on the basis of dilatometric tests. The research confirmed that the strain accelerates the particularly the transformations controlled by diffusion. Bainitic transformation was accelerated in three of the four steels. In the case of martensitic transformation the effect of the previous deformation was relatively small, but with clearly discernible trend.

   **Susceptibility Testing for Welding of AlMg alloys intended for extrusion.** The objective of research was to determine the weldability, using Tungsten Inert Gas (TIG) of extruded sections made of hard-deformable 5xxx series aluminum alloys with differing magnesium content, i.e. AlMg3, AlMg4,5, AlMg5, AlMg7. Welded joints were obtained as a result of a welding process consisting of several steps. Only welds characterized by very good appearance and quality were selected for tests. As a result of conducted research, TIG welding parameters were determined for sections with a thickness of 8 mm. It was observed that alloys of differing Mg content are characterized by high weldability and do not exhibit a significant reduction of the yield point. Moreover, joints exhibit uniform hardness distribution in the welded joint and heat-affected zone. Tensile strength is reduced.

4. I. Jandrlik, S. Reškovíč, F. Vodopivec
   **Determining the amount of Lüders deformation in niobium microalloyed steel.** The article presents the results of measuring the amount of deformation during the formation and propagation of Lüders bands through the deformation zone. The amount of deformation was determined by applying the viscoplasticity method with digital image correlation, and analyzing the captured images with the MatchID software package. Results show that during the formation of Lüders bands the deformation of 0.004 mm/mm was achieved. Also, it was determined that during the propagation of Lüders bands through deformation zone, the sample was deformed for the amount of 0.05 mm/mm.

5. S. Mróz, P. Szoła, A. Stefanik, G. Stradomski
   **Theoretical and experimental analysis of the possibility of employing the groove rolling process for the manufacture of Mg/Al bimetalllic bars.** The paper presents the results of investigation into the possibility of employing the groove rolling process to produce round Mg/Al bimetallic bars. Based on the theoretical and experimental analysis it has been found that one of the main rolling process parameters influencing the quality of bond between the bimetal components is the initial stock temperature. In spite of using Mg/Al bimetalllic stocks distinguished by high bond strength, cracks and delaminations occurred at the bond boundary in the transition layer in samples rolled at a temperature of 400°C. Lowering the rolling temperature to 300°C considerably reduced the occurrence of cracks in the regions of the bond transition layer. In a sample taken from band rolled from stock that was characterized by a bond without a transition layer, cracks were completely eliminated.

6. R. Mula, S. Mróz, P. Szoła, S. Sawicki
   **Analysis of the plastic deformation of two-layer Mg/Al materials.** The paper presents the results of physical modelling of the plastic deformation of the two-layered Mg/Al material using the Gleeble 3800 metallurgical processes simulator. The tests were performed for two temperatures, 300 and 400°C, and for two strain rates, 0.1 and 1.0 1/s. Based on the analysis of the investigation results it was found that as the strain rate and temperature decreased, the intermetallic phase yielded; a distinct thinning of the intermetallic phase layer occurred in the zone directly affected by the anvil. The number of cracks also decreased. The testing results have revealed that it is possible to plastic deformation the two-layered Mg/Al material at low strain rates and low temperature.

7. K. Laher, H. Dyja, A. Kawalek, S. Sawicki
   **Determination of characteristics of plasticity of selected medium and high-carbon steel grades in hot torsion test.** This study presents results of the examinations aimed at determination of rheological properties of selected grades of medium and high-carbon steel grades (C45 and C72D). The examinations were carried out for the hot torsion test using STD 812 torsion plastometer. The results of experimental studies were approximated with the function used for determination of yield stress depending on strain, strain rate and temperature. The study allowed for development of mathematical models of rheological properties of steel grades studied in the analysed scope of parameters of strain and temperature.

8. A. Gryc, T. Bajor, H. Dyja
   **The analysis of influence the parameters of rolling process in three high skew rolling mill of AZ31 magnesium alloy bars on temperature distribution.** The work presents the results of numerical investigations of AZ31 magnesium alloy bars obtaining by the rolling process in a three high skew rolling mill. An analysis of impact the magnitude of inflicted deformation on temperature distribution in the material was made. The calculations were made using Finite Element Method for 3D deformation state taking into account thermal phenomena that occur during applied deformation scheme. Theoretical investigations were made for two variants of deformation, one temperature of the process that equals 400°C and four rolling rates of 25, 75 and 100 rev/min.

9. A. Kawalek
   **The effect of relative deformation on the energy-force parameters in the asymmetrical plate rolling process.** The paper presents the results of asymmetrical plate rolling in the finishing rolling stand of a 3600 mill. The investigation was carried out for S690QL steel sheets. Tests were conducted for two types of the asymmetric rolling process. In the first case, the asymmetry of the process was introduced by varying the speed of the upper working roll, while in the second case, two types of asymmetry were introduced simultaneously by reducing the rotational speed of the upper roll and reducing the diameter of the lower roll. Based on the obtained results it has been found that the simultaneous introduction of two types of asymmetry significantly reduces the energy-force parameters of the process, and regardless of relative deformation applied, it yields also a straight rolled plate.

10. V. A. Andreyanchenko, M. K. Ibatov, D. A. Issagulova
    **Influence of initial porosity to process ECAP of powder materials.** There was studied technology of processing Ti-6Al-4V powder material with various original density by using method of equal channel angular pressing. The device with the 90, 120 and 135° angled joint channels was used for research. A deformation was conducted at room temperature. It was found that the most favorable stress-strain state is formed in the instrument, where the angle of channel joints equal to 135 degrees. The maximum compression in instrument is reached at 90 degree angle of the channel joints, but it needs more deformation force. To obtain pressed material it is recommended to use high cycle ECAP for any configuration.
The effect of upsetting ratio on mechanical properties for hydromechanically bulged axisymmetric components made from copper tubes. The paper presents experimental results of investigations of hydromechanical bulge forming of copper axisymmetric components whose relative wall thickness was $s/D = 0.045$. The deformation ratio of material in paper was de

The physical and tribological properties of TiCN coating deposited to cold forming tool. The cold forming tool life is limited in particular, by the surface hardness and resistance to abrasive wear. In the case of our tool there is a strong abrasive wear in the contact of tool and material being processed. Our goal was to increase the lifetime of tool used for production of steel seamless reducers by surface modification while improving the quality of manufactured reducers. An analysis of the production process highlighted the need for a comprehensive solution, and it changes the basic material used for the production of tools along with application of CVD coating. For the following innovative tools we have applied TiCN coating and realized a various experimental tests to determine its physical and tribological properties, coating morphology and GDOES analysis of the chemical composition of TiCN coating. The result of this innovation was a significant increase in tool life.

Analysis of mechanical properties, formability and stress-strain states in the production of tubes with contoured internal surface. One of the priorities in company Železiarne Podbrezova in area the development and optimization of technological processes forming is the production of tubes with contoured internal surface. Characterized by a spiral rib on the inner surface and are used in boilers or in heat exchangers. The effect of these tubes is highly evaluated especially for use in boilers in coal-fired plants and operating at sub-critical pressures. The paper deals with the technological process of forming tubes with contoured internal surface, specifically the analysis of mechanical properties, formability of tube and describes the stress-strain states in cross-section tubes in DEFORM 3D simulation environment.

The influence of lubricant carrier and lubrication conditions on mechanical-technological properties of high carbon steel wires. In this paper the effect of the type of soap powder and lubricant carriers on lubrication conditions in multipass drawing process of high carbon steel wires has been determined. The wire drawing process was conducted in industrial conditions by means of a modern multi-die Koch drawing machine. For wires drawn on borax and phosphate lubricant carriers the mechanical-technological properties have been carried out, in which yield stress, tensile strength, uniform elongation, number of twists and number of bends were assessed. It has been proved that the application of phosphate lubricant carrier and also the rotation in the first draft in an essential way improve the lubrication condition in high speed multipass drawing process and makes it possible to refine the mechanical properties of wires.

The impact of the heat treatment parameters on patenting line on mechanical-technological properties of steel cord wires. In the paper the influence of modification of patenting process on steel cord properties has been assessed. It was found that the wires of pearlite structure, in comparison to the wires of pearlite-bainite structure, characterized much better properties which is confirmed by higher tensile strength by more than 12 %, higher by 1.6 % the number of twists and higher by 3.6 % the number of bends. It was found that weaving steel wire cord causes a decline in its exploitation properties, which should be associated with an additional deformation of the wire in the cords manufacturing and the size of the decline depends on the type of wire structure.

Experimental validation of a numerical model of cold drawing of multi-ri

The effect of cross rolling on the microstructure of ferrons and non-ferrous metals and alloys. The cross rolling is the one of most perspective method of severe plastic deformation method by severe plastic deformation method. This method gives ability to get the long length billets. However, deformation and trajectories of the metal is very heterogeneous across the section of the rolled piece. This paper presents the FEM simulation of hot cross rolling and experimental study of the effect of the cross rolling on a different three-roll mills on the microstructure of ordinary structural alloy steel, stainless steel and technical copper in different zones of the bar. Analysis showed significant structure refinement in all cases. The best result was achieved on the stainless steel, and shown the formation of equiaxial ultrafinestrain structure on the bar periphery.

Microstructure and ductility of binary Al-Zn aluminum alloy after severe plastic deformation. This work demonstrates that processing by SPD leads to the formation of UFG structure in the Al-Zn alloys and leads to improved ductility. The supersaturated solid solution in alloys is decomposed during SPD processing resulting in nucleation and growth of a secondary phase precipitates, formation of segregations of alloying elements. It is proposed that the atomic mobility could be significantly enhanced during SPD especially thanks to the high vacancy concentration, solute drag by dislocations, pipe diffusion along dislocations or grain boundary diffusion. We have systematically investigated such dynamic precipitation phenomena in Al-Zn alloys at different SPD processing regimes.
Microstructure, mechanical properties, electrical conductivity and heat resistance of Al alloys after ECAP-conform processing and drawing. This work presents the results of the study of the UFG structure produced as a result of ECAP-Conform processing in Al-Mg-Si and Al-Mg-Zr alloys. The regularities in the variation of the mechanical properties, electrical conductivity and heat resistance of UFG alloys, depending on their chemical composition and features of the produced UFG states, have been investigated. It has been shown that the formation of specified UFG structures ensures achieving a combination of their high strength and electrical conductivity, as well as heat resistance. The possibility of producing UFG conductors from Al-based alloys through ECAP-Conform processing followed by cold drawing has been demonstrated.

Ultrafine-Grained High Strength Mg-Al-Zn-Mn Alloy After Radial-Shift Rolling. Radial-shift rolling (RSR) of the Mg-4.4%Al-0.9%Mn(wt.%) alloy was carried out with gradual reduction of diameter from 38 to 15 mm (true strain = 2.63) and reduction of deformation temperature from 420 to 150°C. With decreasing of rolling temperature reduction of the grain size is observed. A final state of the samples at the rolling temperature 150°C represents relatively uniform UFG structure with the average grain size ~1.5 micron. Reduction of grain size at decreasing of rolling temperature changes the rolling texture to axial prismatic texture. With reduction of the grain size the strength increases up to UTS = ~200 MPa, and UTS = ~330 MPa.

Investigation of the effect of SPD processing on the structure and properties of martensitic steel. The aim of this work is the formation of an ultrafine-grained (UFG) structure in the steel EI-961Sh of the martensitic class by severe plastic deformation (SPD) processing. SPD techniques enable producing bulk materials with a grain size below 1 µm and predominantly high-angle grain boundaries, which ensures a combination of unique characteristics of strength and ductility. The structural features of the produced UFG samples will be studied by transmission electron microscopy and X-ray structural analysis. Tensile mechanical tests at room and elevated temperatures will be performed. The thermal stability of the UFG structure will be investigated.

The relationship of strain and structural states during SPD. The nonconformities of the estimation of the strained state SPD methods by the analytical formulas, which traditionally are used in metal forming, are established. So the calculated values of the accumulated deformation can differ several times for one structural state. The reason for the nonconformity in indicated the fact that at the basis of formulas for calculating the degree of deformation different components of tensor of distortion are used. Examples of calculation in the amount of the accumulated deformation of the contribution of rotary mode and its influence on the formation of grains are shown.

25. S. V. Dobatkin, G. V. Rybalchenko, A. Klianga, A. A. Tokar
Structure and Properties of Cr-Ni Austenitic Steels after Shear Strain. The structure and properties of ASTM F138 and Cr-Ni-Ti steels after HPT at the range of 300 – 450°C and after ECAP at 400°C were studied. Shear strain produces nano- and UFG structure with grain size less than 125 nm after HPT and grain-subgrain structure with structural elements of 100-400 nm after ECAP. Due to obtained microstructure yield strength of steels after HPT significantly increases. After ECAP the strength characteristics of steels are lower than those produced by HPT. The fatigue limit of both steels is virtually equal and exceeds the initial level by almost a factor of 2.

26. D. V. Shangina, N. R. Bochvar, M. V. Gorshenkov, S. V. Dobatkin
Structure and properties of ultrafine-grained Cu-Cr and Cu-Cr-Zr alloys produced by high pressure torsion. Low-alloyed copper-based alloys have excellent thermal and electrical conductivity in combination with moderate strength. Severe plastic deformation (SPD) can further enhance the strength of these alloys by forming an ultrafine-grained (UFG) structure. Alloying of Cu-Cr alloy with zirconium decreases its average grain size from 209 µm to 141 µm after high pressure torsion (HPT). It is shown that Cu-Zr particles suppress the grain growth in UFG structure more effectively than the Cr particles and provide additional hardening during aging. A combination of quenching, HPT and following aging of Cu-0.5%Cr-0.08%Zr alloy allows obtaining simultaneously high-strength and electrical conductivity (HV=2.26 GPa and 69 % IACS).

27. M. Suliga
The influence of drawing speed on surface topography of high carbon steel wires. In this work the influence of the drawing speed on surface topography of high carbon steel wires has been assessed. The drawing process of φ 5.5 mm wire rod to the final wire of φ 1.7 mm was conducted in 12 passes, in industrial conditions, by means of a modern Koch multi-die drawing machine. The drawing speeds in the last passes were: 5, 10, 15, 20 and 25 m/s. The increase in drawing speed causes a decrease in surface roughness of wires. Significant smoothing of the surface of the wires drawn at a speed of 25 m/s confirm the parameters of amplitude, spatial and geometric structure of the hybrid surfaces which are from 20 to 50% lower than those obtained for wires drawn at a speed of 5 m/s.

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29. K. Labor, H. Dyja, M. Kalamorz
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36. M. Jabłońska, I. Bednarczyk, K. Rodak, A. Śmiglewicz
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39. M. Janjić, M. Vukčević, Z. Jurković, N. Šibalić, S. Savićević
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40. Z. Pater
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Transformation kinetics of selected steel grades after plastic deformation, Metalurgija, 55 (2016) 3, 357

42. P. Vaňová, J. Sojka, T. Kulová, V. Vodárek, M. Sozaňska, B. Chmiela, J. Lelątko
The effect of deformation on the change of hydrogen diffusion in C-Mn-Si-P trip 800 steel, Metalurgija, 55 (2016) 3, 361

Plastometric study of hot formability of hypereutectoid C – Mn – Cr – V steel, Metalurgija, 55 (2016) 3, 365
1. T. Karkowska
Factors influencing the requirements fulfillment in the zinc coating processes. The aim of the analysis was the assessment of the zinc coating process with application of the authorial methodology which allows in the highest degree to reflect the threats occurring in this process. Findings of the analysis are as follows: factors influencing the requirements fulfillment in the zinc coating process are not only the significance and the probability of occurrence of the incompatibilities and the possibility of process supervision, but also the influence of the technological parameters realization on ensuring the specific requirements and technical difficulty of parameters realization.

2. H. H. Yu, X. Li, Z. G. Yuan
Synthesis and characterization hollow spherical La$_{0.9}$Sr$_{0.2}$Ca$_{0.1}$Co$_{0.9}$Fe$_{0.1}$O$_{3-δ}$ (LSCCT) for cathode of solid oxide fuel cell (SOFC). Hollow spheres structures of La$_{0.9}$Sr$_{0.2}$Ca$_{0.1}$Co$_{0.9}$Fe$_{0.1}$O$_{3-δ}$ (LSCCT) have been synthesized via hydrothermal method using carbon spheres as template. The structure and electrical conductivity of obtained samples are characterized by X-ray diffraction (XRD), scanning electron microscope (SEM), transmission electron microscope (TEM) and direct current (DC) four-probe method respectively. The results show that hollow spheres structures of LSCCT with the mean particle size of 0.9 - 1.2 μm is single phase. The electrical conductivity of the samples is higher than 100 S/cm from 600 to 800 °C and can meet the demand of the electrical properties for the cathode materials.

Influence of process parameters on the properties of ADI examined with the use of data mining methods. The article presents opportunities offered by the data mining analysis as applied to studies of the effect of process parameters on the mechanical properties of ADI. The applied methods of regression trees and cluster analysis allow the detection of relationships between parameters and also allow determination of strength and form of the impact of different factors. The results of this study allow the creation of knowledge bases for systems supporting the decision-making process in technology.

4. A. V. Todorut, L. Palin-Popa, V. S. Tselentis, D. Cirnu
Sustainable cost reduction by lean management in metallurgical processes. This paper focuses on the need for sustainable cost reduction in the metallurgical industry by applying Lean Management (LM) tools and concepts in metallurgical production processes leading to increased competitiveness of corporations in a global market. The paper highlights that Lean Management is a novel way of thinking, adapting to change, reducing waste and continuous improvement, leading to sustainable development of companies in the metallurgical industry. The authors outline the main Lean Management instruments based on recent scientific research and include a comparative analysis of other tools, such as Sort, Straighten, Shine, Standardize, Sustain (SS), Visual Management (VM), Kaizen, Total Productive Maintenance (TPM), Single-Minute Exchange of Dies (SMED), leading to a critical appraisal of their application in the metallurgical industry.

5. J. Svetlík
Application device a layer of oil film on the inside surface of tubes of different cross section. Technology solution relates to a device for applying a layer of oil film on the inside surface of tubes of different cross section. It is suitable for metallurgical and engineering applications, which must be applied oil film - the coating film over the inside surface of tubes of different cross-section and different length because of the corrosion protection, because of the disinfecting, reducing the surface friction of the inner surface, or other reasons. The formulation of this concept is applicable to a broad portfolio of type-pipes of different sizes and shapes of cross sections of different lengths. The technical solution falls within the area of mechanical engineering and metallurgy.

6. L. Blachňa, J. Brzoska
The use of the balanced scorecard in evaluating the results of the innovations implemented in metallurgical companies. Implementation of innovations is the main factor of development of companies competitiveness and effectiveness. Innovations result in creation of a value for both the client and the company. The article presents a method of evaluating the innovations implemented in industry which emphasises, on the background of qualitative changes, the measurable (quantitative) effects of various types of innovations. For the purpose of measuring the results of implemented innovations the Balanced Scorecard was used. The method developed by the authors of the paper was used to evaluate results of the innovations implemented in metallurgical companies.

7. D. Burchart-Korol
Development of circular economy principles and life cycle impact assessment methods for steel industry. The main purpose of the paper was to present possibility of development circular economy principles and life cycle impact assessment methods for environmental pollution reduction and resources management improvement in steel industry. Efficient use of resources is critical to sustainable steelmaking. Different life cycle impact assessment (LCIA) methods was used for environmental evaluation. It was chosen the most appropriate LCIA methods for resources evaluation in steelmaking which followed the rules of the circular economy (CE). According to the circular economy reduce of raw materials, zero waste and encourages the materials reuse and recycling should be applied. Application of LCIA methods for assessment of applied CE principles for steel industry was performed.

8. P. Wicher, F. Zapletal, R. Lonort, D. Stai
Measuring the metallurgical supply chain resilience using fuzzy analytic network process. The article presents a methodology for measuring the metallurgical supply chain resilience, which enables finding key resilience capabilities and measurable criteria, and determining a level of the resilience. The methodology is based on Analytic Network Process (ANP), which is used to solve the complex decision-making problems, whose structures can be mapped as non-linear networks. Due to the fact that uncertain pairwise comparisons expressed by the fuzzy sets are considered the Fuzzy Analytic Network Process (FANP) is applied. The methodology is verified on generalised model of a metallurgical supply chain. The SuperDecisions software was used for the application. The performed experiments show that FANP approach is highly suitable to measure metallurgical supply chain resilience.

9. F. Tošenovský, D. Vykydal, P. Klaput, P. Halfarová
Stochastic Optimization of Laboratory Test Workflow at Metallurgical Testing Centers. The objective of the paper is to design a way to shorten the time required to perform laboratory tests of materials in metallurgy. The paper finds a relation between the time to perform a selected test of materials and the number of technicians carrying out the test. The relation can be used to optimize the number of technicians. The approach used is based on probability theory, given that the amount of material to be tested is unknown in advance, and draws on the most powerful modelling techniques available involving the GEE procedure.

10. T. Bakalar, H. Pavolova, S. Khouri, I. Pristaiová
Influence of additives on decrease of temperature of slag flow from energy coal in wet bottom boiler. This paper describes the features of the energy coal combusted in a power plant, its impact on energy production, while the possibility of using natural and secondary raw materials to modify the properties of energy coal. All selected types of additives (fluorspar, DSS, dolomite, and limestone) in admixture of coal have clearly proved their ability to reduce the pour point of the ash in the laboratory experiments. The highest decrease of the temperature at 5 % of the additive was achieved by fluorspar and dolomite from the temperature of 1 593 °C to the temperature of 1 307 °C. In terms of the economy and the availability of the additives the most suitable seems to be DSS.

11. M. Gombar, J. Kmec, M. Badida, L. Sobotova, A. Vagaska, A. Badidova
Experimental analysis of the impact of physical factors on technological properties of aoo layers and environment. In the contribution is evaluated the influence of physical factors of the anodizing oxidation process. The experiment was realised at three different current densities $J_1 = 3\,\text{A.dm}^{-2}$, $J_2 = 4\,\text{A.dm}^{-2}$ and $J_3 = 5\,\text{A.dm}^{-2}$. The microhardness was determined on polished metallographic samples by using 10 g of a load. The results showed, that
by increasing of values of physical factors in the frame of used values, also rise the conditional values of observed layer parameters, thus increasing the protection of the material and its resistance in the environment.

12. A. Myszkowski, W. Matysiak, D. Bartkowski
Evaluation the influence of rotational speed and feed rate of tool on surface quality of the shaped hole using Flowdrill technology. The paper presents results the influence of parameters edgetrimming holes using Flowdrill technology on selected properties of the hole surface. This study was conducted on three types of materials: aluminum, medium-carbon steel and copper. Various parameters of speed and feed rate were applied. Present specimens were prepared using CNC machine without and using intensive air cooling. It was found influence of processing parameters on surface condition of edgetrimming holes.

13. J. Calus Moszko, B. Białecka, M. Cempa-Balewicz, H. Świder
Evaluating the possibilities of obtaining initial concentrates of rare earth elements (REEs) from fly ashes. The article presents the results of initial laboratory research into the possibilities of obtaining REE from fly ash from one of Polish powerhouses. In the work the authors have presented the results of investigations into the obtaining of initial REEs concentrations from fly ashes by physiochemical and hydrometallurgical methods. These investigations provide a basis for developing a technology of REE recovery from fly ashes produced in the process of hard coals combustion.

14. H. Pavolová, S. Khouri, M. Cembali, Ł. Domaracka, M. Puzder
Modelling of copper and zinc adsorption onto zeolite. Adsorption of Cu(II) and Zn(II) ions from metallurgical solutions has been studied and the adsorption capacity of zeolite (Nížný Hrabovec, SK) has been determined. Zeolites are characterized by relatively high sorption capacity, i.e. Cu(II) and Zn(II) can be removed even at relatively low concentrations. The experiments were realised in a batch system and evaluated using isotherms. According to the results of the experiments the adsorption equilibrium of Cu(II) and Zn(II) on zeolite was best described by Freundlich isotherm. The maximum sorption capacity was 1.48 and 1.49 mg/g for Cu(II) and Zn(II), respectively. The experimental results of this study demonstrate that zeolite is suitable for adsorption of copper and zinc from aqueous solutions at low concentrations.

15. D. Badulescu, A. Badulescu, A. Florea
Considerations on the (post) privatisation and corporate governance in the metallurgical industry in Central and Eastern Europe economies. Analysing the literature on the privatization and post-privatization process in Central and Eastern Europe metallurgy sector but also the specific results reported by the industry 25 years after, it can be concluded that the results are much more complex and far from the initial expectations. Privatization failed to lead to an effective corporate governance (in terms of ownership structure, independence of managers, market mechanism and minority shareholders’ rights). Beyond the effects of the crisis and of the restructuring processes, the considerable vulnerability of metallurgical companies can be attributed to their excessive dependence on the strategies implemented by the large global groups, or to the lack of involvement of the state, both as minority shareholder, and in regulation authority.

16. H. Gołąb, A. Mazur, B. Mrugała
Application of risk analysis and quality control methods for improvement of lead molding process. The aim of the paper is to highlight the significance of risk analysis and quality control methods for the improvement of parameters of lead molding process. For this reason, Fault Mode and Effect Analysis was developed in the conceptual stage of a new product TC-G100-NC. However, the final product was faulty (a complete lack of adhesion of brass insert to leak) regardless of the previously defined potential problems and its preventive action. It contributed to the recognition of root causes, corrective actions and change of production parameters. It showed how these methods, level of their organization, systematic and rigorous study affect molding process parameters.

Use of sulphuric acid in obtaining pre-concentrates of rare earth elements (REEs) from fly ash. Laboratory tests have been conducted so as to assess the possibility of using concentrated H2SO4 to obtain concentrates of REEs from fly ash produced in pulverized-fuel boilers. The subject of the study was the influence of temperature, material fineness and the use of ultrasound on the conversion rate and efficiency of the process of leaching REEs from fly ash. The efficiency of each method has been assessed based on the concentration of REE ions. Changes in morphology and chemical composition of selected ash grains subjected to the process have also been determined by SEM/EDS method.

18. Š. Salokyová, J. Dobrinský, A. Panda
Monitoring the intensity of mechanical vibration during lathe processing. Article deals with the examination of the effect of cutting parameters on the occurrence and size of mechanical vibrations on three selected measured points during the processing of chrome steel. It also includes execution, experiment evaluation in this field and comparison of measured vibrations acceleration amplitude values according to the standards. The results of the measurement serve for early identification of a defect, which has great effect on the smoothness and efficiency of the machine. The article concludes with the proposed new findings from the measured vibration evaluation and formulated new recommendations for the operation in production system with lathe turning technology. The measured experimental values of the acceleration amplitude of mechanical vibrations were compared with theoretical values.

19. W. Depeński, L. Nowakowski, E. Miko, P. Hegen
Influence of porosity on machinability of sintered Fe Foam elements. The aim of the experiment was to study the machinability of porous metal foams formed by reduction of metal oxides during sintering. There was analysed the process of machining metal foams in relation to its porosity, mechanical properties, microstructure varies. These are the main elements of the design of machining processes elements made of metal foams. Metallic porous structure has been obtained as a result of sintering processes iron based Fe powders mixture and Fe (III) oxide space holder. Factors that have been tested include: geometrical shape of the sample, the geometric accuracy of the elements, the surface state after treatment depending on machining parameters and porosity of the metal foam.

20. W. Depeński
Effect of carbon addition on the densification behaviour and microstructure evolution of sintered iron foam during pore formation process. The paper presents how carbon addition effects on densification behaviour and microstructure evolution of sintered iron foams. The technique of obtaining porous structures requires applying a metal oxide, easy to reduce by protective atmosphere, during the sintering process. This allows for combining irregular opened cellular structures. Metallic porous structure has been obtained as a result of sintering processes iron based powders mixtures with addition of copper catalyst and Fe (III) oxide as a space holder. Samples were sintered at temperature of 1130°C and 50 min. long, in dissociated ammonia protective gas. The samples were studied on how the addition of carbon powder (0.8%–2%) effects the porosity structure. The use of microscopy, SEM and LM allowed to analyze the changes in the structure of sintered samples.

21. B. Gajdziek, J. Słotko
Steel mill products analysis using qualities methods. The article presents the subject matter of steel mill product analysis using quality tools. The subject of quality control were bolts and a ball bushing. The Pareto chart and FMEA were used to assess faultiness of the products. The faultiness analysis in case of the bolt enabled us to detect the following defects: failure to keep the dimensional tolerance, dents and imprints, improper roughness, lack of pre-machining, non-compatibility of the electroplating and faults on the surface. Analysis of the ball bushing has also revealed defects such as: failure to keep the dimensional tolerance, dents and imprints, improper surface roughness, lack of surface pre-machining as well as sharp edges and splitting of the material.

22. K. Nowacki, T. Lis
Environment-friendly management of iron-bearing metallurgical waste. The main purpose of waste management should be reclamation of valuable raw materials and, consequently, protection of natural environment by reducing consumption of deposits and energy. The metallurgical industry generates considerable quantities of waste containing iron. This article addresses environment-friendly solutions for utilisation of such waste in the form of sludge and steelmaking dusts. What has been discussed is the impact of the technologies proposed on natural environment.
23. M. Kostelac, J. Tepić
Vibrations generation mechanism on trams. For trams moving on rails with shallow groove, resting on concrete sleepers or ground, exists many sources of vibrations with various wavelength. Dynamic forces which occur in the contact point between wheel and rail, because of wheel profile deformation and roundness deviation, generate vibrations with different wavelengths, which are spread through ground to nearby residential objects. Additional dynamic forces are generated during transition through crossings and switches or above poorly performed joints on rails. Uneven supports in curves or on the inclined routes may trigger additional transversal forces. Created frequencies of 4-8 Hz have very unfavorable influence on the surrounding and these cannot be considered as noise generated from vibrations in the frequency range 30-30 000 Hz.

24. A. Gessner
An approach for machining allowance optimization of castings in machine tool industry with the use of optical scanner. The publication demonstrates an application of optical scanner for optimization of casting machining. Two criteria of optimization were assumed: minimum volume of machined allowances and minimum number of machining passes. The research was carried out for a production series of machine tool castings. Their geometry was measured with the use of optical scanner, the obtained models were aligned with the reference one (CAD models) with the use of the best-fit method, the area of every single surface with machining allowance was calculated and finally the real allowances for the alignment were calculated. The optimization results concerning scale factors for both criteria were presented.

25. W. Walke, M. Kaczmarek, M. Stasznuk, M. Basiaga
Influence of purge, time of waiting and TiC4 dosing time in a low-pressure ALD reactor on properties of TiO2 layer. The aim of the study was to evaluate the influence of the ALD process parameters on mechanical properties and corrosion resistance of TiO2 layer. The TiO2 layer was deposited on stainless steel surfaces at constant temperature $T = 200^\circ$C and number of cycles $N_c = 500$ ($g \approx 25$ nm). The applied methodology consisted of potential-static, potentiodynamic and impedance studies, as well as hardness and adhesion test. The obtained results were the basis for selection of surface treatment method for stainless steel implants in contact with blood. Appropriate parameters of surface treatment realized by means of the ALD method is of significant importance. It will contribute to the development of technological conditions of specified deposition parameters of TiO2 layers on steel implants.

26. I. E Uskova, N. L. Chekunova-Tomacheva
Creating conditions for the effective transformation of research results into practical activity of real sector of economy. An innovative mechanism is organizational and economical form of innovation activity implementation and facilitate its innovative solutions, as well as the lever stimulate and regulate this activity. Innovative mechanisms should form functional innovation in its relation to stages of their life cycle. Under the functional securing means innovation, investment and financial security. Matrix structure, which allow to activate the innovation process and form a system of innovative mechanisms are mechanisms of organization, mechanisms of development and implementation, mechanisms of financing and incentive mechanisms for technology transfer.

27. N. L. Chekunova-Tomacheva, I. E. Uskova
Forms and methods of optimization of business procedures resource management research complex. Defining requirement of the market, the profitability for key market actors market actors realization of intellectual products: producer of equipment – the higher the profit; the consumer is the achievement of maximum economic effect from the introduction of innovations. It seems necessary to consider the problem of synthesis of market implementation of new material. Ideal scheme – crafted material in comparison with the analogue of higher quality with less cost. In reality, the difficulty in mastering the production of new material (the cost of research work, preparation of production, etc.) may lead to higher prices.

28. P. Odesskyj, I. Vedyakov, S. Garov
Electric welding pipes profiles for unique engineering structures. Application of the round pipes of high strength in the construction of large-scale public buildings, stadiums, airports, etc. is effective in many respects: a minimum weight of structures, providing of the high resistance to influences and loads. It was installed in practice that the longitudinal welded pipes with diameters $530 - 1420$ mm, with wall thickness of $10 - 50$ mm, with a yield strength of $350 - 480$ N / mm$^2$ possess of high engineering properties. By the chemical composition steels characterize by low carbon content (<0,1%) harmful impurities (S<0,010%, P<0,015%) and gases, therefore, they are welded good. Metal of pipes has a high resistance to brittle fracture with KCV $\approx 100$ J/m$^2$.

29. J. Machnik-Stomka, P. Kordel
Significance of technological entrepreneurship and creativity in metallurgical enterprises. This article presents the categories of technological entrepreneurship and creativity that consti-tute a new perspective on developmental mechanisms of contemporary enterprises. These mechanisms are of particular significance in relation to industrial enterprises, including metal-lurgical ones. Forth purposes of thispublication the significance of technological entrepreneurship and creativity is described with the examples of metallurgical enterprises.

30. A. Sanik, S. Sanik
Areas of particular control in steel production – result of research. The market of steel production in Poland is growing rapidly, even with the decline recorded in Europe. Steel distribution market in Poland is very fragmented and the largest distributors are only a few percent share of the market. The biggest steel customers are construction and automotive segment. In this situation, there is a strong need to implement new methods and solutions which help to improve an effectiveness of steel production companies. The article presents the results of research related to the evaluation of enterprise effectiveness involved in the steel production. The new solution based on specially developed system of indicators is described. It allows the main areas of steel production to be controlled.

31. M. Górska, R. Prusak
An identification and the assessment of improvement need for production systems functioning in enterprises of the metal branch. The improvement of production process is a base of the competitiveness of the enterprise in the metal branch on the market. In the time of strong competition abandoning or the lack of improvement for areas requiring improvement can be fatal for the enterprise. Therefore there are some important actions contributing to the identification and assessments of the need for improvement in the area of producing the iron goods. In this study an attempt of identifications areas for production processes of iron goods that require improvement was made. The determination of such areas can become the source of many valuable information for the enterprise and it make possible to determine the directions of improvement. Results of research allowed also describing area of importance for tasks realization that contributing to improvement of chosen enterprises from the metal sector.

32. F. Tehovnik, F. Vode, J. Burja
Cracking of stainless steel molds for injection glass molding. During glass injection molding hot melted glass is injected in the stainless steel molds. The steel molds have to endure high temperatures and high temperature differences. The investigated molds cracked before their expected life time. A failure analysis was made and the reasons for cracking were found and scientifically explained. The facture surfaces were examined by macroscopic microscopic analysis. The fault resided in the lubrication of the mold and stress-corrosion reactions that were enabled by the given operating conditions.

33. F. Vode, J. Burja, F. Tehovnik
Classification and management of delays for continuous reheat furnaces in steel industry. Continuous reheat furnaces in steel industry are either used for heat treatment or for reheating prior to hot rolling/forging process. Variation of duration of hot rolling process is the main source of disturbances of stock reheating process. A systematic classification of delays dedicated for the closed-loop control of slab-temperatures is presented. Delays are basically divided in two groups: delay with unknown duration and delays with known duration. The later are further divided on four sub-groups with respect to the source of delay, where one group is delay due to hot rolling duration.
34. R. Galuszka, M. Madej, D. Ozimina, A. Krzyzszkowski, G. Galuszka
The characterisation of the microstructure and mechanical properties of DLC coatings for biomedical applications. The paper presents the results of research of diamond – like coating of a-C:H type obtained by using a technique of physical vapor deposition (PVD) on the surface of CoCrMo alloy, commonly used for the elements of the endoprosthesis. The surface has been observed using a scanning electron microscope (SEM). Analysis of the chemical composition and distribution of the different elements were performed using GDOES analysis (glow discharge optical emission spectrometry). It has been shown that the diamond – like coated elements are characterized by high hardness and good adhesion to the substrate.

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