MATERIALS - SECTION "A"

Processing of ferrous and non ferrous alloys

1. O. Cheylyakh; *Pryazovsky State Technical University, Mariupol, Ukraine*
The Creation of New Economical Metastable Functional Alloys and New Strengthening Technologies. The general laws and principles of metastable phase state formation, and principles of purposeful use of control led deformation-induced phase transformations (DIPT) in controlling mechanica1 and operational properties of various steels and cast-irons have been established. Economical (Ni-, Mo-, V-, Nb- free) metastable alloys: high-strength, corrosion-resistant and heat resistant steels wear-resistant steels and cast-irons of improved physical-mechanical and operational properties have been developed on this basis. The ways and the technologies of heat treatment, chemica1-heat treatment, thermo-deforming treatment in order to control DIPT and qualities of the developed and a number of standard constructional and tool steels, wear-resistance steels and cast-irons, surface 1ayers with improved mechanical and operational characteristics have been developed.

2. V. Z. Kutsova, M. A. Kovzel, A. V. Kravchenko, T. V. Kotova, E. A. Gerasimenko, A. I. Shkolik; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Structure and Resistance of Casting Moulds from Grey Pig-Iron. Nowadays increasing of the moulds resistance is the important technological task. The most part moulds is used for steel ingots production, intended for subsequent rolling and forging. The analysis of moulds work shows, that the basic reason of their failure is the formation and development of various cracks. Roughly 90 % moulds fails for this reason. The analysis of the received data testifies, that for increasing of moulds resistance it is necessary: to raise the content of carbon up to eutectic concentration; to define optimum meanings of a carbon equivalent for pig-iron of worked moulds; to optimize structure of cupola pig-iron, raising the content of carbon and alloying elements; to generate optimum structure by modifying Mg-Si and REM-alloying compositions.

3. M. O. Matveeva, V. N. Bespalko, B. V. Klimovich; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Peculierty of Formation Pearlite in Economy-Alloying Pig-Iron. Presence carbide in structure white pig-iron is necessary, but an insufficient condition of their high wears resistance. Researches of an optimum condition of a metal basis in this pig-iron confirm her important role. Though the common opinion about influence of structure of a metal basis on wear resistance is not present till now. In pig-iron this class the metal basis not itself resists to destroying action of an abrasive, and serves as a sheaf, a support highly rigid condition, carrying out a role of a matrix in a natural material. Ability of a metal basis strongly keep condition can to be indirectly determined on microhardness. It determines a urgency of researches of influence of growing quantities amounts chromium on morphology pearlite. It is shown, that the big chemical heterogeneity austenite promotes formation pearlite essentially to different dispersiveness in volume of the same casting.

4. M. O. Matveeva, O. M. Shapovalova; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Kinetics Crystallization Eutectic in Pig-Iron Alloyed Lame. Concentration chromium from 2,14 % up to 5,3 % promotes growth of a share ledeburite to a component in structure white pre-eutectic pig-iron. It is confirmed, that significant interphase both intraphase heterogeneity of alloys and difficult insidecrystalic liquation chromium promote formation ledeburite and cementite in ledeburite with much different microhardness in a small concentration interval of variation chromium. Since the contents chromium 2,14 % are marked change of morphology of structure ledeburite, he becomes more thin-dispersed, that renders positive influence on operational properties of property of pig-iron, in particular, on deterioration.

5. S. I. Gubenko, V. N. Bespalko, E. V. Zhilenkova; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Influence of Temperature and Amount of Reduction on the Molding Box Borides. In the work investigated change of the molding box and distribution borides in high-chromium steel. Explorations of structure of chromium steel with the increased contents of a boron has shown, that her structure will consist from large and fine boride $(Cr, Fe)_2B$ and TiB_2 located on borders and on a body of grains of ferrite. Heating of steel to temperature 1100 °C results to dissociation boride. Borders borides $(Cr, Fe)_2B$ - a matrix became clean from pettydispersed phases with the subsequent with dividing large boride on fine. The further heating accelerates process of dividing borides. Heating up to 1200 °C results in formation rough-differrntieation eutecticums. Occurrence eutectic a component facilitates a cracks formation at small amounts of reduction. Shattering began on eutectic a component and further was accompanied by spreading of cracks on inter-phase borders a boride-matrix. Increase of an amount of reduction changed the molding box and distribution boride inclusion. Large boride the lengthened molding box at plastic warp are bucked, near them also there is a stressing pettydispersed phases. At the big amounts of reduction of 14 % of a proskating rolling it was carried out well.

6. S. Gubenko; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Formation of Deformational, Thermal and Hydrogenous Microcracks near Non-Metallic Inclusions in Steel. One of issues for safe service of rolling stock is the influence of non-metallic inclusions on the microbreaking in steel during manufacturing of metal production. During metal production service, for example - railway wheels, plastic displacement propagates near surface and if non-metallic inclusions are in this zone they cause cracking and part of wear that are also microcracks of the deformation origin. Thermal microbreakes (voids and cracks) are generated either during steel cooling after hot deformation or cooling during thermal hardening. This phenomenon is associated with difference in thermal compression coefficient between non-metallic inclusion and steel matrix that generates thermal stresses near non-metallic inclusions. The same factor is significant during formation of thermal stresses fatigue and, as consequence, microbreaking of the wheel in service thermal cyclic loads. The so-called "hydrogenous" cracks are associated with hydrogen presence in some steels that causes flake formation. Mechanisms of the microbreaking of all types near different non-metallic inclusions had been studied and their influence on the safety margin of the metal wares had been analyzed.

7. S. Rešković, F. Vodopivec*; *Faculty of Metallurgy University of Zagreb, Sisak, Croatia, *Institute of Metals and Technology, Ljubljana, Slovenia*
Influence of the Proceses Parameters on Mechanical Propertis of Nb Microalloyed Tubes. In the paper are presented resu1ts of investigations

on hot-rolling welding tubes micoalloyed with Nb and no microalloyed steel. The experimental work of investigations included create chemical composition, selection of rolling parameters to a final dimension of production on a stretc - reducing milI and testing mechanical properties of tubes. Special attention was given to the degradation of structure and its influence on the mechanical properties tubes.

8. I. Mamuzić, D. Ćurčija, F. Vodopivec*; *Faculty of Metallurgy University of Zagreb, Sisak, Croatia, *Institute of Metals and Technology, Ljubljana, Slovenia*

Lubricant for the Rolling and Drawing of Metals. A survey is given over lubricants for rolling and drawing of metals. Emulsions, suspensions, natural fats and oils and synthetic lubricants are presented. Fluid mechanics Reynolds equations are used for the calculation of lubricants layer in the entering section of the metals deformation zone. Colloide chemistry is used for the analysis of surface active additions on lubricant properties, lubricant layer thickness and the wetting angle. Lubricants for hot rolling based on suspensions and glass are presented too. Special attention is given to the removing of lubricants from the surface after processing, to measures for the protection of workers and to ecological problems of used lubricants.

9. V. Goryany, T. Khlyntseva*, I. Mamuzic, V. Radsinsky*;** *Institute for Applied Materials Technology University of Duisburg-Essen, Campus Duisburg, Germany; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine, **Faculty of Metallurgy University of Zagreb, Sisak, Croatia*

Influence of Cooling Intensity on the Structure Formation in Stripe Steel by Thermomechanical Treatment. The results of research of microstructure of the strips from low carbon steel 45×6 and 30×8 mm in hot-rolling condition and after accelerated cooling of different intensity and schemes of the coolers movement in the cooling chambers are shown. The strengthening layer is spread unevenly-along the perimeter of the rolled steel. The formation character of the structure and its spreading along the cross-section depends on intensity of cooling and the ratio of the width of the stripe to its thickness. Regimes, which provide the high level of steel's strength with the smallest changing of the mechanical properties by the length of the rolled strip, were defined.

10. I. Mamuzić, M. Longauerova*, A. Štrkalj; *Faculty of Metallurgy University of Zagreb, Sisak, Croatia, *Faculty of Metallurgy Technical University of Košice, Slovakia*

The Analysis of Defects on Continuous Cast Billets. First the article presents the system of sampling and methods of correction of defects on continuous cast billets and rolled steel concrete bars. Although the chemical composition of these billets (with increased contents of manganese and oxygen) is adequate to the standard chemical composition (DIN 488 - BSt 500S) there are gas blow holes and cracks as well as central and peripheral segregation. The point is in unsatisfactory deoxidation of hot cracks which develop during solidification. A prove that the hot cracks are decarbonisation in cracks are inclusions of Si, MnS, Fe, S, respectively an increased content of accompanying elements. The hardness value indicates that the rolling process develops regularly, i.e. in the area of recrystallization of metal.

11. F. Tehovnik, M. Doberšek, B. Arh, B. Koroušič, D. Kmetič, V. Dunat*; *Institute for Materials and Technology, Ljubljana, Slovenia, *Litostroj ulitki, Ljubljana, Slovenia*

The Influence of Rare-Eart Elements on Nonmetallic Inclusions and Microstructure of High-Chromium White Cast Iron. The influence of rare-earth elements, such as cerium, lanthanum and neodymium, on the nonmetallic inclusions and microstructure of high-chromium white cast iron has been investigated. It has been demonstrated that rare-earth elements can change the nonmetallic inclusions and micro structural characteristics of white iron containing about 15 % mass % Cr. The content of cerium, lanthanum and neodymium in high-chromium white iron is 0,22 - 0,34 % mass %.

12. M. Kollárová, M. Džupon, A. Leško*, Ľ. Parilák; *Institute of Materials Research, Slovak Academy of Sciences, Košice, Slovakia, *Research and Development Centre of U. S. Steel, Košice, Slovakia*

Formation of Outburst Structure in Hot Dip Galvannealed Coatings on IF Steels. Outburst structure in two industrially produced hot dip galvanized interstitial free steel sheets for automotive industry after additional annealing has been examined. Ti IF steel was found to form weak outburst structure in the early stage of annealing, followed by frontal growth of Fe-Zn phases during further heating. The high reactivity of this steel was confirmed by rapid Γ-phase formation. Under the same conditions, Ti-Nb-P IF steel exhibited frontal growth of Fe-Zn compounds without Γ-phase formation due to relatively high phosphorous content, which is known as inhibitor of Fe-Zn reaction, but simultaneously significant occurrence of undesired outburst structures was recorded. It was assumed that the phosphorous content was insufficient and/or ferrite grain was very fine.

13. J. Zrnik, I. Mamuzić*, P. Lukaš, O. Muransky**, P. Jenčuš**, Z. Novy;** *Comtes FHT, Pilsen, Czech Republic, *Faculty of Metallurgy University of Zagreb, Sisak, Croatia, **Institute of Nuclear Physics Academy of Science of CR, Rež near Prague, Czech Republic*

Design of Thermo Mechanical Processing and Transformation Behaviour of Bulk Si-Mn TRIP steel. In the last decade, a lot of effort has been paid to optimising the thermomechanical processing of TRIP steels that stands for transformation induced plasticity. The precise characterization of the resulting multiphase microstructure of low alloyed TRIP steels is of great importance for the interpretation and optimization of their mechanical properties. The results obtained *in situ* neutron diffraction laboratory experiment concerning the austenite to ferrite transformation in Si-Mn bulk TRIP steel specimens, displaying the transformation induced plasticity (TRIP), are presented. The advancement of ferrite formation during transformation in conditioned austenite is investigated at different transformation temperatures and has been monitored using neutron diffraction method. The relevant information on transformation proceeding is extracted from neutron diffraction spectra. The volume fractions of retained austenite resulting at alternating transformation conditions were measured by neutron and X-ray diffraction respectively. The stability of retained austenite in bulk specimens during room temperature mechanical testing was characterized by *in situ* neutron diffraction experiments as well.

14. S. Bockus; *Kaunas University of Technology, Kaunas, Lithuania*

A Study of the Microstructure and Mechanical Properties of Continuously Cast Iron Products. The horizontal continuous casting has a lot of advantages in comparison with traditional casting methods. But it has a few disadvantages and unsolved problems. The objective of this

research was the experimental investigation of the effect of chemical composition of cast iron and the casting conditions on the microstructure and properties of continuously cast ingots. As a result, tensile strength, Brinell hardness, and pearlite content increased with increasing Cr, Cu, and Sb additions and decreasing carbon equivalent. As for microstructure of graphite, higher silicon to carbon ratio and lower solidification rate decreased a zone of interdendritic graphite. Nomograph of continuously cast iron structure was made.

15. V. G. Prokoshkina, L. M. Kaputkina; *Moscow State Institute of Steel and Alloys, Moscow, Russia*
Structure Formation in Nitrogen-Containing Heat-Resistant Steels under High Temperature Thermomechanical Treatment. Processes of hardening and softening of Cr and Cr-Mo nitrogen-containing (0,11 % N) steels have been studied by hot compression and hardness tests, and structure investigations. The effect of hot deformation regimes on the structure and properties of quenched and tempered heat-resistant steels was determined. The time-temperature ranges for the processes of aging and nitride dissolution are determined. Stress - strain diagrams have been obtained and maps of maximum true strains during hot deformations, as well as hardness maps after thermomechanical treatment of Cr11N and Cr11Mo1N steels have been developed. The diagrams and maps are useful to establish thermomechanical treatment regimes and to control the steel structure and properties.

16. M. Pirnat*,, J. Medved*, P. Mrvar*;** **Faculty of Natural Sciences and Engineering University of Ljubljana, Ljubljana, Slovenia***,** ***CIMOS Titan livarna z obdelavo d.o.o, Kamnik, Slovenia*
Thermodynamic Analysis of Solidification and Malleablizing of White-Heart Malleable Cast Iron. The aim of this work is thermodynamic analysis of both phases at making castings from the white-heart malleable. We followed the solidification and cooling, and in the second phase the malleablizing of the cast iron. The result of this manner of the solidification is cast microstructure, which depends on the composition of the malleable and on the calling rate, which is formed at the solidification and eutectoid transformation. The cast microstructure is changed during the process of malleablizing. For the thermodynamic analysis of the white-heart malleable at different conditions we used (Thermo-Calc) computer simulation method, „in – situ" dilatometry, simultaneous thermal analysis and laboratory dilatometric analysis. We examined our specimens with optical microscopy and performed certain mechanical analysis. The aim of these investigations is to create a model of solidification, cooling and malleablizing of white-heart malleable. With this model it is possible to determine the share of microstructure parts of thick-walled and thin-walled casting at known temperature, what in practice presents grate importance in determining the times of the malleablizing, in attaining of required mechanical properties and in optimizing of the process.

17. J. Bernetič*,, L. Kosec**, J. Triplat*, M. Klinar*, B. Kosec**, I. Anžel***, E. Bricelj*;** **SW ACRONI d.o.o., Jesenice, Slovenia, ** Faculty of Natural Sciences and Engineering University of Ljubljana, Ljubljana, Slovenia, *** Faculty of Mechanical Engineering University of Maribor, Maribor, Slovenia*
Surface Defects of Titanium Stabilized Austenitic Stainless Steel. In the present work surface defects of titanium stabilized austenitic stainless steel were investigated. Inclusions formed during reoxidation and continuous casting is main cause of coil rejection. Slivers promote cracking and impeach the formability properties of steel. As far as the surface quality is concerned, it is generaly observed that titanium stabilized austenitic stainless steels are more sensitive to sliver's formation than other steel grades. As far as laminations are concerned, they are due to the entrapment of slag or exogenous inclusions, and they are more frequent in the first slab of a heat. Sampling points included the VOD vessel after FeTi adition, tundish and mould. Testing samples were also taken from slabs, hot rolled and final plates. Testing samples were examined using optical and scanning electron microscopy in order to determinate chemical and phase composition of non - metallic inclusions during steel - making process.

18. A. I. Gordienko, I. L. Pobol, V. L. Krasikov; *Physical-Technical Institute National Academy of Sciences, Belarus*
Reprocessing of Punching Waste Products for Producing of Medical Implants. The electron beam melting (EBM) is widely used for manufacturing pure metals. The improvement of material characteristics is connected with their purification by removing the nonmetallic inclusions, impurities and gases. This makes the use of EBM promising for reprocessing of waste products of machining and pressure processing. The EBM application becomes more significant taking into account high cost of superalloys and increased requirements to product properties. On hot punching and machining of implant parts, waste reaches 10 to 30 %. The opportunity of waste Co-Cr-Mo products re-use by EBM is of substantial efficiency. The effect of EBM of Co-Cr-Mo waste on its structure and mechanical properties is investigated. EBM promotes softening of the modified alloy that can serve as estimation of improving its technological properties.

19. A. I. Gordienko, I. L. Pobol, A. I. Pokrovsky; *Physical-Technical Institute National Academy of Sciences, Minsk, Belarus*
Gradient Structure Formation in Deformed Iron During Electron Beam Treatment. Hot plastic deformation of deformable iron followed by EB surface melting ensures obtaining of gradient structure distribution. Hot plastic working of iron promotes simultaneous increase in strength and plasticity. When cast iron with 500 MPa tensile strength and 4 % relative elongation is subjected to deformation with a degree of 80 % it is possible to obtain the same parameters equal to 1000 MPa and 7 %, respectively. EB melting forms a layer with ledeburitic fine-grained structure. In a part core a volume structure of gray or high-strength iron (having 1500v - 2500 MPa microhardness) is retained and a white iron layer (16 - 17 GPa) is formed on a surface. It allows increasing the wear resistance of such surface up to 10 times as compared with as-volume quenched conditions.

20. B. Arzenšek, F. Tehovnik, M. Kmetič, B. Arh, B. Pirnar*, A. Kosmač*; *Institute of Metals and Technology, Ljubljana, Slovenia, *Acroni, d.o.o., Jesenice, Slovenia*
Hot Processing of Duplex Stainless Steel. Duplex stain1ess steel is composed of ferrite and austenite in approximately equal parts of 50 %. The phases have different deformation abilities that can cause troubles at hot rolling of the steel. The aim of the work was to establish deformation properties of the steel by experimental rolling and to determine parameters for industrial hot rolling process. All experiments were made on SAF 2205 steel at temperatures 850 to 1250 °C. The characteristics were ascertained by rolling of flat and wedged specimens. After rolling the specimens were water or air cooled and annealed. Properties of rolled steel welt established by metallographical investigations, measurement of ferrite part, hardness measurements and impact toughness. From the results it was ascertained that the steel has superior deformation properties in temperature range of 950 to 1100 °C.

Powder metallurgy

21. O. M. Ivasishin, O. N. Gerasimchuk*, B. A. Gryaznov*; *G. V. Kurdyumov Institute for Metal Physics, National Academy of Science of Ukraine, Kiev, Ukraine; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*
Fatigue Strength of Ti-6Al-4V Alloy. We have studied fatigue characteristics of Ti-6Al-4V alloy synthethized by the simplest powder metallurgy technology including processes of pressing and pressure sintering of powder mixtures based on titanium hydride. The powder material has relatively fine grains of β-phase which, despite availability of residual voids, provide quite high endurance limit (500 MPa) comparable with that of the respective cast alloy. Sites of crack initiation in powder alloy are such stress raisers as the largest voids emanating to the surface of specimen work portion. Application of the given P/M technology makes it possible to ensure cost-effective production of titanium alloys and products with satisfactory static and dynamic mechanical characteristics, which are suitable for their practical application.

22. V. A. Borisenko, V. V. Bukhanovskii, I. Mamuzić*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine; *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*
Correlation Dependences between Short-Term/Long-Term Static Strength Characteristics and Creep Resistance of Tungsten at High Temperatures. Experimental data on high-temperature mechanical properties under uniaxial tension of commercially pure tungsten obtained by powder metallurgy have been analysed. It has been found that for powder metallurgy tungsten in the high-temperature region ~ $(0{,}5 - 0{,}8)T_{melt}$, there is a close correlation among the characteristics of short- and long-term static strengths and creep resistance which are described by a single functional relation.

23. E. Hryha, E. Dudrova, R. Bidulsky; *Institute of Materials Research of the Slovak Academy of Sciences, Košice, Slovakia*
Influence of Powder Morphology on Compressibility of Prealloyed Atomized Powders. The compressibility of metal powders depends on many factors, including morphological and mechanical properties of particles. Alloying of the powders by chromium and manganese has a slightly lowering effect on the compressibility due to strength increasing of the ferrite. Quantification of compacting behavior was performed using compaction equation: $P = P_0 \cdot \exp(-K \cdot p^n)$ [Parilak et al.] and evaluated by dependence of K and n parameters on pressing pressure; P - porosity at pressure p; P_0 - apparent porosity; K and n are parameters related to particle morphology and plasticity of powder particles. Differences in the density values at the pressing pressure 600 MPa are low; tested powders exhibited dissimilarity mainly during the first compaction stage.

24. R. Bidulsky, E. Dudrova; *Institute of Materials Research of the Slovak Academy of Sciences, Košice, Slovakia*
The Behaviour of Manganese Powders During Pressing. The aim of the present paper to analyze compressibility of manganese admixed systems. The equation proposed by Parilak, Dudrova and Rudnayova and verified by Dudrova-Bidulsky-Kabatova $P = P_0 \cdot \exp(-K \cdot p^n)$ was used. Where P_0 is the relative apparent density and p is applied pressure; K and n are the parameters with defined physic-metallurgical substance. The values of the parameters K and n were determined by regression analyses, while the correlation coefficients r of experimental compaction curves were from 0,9884 to 0,9995. The correlation coefficient for the manganese admixed systems was higher than $r = 0{,}97$. The results of compressibility show the slight influence on compressibility of manganese in admixed systems.

25. L. Čajková, M. Kabátová, E. Dudrová; *Institute of Materials Research of SAS Košice, Košice, Slovakia*
Failure Resistance and Fracture Toughness of Fe-Cr-Mo Sintered Steels. The application of sintered structural components in automotive industry requires high failure resistance characterised by the parameters of the fracture toughness. Within this work the effect of both carbon content (0,3, 0,5, 0,7 %) and test conditions on fracture toughness of the Fe-1.5Cr-0.2Mo sintered steels (sintered at 1180 °C; density of ~ 7.0 $g \cdot cm^{-3}$) with yield, tensile and bend strengths in the ranges of 440 - 600, 580 - 790 and 920 - 1300 MPa was investigated. The values of the fracture toughness were in the range from 32 to 40 $MPa \cdot m^{1/2}$. The validity of the K_{IC} values is discussed from the viewpoint of dominant failure mode and type of pre-cracking used for test specimens (fatigue crack and electro-spark crack $r = 0{,}1$ mm).

Physical metallurgy

26. V. V. Bukhanovskii, V. K. Kharchenko, I. Mamuzić*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine; *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*
The Mechanisms of Plastic Deformation and Strength of Niobium-Based Alloys in a Wide Temperature Range. The authors have studied the mechanisms of plastic deformation and established dependences of the characteristics of short- and long-term static strength, creep resistance, and fracture behavior of low- and medium-alloyed niobium-based alloys (Nb-Mo-Zr, Nb-W-Mo-Zr, Nb-W-Mo-Ta-Re-Zr, Nb-W-Mo-V-Ta-Zr, and Nb-W-Mo-Zr-B) on their chemical composition and structural state, as well as manufacturing and service factors determining the latter (heat treatment conditions, welding technology, application of heat-resistant protective coatings, and action of high-temperature aggressive gaseous media) in the temperature range from 290 to 2270 K.

27. V. V. Bukhanovskii, L. M. Bukhanovskaya, I. Mamuzić*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine; *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*
The Effect of Structure on Short-Term Strength and Fatigue Resistance of Molybdenum Alloys and Their Welded Joints. The paper analyzes the experimental data on the short-term static and high-cycle strength of thin sheets of low-alloyed molybdenum alloys (Mo-Al-B, Mo-Zr-B, and Mo-Zr-Hf-B) taking into account the structural state of the materials and manufacturing factors determining their state, specifically the conditions of heat treatment and welding. For these alloys, empirical correlations between the fatigue strength, offset yield strength, and grain size have been established.

28. G. G. Pisarenko, I. M. Vasinyk, A. V. Voinalovich, P. M. Kopchevsky, A. N. Maylo; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*
The Characteristics of Local Inelasticity of Metall Alloys under Cyclic Loading. Macrocharacteristics of physical-mechanical properties

of polycrystalline alloy are integral by the expressed descriptions of separate structural elements of material. The change of distributing of microproperties of such structure at a fatigue possesses definite conformity to the law, depending on evolutions of microstructure. The work suggests a methodological approach for characteristics evaluation of inelasticity of metal alloys in accordance with changes of parameters of random distribution of microcharacteristics of a damaged material, achieved by the acoustic research method.

29. N. K. Kucher; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
The Model of Strain Hardening Theory for Describing Isothermal Deformation Processes. A version of the hardening theory considering the damage accumulated in a material is proposed, which provides describing the cyclic deformation processes. As an evolutionary relationship, the known J. Lemaitre and A. Plumtree's equation with a scalar damage variable is utilized. The parameters of the creep equation and evolution relationship are supposed to be the functions of stress and temperature. A procedure for determining the above material characteristics has been developed. The efficiency of the procedure is illustrated in describing creep curves for 20Kh13 and EP44 steels in a sufficiently wide stress range.

30. N. K. Kucher; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
Refining of Constitutive Equations of Strain Hardening Theory for Non-Isothermal Deformation Processes. The paper considers a version of the hardening theory to predict the processes of non-isothermal deformation. The parameters of the constitutive equations are postulated to depend on stress and temperature. The effect of the loading history on the variation in the creep rate is taken into account using the scalar function of accumulated damage. A procedure for refining constitutive relationships of the isochronous creep theory, developed on the basis of creep test results for materials in sufficiently wide ranges of constant stresses and temperatures, is proposed. The potential of the procedure is demonstrated in describing the creep of 12Kh18N10T steel and VT6C aluminium alloy at a fixed stress and temperature and also in predicting the isothermal creep for 20Kh13 steel at a linearly varying stress. Comparison with the results of similar calculations for constant parameters of the constitutive relationships is presented and the advantages of the approach proposed are shown.

31. L. V. Kravchuk, R. I. Kuriat, K. P. Buyskikh, Ye. A. Zadvornyy, S. G. Kiselevskaya; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
Analysis of Mechanisms of Initiation and Development of Thermal Fatigue Cracks in Structural Elements of Superalloys. The authors have investigated the initiation and propagation of thermal fatigue cracks due to surface damages of various kinds and their influence on the stress-strain state of considered structural elements. The results obtained give a qualitative picture of the effect of damages in the coating on the durability of structural elements and enable describing possible approaches to solving the problems of operation of structures and estimation of their life from their condition.

32. A. I. Babutsky, G. V. Chyzhyk; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
The Influence of Impulse Electric Current Treatment on Microhardness Distribution in Metals. The results of microhardness measurements for low carbon steel, pure aluminum, aluminum alloy, copper, molybdenum and tantalum treated by impulse electric current are presented. It is shown, that electric current treatment leads to the reduction of microhardness scattering. This can be a reason of metal strength enhancing which accompanies above treatment. The results of the treatment were analyzed using the "loading - strength" statistical approach.

33. V. Z. Kutsova, O. A. Nosko; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Influence of Heat Treatment on the Structure and Properties of Alloyed Semiconducting Silicon. The structure and microhardness of unalloyed monocrystal semiconducting silicon and silicon alloyed with B, Sn, Ge, Hf, Zr and B+Sn, M+Mo after different regimes of heat treatment was investigated. It was shown that heat treatment of mono-silicon and silicon alloyed with B, Sn, Ge, Hf, Zr and B+Sn, B+Mo in the subcritical temperatures area suppresses of the second phases formation, decreases of boath amount and changes of dislocation density and microhardness. It ought to improve of the electro-physical properties of semiconductors.

34. I. M. Galushko; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Influence of the Primary Crystal's Share on the Kinetics of Peritectical Structure's Building. The kinetics of peritectical structure's building in crystallizing melts of various structures of the Cu - Cd system is investigated. It is revealed that, under conditions of slow cooling of the melt, the output of the peritectical reaction ε decreases with increase in the share of primary crystals η. The presence of the dependence $\varepsilon = f(\eta)$ is explained by a change of the speed of the peritectical reaction on hardening the melts of different structures. The expression describing this dependence is deduced.

35. I. M. Galushko; *National Metallurgical Academy of Ukraine, Dnepropetrovsk , Ukraine*
The Application of Irreversible Thermodynamic Processes for the Description of Peritectic Structure's Building. The application of the equations of linear irreversible thermodynamic processes for the description of development the phase transformation in peritectic system's crystallizing melts is showed. The concept "the affinity of the reaction", playing a role of generalized force, which causing development of reaction, is introduced. The accounts of peritectic reaction's affinity for some peritectic systems of alloys are given. The influence concentrationing fluctuations on stability of the thermodynamic branch is analyzed.

36. A. P. Gopkalo; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*
Investigation of the Cyclic Crack Growth Resistance of Materials under Nonisothermal Conditions. A procedure for testing the crack growth resistance of material specimens under nonisothermal conditions with a possibility to change the phases of cyclic heating and mechanical low-cycle loading has been developed. For a structural steel the results obtained reveal a triple increase in the fatigue crack growth rate in the case of the in-phase mechanical loading and cyclic heating as compared to the out-of-phase loading. It is demonstrated that due to the dependence of elasticity modulus and yield strength on the temperature during each cycle of nonisothermal loading, of importance is the kinetics of the size of the plastic zone at the crack tip the maximum values of which differ by a factor of 1,75.

37. D. Živković, D. Manasijević, Ž. Kamberović*, M. Cocić*, B. Marjanović; *Technical Faculty Bor University of Belgrade, Bor, Serbia and Montenegro, *Faculty of Technology and Metallurgy University of Belgrade, Belgrade, Serbia and Montenegro, **Copper Institute Bor, Bor, Serbia and Montenegro*

Thermodynamics and Structural Investigation of the Ag-InSb System. The Ag-In-Sb ternary system presents one of possible lead-free solder candidates. Therefore, the results of thermodynamic study of the alloys in the Ag-InSb alloys, obtained using general solution model, are presented in the paper. Obtained data for partial and integral molar thermodynamic quantities in the temperature interval 1000 - 1200 K are given. The characterization of these alloys have been done using DTA, XRD, SEM and optic microscopy, which enabled the construction of the Ag-InSb phase diagram in the concentration range up to 60 wt % Ag.

38. T. Kvačkaj, I. Mamuzić*; *Faculty of Metallurgy Technical University of Košice, Košice, Slovakia, *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*

Development of bake Hardening Effect by Plastic Deformation and Annealing Conditions. The paper deals with the classification of steel sheets for automotives industry on the basis of strength and structural characteristics. Experimental works were aimed to obtain the best possible strengthening parameters as well as work hardening and solid solution ferrite hardening, which are the result of thermal activation of interstitial carbon atoms during paint-baking of auto body. As resulting from the experimental results, the optimal treatment conditions for the maximal sum (WH+BH) = 86 MPa are as follows: total cold rolling deformation ε_{cold} = 65 %, annealing temperature $T_{anneal.}$ = 700 °C.

39. Y. Sidor, F. Kovac, V. Petrychka; *Institute of Materials Research of Slovak Academy of Sciences, Košice, Slovakia*

Secondary Recrystallization in Non-Oriented Electrical Steels. Modelling of kinetics of grain growth process after primary recrystallisation in different types of non-oriented electrical steels is discussed. The ferrite grain growth behavior during secondary recrystallization was analysed by applying the general equation for grain growth. The activation energy for grain boundary motion in both semi-processed and fully processed steels was calculated. An idea of anisotropic mobility's is applied to the columnar grain growth description. It is shown that the value of activation energy for columnar grain development along progress normal direction is higher than the one for rolling direction.

40. L. M. Kaputkina, V. G. Prokoshkina, Yu. I. Lozhnikov; *Moscow State Steel and Alloys Institute (Technological University), Moscow, Russia*

Hot Strain Diagrams of Nitrogen-Containing Steels and their Thermomechanical Treatment. The structure and phase transformations and strengthening in nitrogen-containing corrosion resistant steels resulting from thermomechanical treatment, as well as following tempering processes, have been investigated using X-ray diffraction analysis, optical and electron microscopes, hardness measurement and tensile tests. Hot compression stress-strain diagrams for industrial steels are obtained for the range of austenitization temperatures and strain rates of 10^{-2} to 10 s^{-1}. Alloying by nitrogen increases hot and cold strain hardening and retards polygonization and recrystallization processes under hot deformation conditions. The constructional strength diagrams for thermally and thermomechanically treated nitrogen-containing and similar nitrogen-free steels of various structure classes and applications are built. The schemes and regimes of thermomechanical strengthening treatment are proposed.

41. I. Kladarić, D. Krumes, I. Vitez; *Mechanical Engineering Faculty in Slavonski Brod University of Osijek, Slavonski Brod, Croatia*

The Influence of Retained Austenite on Precipitation Hardening of Maraging Steel. Study of the influence of multiple solution-annealing on kinetics of structural transformation of maraging steels has observed that procedures of solution annealing are not totally reversible. Recurrent solution annealing results the increase of the residual austenite share in maraging steel structure. In this paper the influence of retained austenite on precipitation hardening of maraging steels X2NiCoMo18-9-5 was searched. The laboratory experimental tests have shown that the growth of the retained austenite share in the maraging steel structure results the decrease of the hardness after aging.

42. O. O. Kochubey, I. Mamuzić*, M. V. Polyakov, D. V. Yevdokymov; *Dnepropetrovsk National University, Dnepropetrovsk, Ukraine, *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*

Numerical Calculation of Slow Solid-State Phase Transition. Solid-state phase transitions are widespread in material processing technologies, for example, hardening of metals. The present consideration is restricted by slow phase transformations, calculation method for which was proposed in the previous works by authors. After the temperature field is determined by boundary element method, a thermoelastic contact problem can be solved by boundary element method too. The considered problem is illustrated by several examples.

43. O. O. Kochubey, I. Mamuzić*, T. E. Smolens'ka, D. V. Yevdokymov; *Dnepropetrovsk National University, Dnepropetrovsk, Ukraine, *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*

Asymptotic Analysis of Fast Phase Transitions. In dependence on Stefan number all phase transitions can be considered as slow (small Stefan number) and fast (large Stefan number). Slow phase transitions are widespread in nature and technologies and there are a lot of methods of their calculations, including asymptotic methods. However fast phase transitions are quite seldom phenomena and methods of their calculations are not developed yet. The present work is the first attempt to build an asymptotic mathematical model for fast phase transitions. The Stefan problem for fast phase transition is reduced to a series of Cauchy problems. It is managed to show that zero approximation in this case doesn't depend on boundary conditions on the outer boundaries of phases; it depends on only initial conditions and heat source terms. Results of the present work may be interesting for investigation of high intensive thermal processes.

44. G. Kosec, A. Smolej*, F. Vodopivec, J. V. Tuma**;** *SW ACRONI d.o.o., Jesenice, Slovenia, *University of Ljubljana, Faculty of Natural Sciences and Engineering, Ljubljana, Slovenia, **Institute of Metals and Technology, Ljubljana, Slovenia*

Austenite Transformation of Niomol 490k Steel. The influence for the upper transition temperature of toughness in the weld area is the transformation of coarse grained austenite to upper bainite. The supposition can be tested with the measurements of toughness for the potentially the most brittle microstructures in the heat affected zone (HAZ) of the weld. Reliable data about connection between the microstructure and toughness is available only for the microstructures where they are formating at transformation at cooling for normalisation, and at cooling of structural steels at hot rolling. Set of tests has been done to determine if it is possible to achieve requested microstructures.

45. V. Stoyka, Y. Sidor, F. Kovac; *Institute of Materials Research of the Slovak Academy of Sciences, Košice, Slovakia*
Effect of Second Phase Particles Topology on the Onset Temperature of Abnormal Grain Growth in Fe – 3%Si Steels. The relations between regimes of dynamic annealing, state of secondary particles system and the onset temperature of abnormal grain growth are investigated. Two types of Fe-3%Si grain-oriented steels were used as experimental material. The first type of GO steel shows a sufficiently stabile fraction of precipitates during the heat treatment. The density of second phases is drastically increased after annealing in the second type of the investigated material. The obtained results show that abnormal grain growth in material with certain fraction of second phase particles occurs at specific annealing temperature. Texture and magnetic properties of the investigated samples are appreciated within current study.

46. J. Malina, A. Begić Hadžipašić, M. Malina; *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*
Hydrogen Diffusion in Structural Steels. In this work hydrogen permeation measurements were performed with three low-alloyed structural steels aimed at different purposes. The influence of microstructure on the behaviour of metal in interaction with hydrogen was studied, as it is known that sudden cracking of steel constructions are often the consequence of hydrogen resulting from metal's corrosion. Transport properties of absorbed hydrogen were investigated by laboratory permeation technique with steel membrane between hydrogen entry side and hydrogen exit side. H-permeation values obtained are interpreted based on the trapping theory of HIC. It was shown that steels having the microstructure with more effective traps both delay hydrogen diffusion through steel and reduce the permeation rate of hydrogen atoms.

47. D. Steiner Petrović, M. Jenko, M. Godec, F. Vodopivec, M. Jeram*, V. Prešern*; *Institute of Metals and Technology, Ljubljana, Slovenia, *Acroni d.o.o. Jesenice, Slovenia*
The Influence of Copper on the Mictotexture of the Fe-Si-Al Alloys for Non-Oriented Electrical Steels. The microtexture of the Fe-Si-Al alloys which are used for non-oriented electrical steels was examined. The materials used in the study were copper containing laboratory manufactured Fe-Si-Al alloys and the industrial samples of non-oriented electrical steels with a range of copper content (from 0,01 to 0,60 wt. % Cu). The samples were in the form of cold-rolled steel sheets, after decarburization and recrystallization-annealing. Using EBSD method (electron backscattered diffraction) we determined the microtextures of the Fe-Si-Al alloys with copper content and without it. We found that the microtextures of the alloys containing copper had fewer crystal grains oriented with an easy axis of magnetization, which has a negative influence on the magnetic properties of such a soft-magnetic material.

48. A. I. Pokrovsky; *Physical-Technical Institute National Academy of Sciences, Minsk, Belarus*
Structure Formation of Iron During Hot Plastic Deformation and Develoment of Technology for Production of High-Quality Items. The relationships have been determined between structure and properties of irons after their subjecting to casting, deformation and thermal treatment. Owing to deformation of iron its properties are improved by a factor of 1,5 to 2 and approach the level of alloyed steels. For instance, the values achieved for a high strength iron are as follows: σ_B = 1550 MPa, δ = 9 %. The specific features of graphitization and bainite transformation kinetics of a deformed iron have been investigated. The casting-deformation technology developed for manufacturing parts from iron involves obtaining a casting, its preliminary thermal treatment and mechanical working, heating and plastic deformation in a special die tooling and finishing thermal treatment and mechanical working.

49. F. Tehovnik, B. Arh, B. Arzenšek, D. Kmetič, S. Jakelj*; *Institute of Metals and Technology, Ljubljana, Slovenia, *Acroni, d.o.o., Jesenice, Slovenia*
The Recrystallization of Austenitic Stainless Steels. 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 tensile tests and rolling experiments with wedged specimens. The fraction of the recrystallization was determined by metallographic investigation and the degree of mechanical softening.

Mechanical properties

50. V. V. Bukhanovskii, L. M. Bukhanovskaya, I. Mamuzić*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine; *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*
Interrelation between the Short- and Long-Term Static Strength and the Creep Resistance of Niobium-Based Superalloys. The authors have performed a joint analysis of the experimental data on high-temperature mechanical properties and fracture patterns of low- and medium-alloyed niobium-based alloys (Nb-W-Mo-Zr), produced by vacuum-arc melting, in the recrystallized and cast conditions under uniaxial tension. The characteristics of short- and long-term static strength, plasticity, and creep resistance of the materials under study in a high-temperature region $(0,5 - 0,8)\cdot T_{mp}$ have been found to correlate closely. Both partial and generalized empirical relations between the high-temperature strength of the alloys and their ultimate strength and relative elongation in short-term static tension, which are unaffected by the structural state and fracture behavior of the material, have been obtained.

51. V. V. Bukhanovskii, V. K. Kharchenko, I. Mamuzić*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine; *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*
High-Temperature Creep Resistance of Molybdenum Alloy (Mo-Ti-Zr-C). The authors have studied the characteristics of short-term static strength and second creep resistance of low-alloyed molybdenum alloys VM-1 (Mo-Ti-Zr-C) in a temperature range of 1820 - 2270 K. The values of 0,5 % and 1,0 % creep limits of the alloy for loading times of 10^2, 10^3, and 10^4 s at temperatures of 1820, 2120, and 2270 K have been obtained. Generalized empirical correlations between the characteristics of short-term strength, plasticity, and creep resistance of the alloy in the temperature range under study are proposed.

52. V. A. Borisenko, V. V. Bukhanovskii, R. Križanić*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine; *Tube Rolling Mill, Sisak, Croatia*
Strength, Creep Resistance, and Plasticity Characteristics of Low-Alloyed Temperature Zirconium Alloy in a Range of 290 - 690 K.

The paper outlines the methods and results of studying the deformation behavior, strength, creep resistance, and plasticity of pipes of zirconium alloy Zr + 1,0 wt. % Nb, produced by way of calciothermic reduction of zirconium tetrafluoride with subsequent electron-beam remelting and refining, under short- and long-term static loading at room and elevated temperatures.

53. V. V. Bukhanovskii, V. K. Kharchenko, I. Mamuzić*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine; *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*

The Effect of Structural State, Temperature, and Test Conditions on Mechanical Characteristics of Molybdenum Alloy (Mo-V-C). The paper presents the data on strength and plasticity of molybdenum alloy (Mo-V-C) in different structural states within a temperature range of 290 - 2520 K. The conditions of high-temperature short-term static tests (heating rate, the hold time of specimens before loading to create a uniform high-temperature field, strain rate) have been found to influence considerably the experimental results.

54. V. V. Bukhanovskii, I. Mamuzić*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine; *Faculty of Metallurgy University of Zagreb, Sisak, Croatia.*

Strength and Creep of Welded Joints of Low-Alloyed Molybdenum Alloys in High-Temperature Cyclic Tension. The paper presents the data on some cyclic creep and low-cycle fatigue characteristics of the cast weld metal of joints formed by welding low-alloyed molybdenum alloys (Mo-Al-B, Mo-Zr-B, and Mo-Re). The data have been obtained in high-temperature cyclic tension and compared with the similar parameters of the base metal. It has been shown that the experimental data obtained can be satisfactorily described by analytical expressions using equivalent stresses and data of static creep and long-term strength tests for the analogous temperatures. Some analytical expressions for stresses equivalent to those for a trapezoidal loading cycle have been derived on the basis of the time-dependent and energy-based criteria.

55. V. V. Bukhanovskii, L. M. Bukhanovskaya, I. Mamuzić*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine; *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*

The Effect of Plastic Prestrain on Mechanical Characteristics of Titanium Alloys under Static Loading in a Wide Temperature Range. The paper reports the results of an experimental study of the dependences of ultimate strength, offset yield strength, relative elongation, and relative uniform strain of VT 1-0, OT 4-1, and PT 7M titanium alloys on the plastic prestrain value in a temperature range of 290 - 1270 K. The plastic prestrain has been found to considerably affect the mechanical characteristics of titanium alloys in the temperature range from 290 to 770 - 970 K. The highest sensitivity to plastic prestrain is exhibited by offset yield strength and relative uniform strain of the alloys.

56. A. Ševčík, J. Ševčíková*; *Istitute of Material Research SAS, Košice, Slovak republic, *Department of material science HF TU in Košice, Košice, Slovak republic*

Fracture Behaviour of Low Carbon Steels in the As-Cast State at High Temperatures. High temperature properties of low carbon steels in the as-cast state were investigated by high temperature tensile tests in a temperature region from 850 - 900 °C up to the melting temperature at a deformation rate of $4{,}7 \cdot 10^2\ s^{-1}$ A reduction of area values drop was established at lower testing temperatures, from 850 up to 1190 °C, and at the very high ones, from 1290 up to 1410 °C. At lower testing temperatures, intercrystalline fractures were formed. The plasticity drop at very high temperatures was accompanied by formation of intercrystalline decohesion fractures, interdendritic fractures, and fractures with mixed morphology. The interdendritic fracture formation was promoted by increasing the C and N content in the steel.

57. A. Ševčík, J. Ševčíková*; *Istitute of Material Research SAS, Košice, Slovak republic, *Department of material science HF TU in Košice, Košice, Slovak republic*

Statistical Calculation of the Reduction of Area Values Drop at High Temperature Testing of Low Carbon Steels in the As-Cast State. High temperature properties of low carbon steels in the as-cast state were investigated by high temperature tensile tests in a temperature region from 850 - 900 °C up to the melting temperature. The plasticity was evaluated as reduction of area values. Characteristic points were determined on the curve of reduction of area values vs. temperature. These parameters were then statistically analyzed. It can be followed from these analyses that at lower testing temperatures the temperature of plasticity loss predominantly increases with the increasing of as content and the austenite grain size. At very high temperatures the temperature of the reduction of area values drop is primarily influenced by the P content via weakening strength of the grain boundaries and by liquid phase formation.

58. F. F. Giginyak; *Pisarenko Institute for Problems of Strength National Academy of Sciences of Ukraine, Kiev, Ukraine*

Cyclic Creep and Low-Cycle Fatigue of Pressure Vessel Steels at a Complex Stress State under Conditions of Corrosion. On the basic of the results of experimental investigation on heat-resistant steel 15Kh2MFA at a complex stress state under cyclic loading and under the action of corrosive medium in the temperature range from 20 to 270 °C, the regularities of the deformation and fracture processes for the above steel have been studied

59. N. P. Rudnitskii; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*

Correlation between the Strength Characteristics and the Hardness of AK29 Steel at High Temperatures. Changes in the strength characteristics, namely, the 0,2 offset yield strength, hardness, and ultimate strength upon healing, are controlled by the same mechanisms, whose temperature ranges are the same for these quantities. We determined the coefficients of regression equations that relate hardness to other strength characteristics of shipbuilding steel for each temperature range. We experimentally determined the relation between the changes of the strength characteristics and the hardness of AK29 steel in a temperature range of 290 - 1300 K and the correlation between them.

60. G. V. Stepanov; *Pisarenko Institute for Problem of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*

Strength and the Fracture of Structural Materials under Impact Loading. The brief review of the main investigations, executed in the Institute, on strength and plasticity of structural materials and their specific behavior at the high strain (up to $10^5\ s^{-1}$, caused by the impulse loading of the impact and explosive nature is given in the presentation. Main features of the metal deformations under such loadings are examined which include: the nonstationary nature of the stress-strain state, caused by the propagation of elastic-plastic and shock waves; the wide range band of stress intensity, high pressure (up to 20 GPa), and high strain rate as well as accumulation of damages in the material; the initiation

and the development of a numerous regions of plastic strain localization in the result of plastic deformation instability, accelerated with the temperature increase during adiabatic plastic flow.

61. V. A. Strizhalo; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
Mechanical Behavior of Metals and Alloys under Conditions of Deep Cooling down to 4,2 K. On cooling, the main competitive processes occurring in metals and determining the character of variation in their properties are low-temperature hardening and embrittlement. Therefore, in designing structures to be operated at cryogenic temperatures it is necessary to allow for the ratio between the intensities of these effects and assess the possibility of neutralization of material hardening by embrittlement. It is shown that for Cr-, Ni-, Al-, and Ti-based alloys intended for low-temperature use, which have no cold brittleness threshold in the temperature range from 293 to 4,2 K, consideration of the low-temperature hardening makes it possible to essentially increase stresses in strength calculations and reduce the material consumption of structures.

62. E. V. Vorob'ev; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*
Assessment of Limit States of Structural Alloys Connected with the Realization of Low-Temperature Discontinuous Yielding Effect. The paper presents a systematization and classification of limit states and corresponding criteria characteristics determined during the realization of the low-temperature discontinuous yielding effect in metals considering many relevant factors and its stagewise nature. The authors show that in this case, the only acceptable measure of the material strength is the lower critical stress corresponding to the lower peak of the jump. Ultimate strength cannot be used to determine allowable stress.

63. V. V. Krivenyuk; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*
Correlation and Extrapolation Methods for Creep Rupture Data. Based on the interpolation processing of more than 1,000 creep-rupture diagrams obtained at the National Institute for Materials Science in Tokyo (NIMS), creep-rupture strength was predicted by the parametric methods and the MBD (MBD-1 was used to extrapolate short-term creep-rupture data to longer times by one order of magnitude and MBD-2 by two, three, and more orders). Comparison of the results showed the predictions by the parametric methods to be somewhat better. This is, to some extent, due to a less number of constants used in calculations by the MBD and, in the case of MBD-2, longer times.

64. G. V. Tsyban'ov, Yu. P. Kurash; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
Experimental Study of Fretting Processes in Materials. For the comprehensive study of fretting fatigue in materials it is necessary to determine both all the loading parameters, which accompany fatigue, contact, and friction under fretting conditions, and the parameter, which characterizes the processes of nonmechanical character. To solve this problem, the authors proposed a procedure for fretting-fatigue testing of materials, which allows one to vary and control the friction force, sliding amplitude, and contact force. The authors also justify the use of the magnitude of electric microcurrents occurring in the contact zone in the course of testing as a parameter for the evaluation of the level of the processes of nonmechanical nature. In order to obtain all the above data in real time, the information about the parameters is accumulated in a computer and preliminary processed.

65. V. V, Bukhanovskii, I. Mamuzić*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine, *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*
Low-Cycle Strength and Cyclic Creep of a Molybdenum-Tungsten Alloy upon High-Temperature. The characteristics of low-cycle strength and cyclic creep of a Mo-30%W-NbC-C alloy produced by powder metallurgy are studied at temperatures of 1770, 2020, and 2270 K. In this temperature range the unified dependence of the cyclic steady-state creep rate on the ratio of the equivalent stress to the yield strength of the material at a certain temperature is obtained. Moreover, the generalized curve of the low-cycle strength of the alloy is constructed. The cyclic character of the loading accelerates the processes of directed plastic deformation and fracture in the powder alloy by a factor of 1,5 - 7 as compared to the corresponding long-term static loading, with the curves of cyclic and static creep being qualitatively similar.

66. J. Slota, E. Spišák; *Faculty of Mechanical Engineering Technical University of Košice, Košice,Slovakia*
Determination of Flow Stress by the Hydraulic Bulge Test. In sheet metal forming operations the mechanical properties of the sheet metal (stress-strain curve, flow stress) greatly influence metal flow and product quality. Accurate determination of the stress-strain relationship is important in process simulation by finite element method. In this paper the sheet thickness gradation in different points of the hemisphere formed in the bulge test is analyzed, both theoretically and experimentally. A precise determination of sheet thickness at the pole is very important in the precise determination of stress-strain relationship. The use of the hydraulic bulge test for estimation of flow stress under biaxial stress-strain state is discussed.

67. M. Buršák, I. Mamuzić*; *Faculty of Metallurgy Technical University of Košice, Košice, Slovakia, *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*
The Influence of the Loading Rate on the Mechanical Properties of Drawing Steel Sheet. The paper analyzes the influence of the loading rate in the interval from 1 to 1000 mm/min on the mechanical properties of drawing steel sheet H260LAD with the gauge of 1 mm, used for the manufacture of automotive parts, under tension and bending conditions. It describes the aspects of material characteristics under tension and bending conditions, while bending tests were made on notched specimens (a modified impact bending test). The paper presents knowledge that using a modified notch toughness test it is possible to achieve the pressability (formability) characteristics corresponding to dynamic strain rates even under the static loading.

68. I. Mamuzić; *Faculty of Metallurgy University of Zagreb, Sisak, Croatia,*
Mechanical Properties of Blasted Steel Sheet. Blasting results in a change of properties of the substrate surface; among others, the strain hardening, the formation of residual stress and a change in the surface morphology take place in the surface layer. The paper deals with the influence of the blasted layer on the resulting mechanical properties of blasted steel sheet RSt 37.2 (11 523.1) with the thickness from 1,5 to 3 mm. While the sheet thickness decreases, the yield point exponentially increases and the deformation properties of blasted sheet decrease. The paper analyses the nature of these changes.

69. A. Ševčík; *Institute of Materials Research of the SAS, Košice, Slovakia*
High Temperature Strength Analysis of Low Carbon Steels in the As-Cast State. Results of the study of the influence of chemical composition and microstructure on the strength values at high temperature tensile tests are described and discussed. By increasing the testing temperature, strength values in the low carbon steel slab continually decrease. Mathematical description of the temperature course and scatter zone of strength values was realized. Influences of the chemical composition and grain size on the strength values in a temperature interval from 900 to 1500 °C with a step of 100 or 50 °C was established by means of regression analyses. These influences are temperature-dependent. Strength values at 1400 °C, which chiefly depend on the effective grain size, were thoroughly analyzed.

70. A. Ševčík, J. Macurák, J. Ševčíková*; *Institute of Materials Research of Slovak Academy of Sciences, Košice, Slovakia, *Faculty of Metallurgy Technical University of Košice, Košice, Slovakia*
High Temperature Mechanical Properties of the As-Cast Low Carbon Steels and Their Prediction. High temperature properties of as-cast material, as reduction of area and strength, were tested in a temperature interval from 850 °C up to the melting temperature on measuring equipment provided with high frequency heating. The software for prediction of the high temperature plasticity development based on physical metallurgical and regression analyses was elaborated for the cast state of low carbon steels. The program was verified by using experimentally estimated values.

71. E. V. Naidenkin, S. V. Dobatkin*, P. D. Odessky, Yu. R. Kolobov, G. I. Raab***, S. V. Shagalina*;** *Institute of Strength Physics and Materials Science of RAS, Sibirean Branch, Tomsk, Russia, *A. A. Baikov Institute of Metallurgy and Materials Science of RAS, Moscow, Russia, **Institute of Steel Constructions, Moscow, Russia, ***Ufa State Aviation Technical University, Ufa, Russia*
Mechanical Properties of Submicrocrystalline 0,1%C-Mn-V-Ti Steel at Elevated Temperatures. The mechanical properties of the submicrocrystalline 0,1%C-Mn-V-Ti steel taken in the bainitic and ferritic-pearlitic initial states were studied at temperatures 20- 700 ^{0}C after ECA pressing. The steel in the initially bainitic state, compared with the ferritic-pearlitic one, after ECA pressing exhibits higher strength characteristics at test temperatures ranging between 20 and 500 °C: $\sigma_{0.2}$ = 1125 and 870 MPa at T_{test} = 20 °C and 485 and 400 MPa at T_{test} = 500 °C, respectively. At T_{test} = 600 °C, the strength decreases to $\sigma_{0.2}$ = 150 MPa for both initial states. Thus, the 0,1%C-Mn-V-Ti steel after ECA pressing remains high-strength up to T_{test} = 500 °C. This work was supported by Grant ISTC № 2114.

72. Y. G. Andreev, V. Y. Turilina; *Moscow State Institute of Steel and Alloys (Technological University), Moscow, Russia*
Influence of Retained Austenite on Mechanical Properties and Fracture Resistance of the Maraging Steel. Mechanical properties, static fracture resistance and characteristics of fatigue property of high-strength maraging steel (0,03C-18Ni-9Co-5Mo-Ti) with various amount of retained aystenite were investigated. The retained austenite content in the steel may be controlled by aging in the two-phase ($\alpha+\gamma$) field at 480 - 650 °C. The magnetic method was applied to the measurement of volume fraction of retained austenite in the steel after heat treatment. Since a small amount of retained austenite influences the mechanical properties, crack resistance and fatigue behavior of the steel. The maraging steel structure containing small amount of retained austenite (2 - 10 % vol.) after a heat treatment with aging temperature at 500 - 560 °C provides a optimal combination of strength, static fracture resistance and fatigue properties.

73. M. Bursák, I. Mamuzić*, J. Micheľ; *Faculty of Metallurgy Technical University of Košice, Košice, Slovakia, *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*
New Approach to the Evaluation of Formability of Higher-Strength Strip Steels. The paper analyses the influence of the strain rate ranging from 10^{-4} to 10^{2} s^{-1} on the material characteristics of formability of galvanized sheet, made of micro-alloyed steel with the yield point of 220 - 380 MPa and the thickness of 1 - 2 mm. The influence of the strain rate on traditional characteristics of cold formability, determined using mechanical and technological tests, as well as modified tests, is determined. The result of the paper is the determination of a critical strain rate, exceeding of which results in decreased cold formability of the tested steels. The paper responds to current demands from the practice, namely decreasing the weight and increasing the strength, the corrosion resistance and the productivity of cold formed products.

Wet and dry corrosion, corrosion resistance

74. V. V. Bukhanovskii, V. K. Kharchenko, I. Mamuzić*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine; *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*
The Influence of Heat-Resistant Coatings on High-Temperature Strength of Niobium-Based Alloys (Nb-Mo-Zr-C). This paper examines the strength, deformability, and load-carrying capacity of niobium-based alloys VN-3 and VN-9 (Nb-Mo-Zr-C), both in the initial state and with ceramic slip coatings based on molybdenum-hafnium silicides, under conditions of short- and long-term static tension in vacuum, inert medium, and in air in the temperature range from 1770 to 2020 K. A method has been developed to assess the damage accumulated in the niobium alloy/silicide-ceramic coating composite under high-temperature loading. As a result of studying the creep and long-term strength of the niobium alloy/silicide-ceramic coating composite, the values of 0,5 % and 1,0 % creep limits of the composites for test times of 0,1; 1,0; and 10 hours at temperatures of 1770 and 2020 K have been obtained.

75. J. Ševčíková, M. Halama; *Faculty of Metallurgy Technical University of Košice, Košice, Slovakia*
Corrosion Resistivity of Hot-Dips Zinc Coated Steel in the Atmosphere. The contribution deal with evaluated results of corrosion degradation research of hot-dip zinc coated steel sheets and bimetallic couples of non-alloy steel - zinc steel. Samples were long-term corroded at atmosphere of town Košice (C3). Discussion goes through changes of electrochemical properties after chosen times of corrosion tests of these samples and govern also results of gravimetrical and metallographical analyses. Continual qualitative deep profile analyses of coating and its chemical composition before and after corrosion application in atmosphere were measured by GD-OES method. Quantitative analyses of chemical composition were determined by EDX analyses.

76. J. Ševčíková, A. Ševčík*; *Faculty of Metallurgy Technical University of Košice, Košice, Slovakia, *Institute of Material Research of the Slovak Academy of Sciences, Košice, Slovakia*

Metallographic Analysis of Materials used in Power Engineering Equipment. External surface of metallic materials of boiler pressure system is damaged by oxidation effect of flues, whereas the temperature decreases from the burner to chimney. The internal surface is affected by oxidation effect of water and gaseous water steam. Some other reasons of corrosion are also possible during the boiler maintenance. The high operating pressures and thermal dilatation changes of structural materials cause theirs stress states and corrosion - mechanical damage. Corrosion degradation analysis of metallic materials is one of possible assumption of controlled operating degradation. The identification and quantification of material degradation by the metallographic analysis allows not only determination of ageing state, i.e. determination of lifetime limit of structural material, but also offer records for selection and application of suitable anticorrosive action.

77. J. Ševčíková, M. Halama; *Faculty of Metallurgy Technical University of Košice, Košice, Slovakia*
Galvanic Corrosion of Structural Steels in Atmospheric Environment. The paper includes test results of corrosion resistance of structural steels S355JOWP, S355JZG3, WTSt52-3, and X12CrNi18 8 in the model atmospheric corrosion environment. Some results of electrochemical characteristics of tested samples and mass changes during its contact and non-contact application in 0,1 mol l^{-1} Na_2SO_4 are given.

78. M. Halama, J. Ševčíková; *Faculty of Metallurgy Technical University of Košice, Košice, Slovakia*
Ultraspeed Modeling of Bimetallic Compatibility of Chosen Structural Metal Materials. Ultraspeed testing of corrosion resistance of metals under various conditions were performed. Mainly bimetallic corrosion was observed by potentiostatic and potentiodynamic measurements in model electrolytes. The contribution deal with measurements of Evans polarization diagrams for chosen structural metals such as carbon steel, weathering steel, hot-dip zinc coated steel, titaniumzinc, aluminium and copper. Corrosion current densities and corrosion potentials were compared for corrosion macrocells in 3 % NaCl, 0.1mol.l^{-1} Na_2SO_4 and precipitation rain. These results served as input data for prediction of bimetallic compatibility of tested metal materials.

79. M. Halama, J. Ševčíková; *Faculty of Metallurgy Technical University of Košice, Košice, Slovakia*
Evaluation of Potential Data in Form of Gradient Maps for Corrosion Research. One way of corrosion study under atmospheric conditions is ability to study corrosion metal behaviour in both contact and non-contact application by observation of potential changes on surfaces of corroded metals or by research of potential distribution at contact zones. The contribution deal with results of new developed method for measuring of gradient potential maps on bimetallic samples of structural metals exposed at urban site atmosphere (corrosion agresivity C3) for 0,5, 1 and 2 years. Method of potential analysis was tested on steel 11523 samples corroded in bimetallic joint with Zn-Cu-Ti alloy (Zn 98,5 %, Cu 1 %, Ti 0,5 %).

80. B. A. Lyashenko, V. I. Mirnenko, A. V. Rutkovskiy; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
Technological Ensuring of the Durability of Compressor Blades for Aircraft Gas-Turbine Engines with Allowance for the Mechanical Properties. Compressor blades for helicopter engines operate under the influence of adverse conditions. One of the ways of technological ensuring of high bearing strength of the blades made of titanium alloys is the use of protective coatings. For the deposition of the coating, the PVD-method was chosen. The arrangement of the structure of a multilayer coating and the technology control were made with allowance for a set of criteria: creep, low-cycle fatigue, high-cycle fatigue, gas-abrasive resistance, roughness, and microhardness. This research gives the possibility to install titanium compressor blades with new coatings instead of steel one. This results in reducing the weight of an engine and extending its lifetime. The PVD-technology allows restoring the compressor blades during the engine overhaul.

81. G. V. Tsyban'ov , Yu. P. Kurash; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
Experimental Estimation of Crack Initiation in Structural Materials under Fretting Fatigue. A method of indirect determination of fretting fatigue crack initiation in materials has been developed and some experimental results obtained. The method includes interrupted fretting fatigue tests and uses the staircase method. The first one implies experimental obtaining the number of cycles of loading which results in fretting fatigue crack initiation and the second one gives statistical substantiation of results obtained. As a consequence of the experiments and their statistical processing a fretting fatigue curve may be graphed that enables to determine lifetimes for fretting fatigue crack initiation. These lifetimes correspond to initiation of the crack 50 - 100 microns long for mild steel investigated.

82. A. Hernas, B. Dytkowicz, M. Imosa; *Silesian University of Technology, Katowice, Poland*
High-Temperature Corrosion Resistance of Some Metallic Materials. The paper presents some results of investigation of corrosion resistance some metallic materials under conditions of sulphur and chlorine corrosion at the range of temperature 500 - 800 °C. The reaction medium had the following composition: N_2 + 9 % O_2 + 0,2 % HCl + 0,08 % SO_2 and is connected with typical environment of boiler waste combustion. Corrosion tests were carried out on the heat resisting steels and alloys - P91, P92, HCM12, TP347H, Nicrofer and Haynes alloys and also Fe-Al intermetallic materials. The corrosion resistance characteristics up to 1200 hrs, microstructure and X-ray analysis of corrosion products were determined.

83. G. Čevnik*,, L. Kosec**;** **SW Metal Ravne d.o.o., Ravne na Koroškem, Slovenia, ** Faculty of Natural Sciences and Engineering University of Ljubljana, Ljubljana, Slovenia*
Oxidation of Iron – Vanadium Alloys. During high temperature annealing iron – vanadium alloys in oxygen rich atmospheres very accelerated oxidation occurs. This is due of easy and accelerated transport of oxygen to phase boundary metal – oxide owing to the molten oxide or cracks and another discontinuities in solid. We have investigated microstructures, kinetics and mechanisms of oxidation in binary and ternary alloys and also in some steels with high vanadium and another alloying elements concentration in the temperature range 700 to 1200 °C.

83. D. Mandrino, M. Lernut, M. Godec, M. Torkar, M. Jenko; *Institute of Metals and Technology, Ljubljana, Slovenia*
Analysis of Oxide and Nitride Protective Layers Formed on Stainless Steel by Thermal Treatment by Different Techniques. Protective layers on AlSi 321 stainless steel were prepared by thermal treatments in air and two controlled atmosphere types resulting in formation of an oxide and/or nitride layer on the surface of material. These layers were investigated by SEM, EDS, AES, XPS and WDS. Analysed samples

showed considerable differences with respect to their surface morphology, oxide/nitride layer thicknesses, compositions and layer-metal interface thickness. Layer characteristics dependence on thermal treatment and atmospheric parameters are discussed.

Surface technology

84. A. P. Gopkalo, A. V. Rutkovskii; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*
Investigation of the Effect of a TiN Vacuum-Plasma Coating on the Titanium Alloy Resistance to Mechanical Loading. The results of experimental investigations into the static and cyclic strength of a VT20 titanium alloy with a TiN vacuum-plasma coating are presented. Application of a TiN vacuum-plasma coating increases the ultimate strength and yield strength by 6,5 % and 17,37 %, respectively, thus decreasing the relative elongation by 6,5 % and relative reduction of area by 25,39 %. The difference between the stresses at the end and at the beginning of the strain hardening region for coated specimens is 8,9 MPa, whereas for the initial material it is 134,7 MPa. Under the conditions of low-cycle stress-controlled loading TiN coatings increases the fatigue limit in the region of quasi-static fracture by 4,7 %. In the region of fatigue fracture, the zone of transition from quasi-static to fatigue fracture is displaced into the region of shorter lives. In this case, an abrupt increase in the sensitivity of cyclic life to stress changes takes place (the susceptibility to brittle fracture increases).

85. V. V Bukhanovskii, V. A. Borisenko, V. K. Kharchenko, I. Mamuzić*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine, *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*
High-Temperature Strength of Niobium Alloy 5VMTs with a Silicide-Ceramic Coating. Part 1. Short-Term Strength Characteristics. Experimental data on the short-term strength and plasticity of niobium alloy 5VMTs of the system Nb-W-Mo-Zr in its initial state, after annealing, and with a silicide-ceramic protective coating obtained by testing in vacuum, an inert atmosphere, and in air in the temperature range from 290 to 2270 K are analyzed. The process of microcrack initiation and propagation in the protective coating and matrix is investigated in high-temperature static tension. The limiting plastic strain values have been established at which the composite retains its load-carrying capacity in high-temperature aggressive and oxidizing gas atmospheres.

86. V. V Bukhanovskii, V. A. Borisenko, V. K. Kharchenko, I. Mamuzić*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine, *Faculty of Metallurgy University of Zagreb, Sisak, Croatia*
High-Temperature Strength of Niobium Alloy 5VMTs with a Silicide-Ceramic Coating. Part 2. Characteristics of Short-Term Creep. The regularities of variation in the characteristics of short-term (second) creep and long-term strength of niobium alloy 5VMTs and a composite (alloy 5VMTs/silicide ceramic coating) have been studied using short test duration in the temperature range from 1770 to 2020 K. The creep strength values of the alloy and the composite have been obtained for residual strain tolerance of 0,5 and 1,0 % for test duration of 0,1, 1,0 and 10,0 h at temperature of 1770, 1970 and 2020 K in vacuum an inert atmosphere, and in air.

87. I. Uygur; *Faculty of Technical Education Abant Izzet Baysal University, Beciyorukler, Duzce, Turkey*
Microstructure and Wear Properties of AlSi 1038 H Steel Weldments. In this study, wear resistance of AlSi 1038 H cladding was deposited by MIG welding using with various wires. Microstructure, hardness, tensile and wear properties of the materials were investigated and measured on specimens prepared under different alloy composition, load and welding conditions. The wear behavior of the clad was studied using pin-on-disk test apparatus. The results showed that the wear rates were significantly increased with increasing load, welding current, wear distance and poor mechanical properties. A larger amount of C, Cr, and Mn specimen (W3) showed the best wear resistance since it contained a number of hard MC-type carbides. Furthermore, for all materials the weight loss increases linearly with increasing welding arc current, load and wear distance.

88. S. A. Astapchik, A. I. Gordienko, V. S. Golubev; *Physical-Technical Institute National Academy of Sciences, Minsk, Belarus*
Development of Laser Modification Methods of Metal Surfaces. Considered are the results of lasers application for heat treatment, cladding and alloying of Fe-, Ti- and Al - based materials. On laser alloying intermetallic, carbide, boride, nitride and other compounds can be formed on the surface layers. This treatment results in formation of laminated composite structures characterized by high values of hardness, wear resistance and contact strength. The developed parameters of the laser effect make it possible to produce layers with hardness of HRC 65 - 70 on steels and titanium alloys, and HRC 30 - 35 on aluminium alloys. The use of laser radiation is promising also for deposition of wear-resistant coatings, which can be utilised both for the manufacture of new parts and repair of worn-out ones.

Computer calculation and modelling

89. M. V. Borodii, V. O. Strizhalo; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*
Cycle Creep Model for Proportional and Nonproportional Loading. For the prediction of the stress-strain state under asymmetrical stress-controlled loading a version of the endochronic theory of plasticity has been developed. To describe the one sided strain accumulation a new rule of kinematic hardening is proposed. The parameter which used for model concretization and correlating with cycle creep rate on steady state stage is proposed. For proportional loading it is multiple the maximum stress and amplitude stress. The model reliability is confirmed by good agreement of the calculated values of the maximum strain as a function of the cycle number and the known Hassan and Kyriakides experimental results of the uniaxial ratcheting for carbon steels AISI1020 and AISI1026 at different values of mean stresses and stress amplitudes in a cycle. For biaxial cycle creep a system of the resolving equations has been developed.

90. V. A. Leonets, O. A. Leonets*, O. D. Tokaryev;** *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine; *"Rhythm" Institute for Problems of Mechanics, National Technical University of Ukraine "KPI", Kiev, Ukraine; **State Scientific Research Centre of Railway transport of Ukraine, Kiev, Ukraine*
Determination of a Set of Stresses Occurring in Locomotive Bogie Frames with a View to Assessment of their Remaining Life. In calculating the remaining life of structural components of locomotive under frames, for example, by correcting the hypothesis of linear summation

of fatigue damages, the quantile of the normal stress distribution corresponding to the probability of appearance of fatigue cracks depends on the accuracy of determined mean statistical amplitudes of stresses occurring in these structures and fatigue limits of their elements. The number of tests can be significantly lowered provided that the stress amplitudes can be divided into portions in the same manner as it is done in processing oscillograms, for example, by the rainflow-counting algorithm. The set of stresses occurring in components of the load-bearing structures of locomotive underframes is determined using the developed on-board measurement system whose performance characteristics match the world's best.

91. B. S. Karpinos, V. G. Barilo S. V. Petrov, N. G Solov'eva; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*
Kinetics of stresses and temperatures in Railroad Wheels after Hardening. We have studied thermal and termostressed states of railroad wheel tread after local surface hardening. For various points of the tread cross section we have determined the kinetics of temperatures, thermal stresses, strains and strain rates, as well as of ratios between the main stresses. It is found that the hardened material is subjected to reversal elastoplastic deformation. Effect of plazmatron location on the levels of temperatures and thermal stresses is analyzed.

92. O. N. Gerasimchuk, Yu. S. Nalimov, B. A. Gryaznov; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*
Influence of Technological Defects on Cyclic Strength of Ti-6Al-4V Alloy. Spits (microdroplets) in condensate were shown to decrease the endurance limit 1.5 times as compared to a defect-free material. The fatigue limit of spits-free condensate was not lower than that of the substrate material. The endurance limits of the defect-free condensate and substrate were calculated with the use of the linear fracture mechanics approach. The calculation results correlate well with the experimental data.

93. V. Kharchenko, E. Kondryakov, S. Lenzion; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
Temperature-Rate Conditions of Material Deformation at Impact Tests of Charpy Specimens. A numerical calculation scheme was developed and a numerical simulation of impact tests of Charpy specimens with account taken of the damage accumulated in material was fulfilled. The effect of impact velocity within a range of 1-10 m/s on the temperature of the deformed material in such tests was analyzed. The results obtained in adiabatic heating and heat diffusion was compared.

94. E. A. Kondryakov, S. V. Lenzion, V. V. Kharchenko; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
Modeling of Deformation and Destructions of Specimens with Different Form Concentrators under Static and Dynamic Loading. In this work the analysis of Gurson-Tvergaard-Needleman damaging model parameters influence on deformation process at stages of weakening and ductile failure under static and dynamic loading was carried out. The results of experimental studies were compared with numerical calculations for specimens with different form concentrators.

95. A. A. Lebedev, B. I. Koval'chuk[*]; *Pisarenko Institute of Strength, National Academy of Science of Ukraine Kiev, Ukraine; [*]National Technical. University "KPI", Kiev, Ukraine*
Influence of the Temperature and Loading Regime of Ultimate State of Structural Materials. The results of theoretical and experimental investigations into the ultimate state of structural materials of various classes under combined stress state with the account taken of the history and prehistory of loading in a wide temperature range have been generalized.

96. T. Yu. Yakovleva; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
State Evolution Model for Metallic Material under Cyclic Loading. The phenomenon of fatigue in metals and alloys with different crystallographic structure is discussed. The physical model of the formation of local plastic deformation regions is stated in analytical form. The model is valid for incubation and active fatigue fracture periods. Fatigue curve and kinetic fatigue fracture diagram equations are derived, which take account of cyclic loading rates in explicit form. The equation of the kinetic fatigue fracture diagram holds for the whole range of crack lengths, from short to macroscopic ones.

97. G. V. Stepanov, A. I. Babutsky; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
Impulse Current-Induced Stress State in Defect-Containing Metals. Results of numerical simulation of a high-density pulse current-induced stress-strain state in a metallic body with such defects as macrocracks or pores are presented. Nonstationary local stress-strain kinetics of the metal in the vicinity of defects under current pulses and mechanical loads was investigated by the finite element method. Local areas of residual stresses influencing the level of maximum stresses under further mechanical loading were shown to be formed in the vicinity of defects as a result of the above thermomechanical effects. Potential "healing" of crystal lattice microdefects under local thermomechanical loading is illustrated by simulation results obtained with the method of molecular dynamics.

98. G. V. Stepanov, A. I. Babutsky; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
Strain Localization Kinetics in a Metal Strip in Tension. Simulation results for strain localization in a metal strip are obtained with analytical and numerical methods. The initiation of strain localization is shown to be determined by the initial nonuniformity of material properties and by loading conditions. The more uniform material properties, the higher the strain level at which localized flow starts to develop. Metal heating under adiabatic deformation (as a result of the thermal plastic strain effect) causes a decrease in a strain level at which its localization starts. The impulse current passage, accounting for its thermal effect, exerts a similar influence.

99. G. V. Stepanov, A. I. Babutsky, I. A. Mameyev; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
High-Density Impulse Current-Induced Unsteady Stress-Strain State in a Long Rod. The results of experimental investigations and nu-

merical calculations of the unsteady stress-strain state in a thin steel rod prestressed statically below the yield strength upon the passage of a high-density current pulse are presented. The current pulse gives rise to oscillations of axial stresses with a period corresponding to the period of natural longitudinal oscillations of the rod. Maximum compression and tensile stresses are determined by current pulse front duration and its amplitude. A high level of the above stresses in the central portion of the rod brings about local losses of longitudinal stability. The results of numerical simulation of the stress-strain state in the rod upon its heating with a current pulse correspond to experimentally observed effects.

100. G. V. Tsyban'ov, M. A. Ageyev*; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine; *State Enterprise "Production Association Southern Machine-Building Plant Named after A. M. Makarov", Dnepropetrovs'k, Ukraine*
Stress State Estimation of Alighting Gear Components under Various Takeoff Run Regimes. The main geometric and force factors affecting the strength and lifetime of alighting gear components are analyzed. Special attention is concentrated on analysis of stress state in concentrators of the lever-type components under a severe takeoff run regime, namely running at a ground runway. Distribution of stresses along the components is calculated using a finite element method. A shift between the maximums of normal and tangential stresses may be observed in some components. Complexities of the components configurations and their loading history result in non-proportional loading that should be taken into account while lifetime of these structural elements is calculated though at present time this factor is not included in the calculation procedure.

101. G. V. Tsyban'ov, M. V. Tsyban'ov*; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine; *Dnepropetrovs'k National University, Dnepropetrovs'k, Ukraine*
Use of Cyclic Strengthening Model of Material for Crack Initiation Lifetime Estimation. The approach suggested implies determination of cyclic strengthening function for a material surface layer. Henceforward this function is used for determination of cyclic crack initiation onset. The Orowan-Aphanas'ev's model, that takes into consideration the strengthening of material, is applied to describe an interrelation between number cycles of loading, plasticity of material, current yield stress and stress amplitude. In contrast to this model the authors suggest to consider just the cyclic property of material surface layer where fatigue crack initiates. In order to determine parameters of the strengthening function, some assumptions are adopted and experimental data on fatigue crack initiation (French's line) are used. Onset of crack initiation corresponds to reaching by the material in the surface layer to a fixed elastic stress due to strengthening after certain number of cycles.

102. M. Godec, B. Šuštarić, M. Jenko; *Institute of Metals and Technology, Ljubljana, Slovenia*
High Magnification EBSD Mapping Analysis of Fe-Si-B Powder Particles. Amorphous Fe-Si-B soft magnetic powder was produced by water atomization. During annealing powder particles obtain nanocrystalline structure. Annealing over 700 °C leads to formation of ferrite and boride phases. High magnification EBSD mapping analysis of powder particles in combination with FESEM are presented in the article. Some of the problems associated with the powder particles preparation for EBSD analysis as well as drift problems occurring during EBSD mapping are commented on.

Composites

103. V. V. Bukhanovskii, N. I. Grechanyuk*, I. N. Grechanyuk*, V. V. Kharchenko, I. Mamuzić, V. A. Osokin*, N. P. Rudnitskii;** *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine; *Gekont Science& Technology Company, Vinnitsa, Ukraine; **Faculty of Metallurgy University of Zagreb, Sisak, Croatia*
Structure and Physical-Mechanical Characteristics of Copper-Carbon Microlayer Composite Material in a Wide Temperature Range. The structure, chemical composition, hardness, strength, and plasticity of laminated copper-carbon composite materials obtained by electron-beam evaporation and layer-by-layer chemical vapor condensation have been studied in a temperature range of 290 - 870 K. A correlation between the hardness and strength of the composite has been established.

104. N. P. Rudnitskii; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*
Hardness of Composites Cu-ZrO_2 and Cu-Al_2O_3 at High Temperatures. Temperature dependences of hardness for pure copper and its composites with 3, 5 and 10 % of zirconium dioxide and aluminum oxide contents by volume have been studied within a temperature range from 290 to 1070 K. The general thermodynamic activation analysis of the obtained dependences has been performed for the (0,2 - 0,8) T_m copper. For all the materials, at temperatures up to 450 K hardness increases with increasing content by volume of the (0,1 - 0,2) μm disperse particles, while within the range from 450 to 1070 K hardness decreases for materials with 3 and 5 % -contents by volume of ZrO_2 and 3 %-contents by volume of Al_2O_3.

105. V. Z. Kutsova, A. Yu. Kutsov, M. A. Kovzel, A. V. Kravchenko, A. V. Zhivotovich; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Structure and Properties of Composit Rolls witch were made by Eshn Method. Structure, microhardness of structure components, hardness and wear capability of surfaced layer of composite rolls were investigated. It was shown that structure inhomogeneity as well as the defects which play a part of a concentrator voltages is occur in surfaced layer of composite rolls which were made by ESHN method. High-Chromium iron with the following bainitic hardening is the best materials for reception of surfaced layer of composite rolls and reduction of the expenses on source materials.

106. V. Akhundov; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Modelling with Weak Reinforced Fibres of Soft Composite Material. Composite materials at large deformations of structure elements are modeling with weak reinforced fibres. Researches of elastomer composits with three and four systems are represented, the fibres of which are oriented on ribs and diagonals of cube accordingly.

107. N. I. Grechanyuk, I. Mamuzić*, V. V, Bukhanovskii;** *The Research and Producing Company "Gekont" Vinnitsa, Ukraine, *Faculty of Metallurgy University of Zagreb, Sisak, Croatia, **Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*

Production Technology and Service Characteristics of Microlayer Composite Materials for Electric Contacts of New Generation. The paper presents description of the production technology of microlayer composite materials for electric contacts of the system copper- zirconium- yttrium- molybdenum obtained by the method of electron-beam evaporation and layer condensation from the vapor phase and a study of their chemical composition, structure, density, electric conductivity, hardness, and main mechanical characteristics in the temperature range from 290 to 1070 K.

108. V. A. Borisenko, V. V Bukhanovskii, N. I. Grechanyuk*, I. N. Grechanyuk*, I. Mamuzić, V. A. Osokin*, N. P. Rudnitskii;** *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine, *The Research and Producing Company "Gekont" Vinnitsa, Ukraine, **Faculty of Metallurgy University of Zagreb, Sisak, Croatia*
Temperature Dependences of Static Mechanical Properties of an MDK-3 Laminated Composite. The structure, hardness, strength and plasticity of a laminated composite nanomaterial of the copper-zirconium-yttrium-molybdenum system obtained by electron-beam evaporation and layered vapor condensation over a temperature range of 290 - 1070 K are studied. Correlation between the hardness and strength of the composite was established.

109. A. Patejuk, R. Uscinowicz; *Faculty of Mechanical Engineering Bialystok Technical University, Bialystok, Poland*
Modeling of Composites from Cd-Zn System by Precipitation Hardening. The method of producing metal composites from Cd-Zn system by precipitation hardening was presented in the article. The analysis of composite materials of hypereutectic, eutectic and hypoeutectic constitution was performed. It was found that the cooling rate in the range 0,05 - 400K/s influenced mechanical properties of produced composite material. The increase in cooling rate caused fragmentation of precipitates in composite materials that consequently leaded to the rise of the hardness of investigated alloys.

110. R. Rudolf, L. Kosec*, A. Križman, I. Anžel; *Faculty of Mechanical Engineering University of Maribor, Maribor, Slovenia, *Faculty of Natural Sciences and Engineering University of Ljubljana, Ljubljana, Slovenia*
Microstructure Analysis of Internally Oxidized Cu-C Composite. On the basis of experimentally obtained data, it was established that submicron-size bubbles are formed by the internal oxidation of Cu-C composite with fine dispersed graphite particles. They are homogeneously distributed in the Cu-matrix. The internal oxidation kinetic in Cu-C composite depends on the diffusion of oxygen in the copper matrix, and the penetration depth of the internal oxidation front indicates the parabolic nature of the process.

111. A. T. Valochka, A. P. Laskauneu, Zh. E. Makarava; *Physical-Technical Institute National Academy of Sciences, Minsk, Belarus*
Composite and Ceramic Materials Obtained Using Waste Products of Aluminium Alloys. There are some most significant results in research of complex recycling of aluminium wastes (chips, slag, etc.). There is a consideration of their mechanical dispersion and receiving powders, dough, composite materials of antifriction purpose and ceramic materials for aluminium casting.

112. K. Gawdzinska; *Institute of Basic Technological Sciences Maritime University of Szezecin, Szezecin, Poland*
Influence of AlSi9/SiC Composite Casts Production Methods on Selected usable Properties. The paper compares tribologic properties and compression strength in composites strengthened with SiC particles in AlSi9 matrix and manufactured using different methods. These include comosite foam, suspension composites and composites produced by saturating strengthening blocks with liquid metal.

Methodology of investigation

113. G. G. Pisarenko, I. M. Vasinyk, A. V. Voinalovich, Y. M. Golovanev; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*
Automatize Complex for the Visualization of Fatigue Cracks in the Metallostructures. The work presents some specialties of constructing and operation parameters of the worked out highly sensible measuring device for quantative evaluation of damage state of a surface layer of a constructive element. The developed measuring complex allows determining position of superficial defects, with polihromnoy visualization of their geometrical parameters in the screen of monitor of the PC. Used in a measuring complex sensors are not sensible to the roughness of surface and allow to expose defects at the roughness of surface anymore Rz60. Influencing of regional effect and effect of taking of sensor is absent. The applied in the given development technical decisions enable to expose defects under inflicted on the surface of material by the dielectric sheeting by a thickness to 5 mm.

114. I. V. Orynyak V. V. Rozgonyuk*; *Pisarenko Institute for Problems of Strength National Academy of Sciences of Ukraine, Kiev, Ukraine; *Representation in Ukraine "Gazexport" Ltd, Kiev, Ukraine*
Consideration of Geometrical Nonlinear at Calculation of the Thin-Walled Elastic Pipes with Long Axial Cracks. The known method of Cheng and Finnie for calculation of elastic pipes with long defect has two features - a crack is considered as a concentrated compliance, and the deformation of pipe (ring) is determined as for a curvilinear beam. In the present work the more universal description of the beam behavior is proposed, which is based on the method of initial parameters with consideration of geometrical nonlinearity. Evidently, for the first time in literature the values of SIF are obtained in geometrically nonlinear formulation, when the increase of pressure results in somehow slowed increase of SIF.

115. V. G. Barylo; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*
Effect of Component Dimensions on its Load-Carrying Capacity. A method to calculate the ultimate stresses by analyzing changes in the stiffness of components in the process of their deformation is proposed. The method proposed enables estimating the conditions under which the Saint Venant principle does not hold true. In this case, the attainment of the material limit state leads to the loss of load-carrying capacity for components regardless of their shape or dimensions. In other cases, the fracture in some part of a component does not result in the loss of its load-carrying capacity. The material limit state depends on the geometry. The method allows assessing the load-carrying capacity of components after changes in their dimensions without additional experiments.

116. A. P. Zinkovskii, I. G. Tokar, B. A. Gryaznov; V. I. Vlasenko, Yu. S. Nalimov; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*
Efficientcy Improvement for Electrodynamic Excitation of Vibration in Fatigue Tests of Machine Parts. Research results are presented on substantiation of approaches for selecting the scheme of machine parts fastening to eletctrodynamic excitater's movable table in fatigue tests. It is shown that efficiency improvement for eletctrodynamic excitation of vibrations is achieved in the case of antiphased vibration of the tested part and one of the fastening components of the vibration equipment system, as well as in the case of simultaneous optimal detuning of their natural frequencies.

117. E. Kondryakov, V. Zhmaka, V. Kharchenko, A. Babutsky, S. Romanov*; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine;*Association "Reliability of Machines and Structures", Kiev, Ukraine*
The Multichannel System of Strains and Temperature Measurements under Tests of Materials on Impact Toughness. The multichannel system of high rate measurements of strains and temperature under impact tests of materials was developed. Four-channel analog-digital converter is used for registration of the respective signals. The system was tested using rotational and vertical drop hammer for various loading rates and temperatures. Some results of impact testing of Charpy specimens are obtained with registration of stress variation in the test machine seat/support during the testing process.

118. L. S. Novogrudskiy; *Pisarenko Institute for Problem of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
Ultimate State of Structural Alloys to the Action of Electric Current Pulses at a Cryogenic Temperatures. Electromagnetic effects (magnetic fields of high intensity, electric current pulses of high density), which are among the main service factors acting in load-carrying elements of superconducting electromagnetic systems, give rise to the plastic flow of metals at the stresses that are essentially lower than the values of their yield stresses. In this paper, based on the peculiarities of deformation and fracture of steels and titanium alloys revealed under conditions of the action of the electric current pulses and cryogenic temperatures, the material ultimate state criteria have been formulated and the main principles of the methods for their determination at uniform, nonuniform and complex stress states as well as with the presence of a crack have been reported.

119. A. A. Lebedev, V. M. Mikhavich*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine Kiev, Ukraine; *Vinnitsya Technical University, Vinnitsya, Ukraine*
Tensor Models for Determining the Residual Life of Materials. The paper presents the data that make it possible to develop the algorithm for determining the residual life within the framework of the tensor approach to the description of the material damage. Explicit criterion relations for determination of residual life were obtained, which enable extension of the known relations to a wider range of loading processes.

120. L. S. Novogrudskiy; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
On the Assessment of Low-temperature Hardening of Alloys From Its Strength, Strain and Energy Parameters. Valid increase of allowable stress, using the properties of metals to increase its strength with lower of temperature, allows to considerably reducing the specific amount of metal of cryogenic structures. Known methods of applying the low-temperature hardening (LTH) of materials to raise the allowable stress level have been considered. On the basis of the analysis of the LTH parameters defined in static tension of specimens from steel and aluminum alloys differing in size and geometry, the author demonstrate the subjectivity of estimation of the LTH from strength, strain, and energy characteristics of materials and give recommendations as to the choice of critical and allowable stress in strength analysis for cryogenic structures.

121. T. Yu. Yakovleva, G. G. Pisarenko, L. E. Matokhnyuk; *Pisarenko Institute for Problems of Strength of the National Academy of Sciences of Ukraine, Kiev, Ukraine*
Quantitative Evaluation of Fatigue Damage Accumulation Kinetics. We have considered the possibilities and basic methodological approaches for the application of the Fourier spectrum method for the quantitative analysis of evolution of the structural state of metals on the example of the AMg6 aluminum alloy subjected to symmetric push-pull tests at room temperature with 100 Hz frequency. It is shown that the parameter delivered from the diagrams of integrated anisotropy can be used as an integrated structural characteristic. For the investigated structural states of the Амг6 aluminum alloy this parameter varies from 0,11 for the residual durability value of 90 % to 0,31 for 10 % of residual durability (i.e. for the state prior to fracture). This signifies that the structural parameter changes by 182 % even in the relatively stable process of integral accumulation of fatigue damages.

122. T. Yu. Yakovleva, L. E. Matokhnyuk, B. Yu. Mozeiko*; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine; *Engineering Center of Technical Diagnostics "SAMARATRANSGAZ," Samara, Russia*
Using High-Frequency Tests for Fracture Characteristics Prediction for Metals. The method is proposed for the prediction of the cyclic crack growth resistance characteristics for metallic materials at low loading frequencies by the results of high-frequency tests. The method is based on the model for the development of the regions of local plastic deformation during the fatigue damage accumulation and crack growth. Kinetic fatigue fracture diagram equations which take account of cyclic loading rates in explicit form are used.

123. T. Yu. Yakovleva, L. E. Matokhnyuk; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
Using High-Frequency Tests for Fatigue Resistance Characteristics Prediction for Metals. The method is proposed for the prediction of the fatigue resistance characteristics for metallic materials at low loading frequencies up to 1010 cycles by the results of high-frequency tests. The method is based on the model of fatigue fracture which takes account of cyclic loading rates and asymmetry ratio. Potentialities of the method are illustrated by the compare of testing and calculate for Nickel, Aluminium and Titanium Alloys. Results of prediction for loading frequencies from 35 Hz till 10 kHz and asymmetry ratio from -1 till 0,5 are deviated from experimental results about 10 % generally.

124. V. A. Romashchenko; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*
The Dynamics of Multi-layered Thick-walled Cylinders with Spiral Reinforcement. Based on the Wilkins 2D-algorithm, the technique of numerical study of the dynamics of multilayered thick-walled spirally orthotropic cylinders with various structures of helical reinforcement has

been developed. Test calculations closely agree with the known solutions. Based on the Ashkenazy failure criterion for orthotropic materials, the method of evaluation of the dynamic strength of anisotropic cylinders under impulse loading has been suggested. The peculiarities of dynamic behavior of bi-layered cylinder under various schemes of spiral reinforcement have been investigated. Some recommendations as to optimal projection of such constructions were made.

125. G. V. Stepanov, A. I. Babutsky; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*
Stress Intensity Factor Variations near the Edge Crack Tip upon Its Stepwise Growth. Calculation results to evaluate the variations of the stress intensity factor in time near the tip of the edge crack upon its stepwise growth are presented. The crack pop-in in a thick plate under tensile loading is shown to result in cyclic K_1 variations with a period and amplitude that are dependent on the initial crack length, pop-in length and plate dimensions. Time-average K_1 values correspond to those calculated for the stationary crack. Instant application of tensile loads to a crack-containing plate results in nonstationary stress variations near the crack tip with the maximum stress intensity factor $K^{dyn}{}_{1max}$ that is about two times higher than $K^{st}{}_1$ under static loading.

126. V. Gnatushenko; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Model of Digital Metal Image Processing on the Wavelet-Analysis Basis. The model of preliminary processing of digital metal images, using ample opportunities wavelet-analysis is offered. Influence of parameters of functional wavelet-bases such as a class, type, decomposition level on change informative significance and visual quality of the mentioned images is investigated. Biorthogonal spline wavelet-filter of 10 decomposition level has shown the best results. Results of use of offered model and check of its adequacy are submitted.

127. A. I. Mikhalyov, A. I. Derevyanko, Yu. A. Vodolazskiy, V. V. Pomulev; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Multifractal Approach in Metallographical Images Analysis. In the work a question of multifractal technique application is discussed. The multifractal approach allows achieving the new quantitative values for exploration of Cu covers represented as series of color images. The results show that multifractal values depend on input parameters (such as current's density etc.) of process of electrochemical deposition.

128. P. Fila, L. Martínek, M. Balcar, J. Bažan*, Z. Adolf*; *ŽĎAS, a. s., Žďár nad Sázavou, Česká Republika, *VŠB TU, Ostrava, Czech Republic*
Evaluation of Super Clean Steels According to Chemical Composition. Realization of products in power engineering represents the verification and optimization of steel making technology of 2,8NiCrMoV and 3,5NiCrMoV types intended for forgings of the gas turbine shaft and compressor disk. The minimum content of tramp and trace elements is requested, especially phosphorus, sulphur, copper, antimony, arsenic and tin. Silicon, manganese and aluminium are considered as undesirable elements.

129. S. A. Nikulin, A. B. Rojnov, V. A. Belov, A. V. Babukin, M. G. Grigoriev; *Moscow State Steel and Alloys Institute (Technological University), Moscow, Russia*
Estimation of Technological Ductility of Thin-Walled Zirconium Cladding Tubes. The technique of tests for an estimation of technological ductility of zirconium thin-walled tubes for spacer grids is developed and tested. The technique is based on carrying out of tensile tests of special small-sized tube specimens, the joint analysis of deformation diagrams and acoustic emission (AE), and characteristics calculation of deformation hardening and true uniform deformation. Trial tests of tube specimens made of zirconium alloys E110 and E635 in cold-rolled, partially recrystallized and fully recrystallized conditions have been carried out. Obtained data testify that the developed approach is effective for an estimation of a ductility margin of zirconium thin-walled tubes before profiling of spacer grids.

130. V. V. Roshchupkin, M. A. Pokrasin, N. A. Semashko, N. L. Sobol, A. I. Chernov, M. M. Lyakhovitskiy; *A. A. Baikov Institute of Metallurgy and Materials Science of RAS, Moscow, Russia*
Degrade Kinetics Investigation of Material Constraction Structure by Method of Acoustic Emission. An experimental approach for the identification of physical processes occurring in deformed solid with acoustic emission (AE) parameters is considered in the present work by the example of structural steel St20. Form factors K_f, the degree indication of pulsed flow correlation, and K_p, which characterizes the energy of separate pulse, were calculated for each registered signal. Two-parametric distribution diagram (K_f/K_p) was build for each sample. The plane of registered for the whole cycle of deformation and destroying signals collection was divided into four parts by the help of two corresponding to K_f and K_p critical values lines.

131. K. Gawdzinska, I, Wojnar*; *Institute of Basic Technological Sciences Maritime University of Szezecin, Szezecin, Poland, *Faculty of Mechanical Engineering Institute of Applied Computer Science Cracow, University of Technology, Cracow, Poland*
Review of Selected Testing Techniques Applied for Detecting Defects in Composite Metal Casts. The paper reviews selected testing techniques such as microscope testing, ultrasound defect detection, X-ray, and describes 3D computer analysis of microtomography pictures, which is a new tool, used for testin and identififying selected defects in composite metal casts.

Aluminum and magnesium alloys

132. V. Z. Kutsova, O. A. Nosko; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Influence of Modification with B on the Structure and Properties of Hypereutectic Silumins. Microstructure, microhardness, size and distribution of primary β-Si crystals of solid solution and eutectic component of hypereutectic piston sliminess were studied. It was shown that modification with B of hypereutectic sliminess provides the essential pulverizing of primary β-Si crystals of solid solution as well as decreases crystal size in 1,5 - 2,0 times not only at cooling rate 0,04 - 0,4 °C/min but also at high cooling rate (10 - 10^2 °C/s). Increasing of microhardness of primary β-Si crystals of solid solution and eutectic component provides increasing of hardness and wear capability of sliminess. Data about phase composition, structure and properties of hypereutectic sliminess under modification with B witness are shown that solid solution mechanism of modification is the most probable for this material.

133. Yu. V. Dotsenko, V. Yu. Seliverstov; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Research of Structure and Properties of the Second Casting Alloys of the System of Al-Si-Mg. It is investigational casting properties of experimental alloys of the system of Al-Si-Mg with the conditional brand of AK5Mr3 and AK10Mr3, the indexes of which are at the level of the known more dear Al-Si and Al-Si-Mg alloys of brands of AK12, AK9. Studied microstructure and phase composition of experimental alloys of AK5Mr3 and AK10Mr3. It is set that in alloys eutecticums appear on the basis of α-Ąland β-Şiincluding phases contain Al, Si, Fe, Mn, that is in complete accordance with the diagrams of the state of the systems of Al-Mg-Si, Al-Fe-Si-Mn, Al-Si-Mn, Al-Fe-Si-Mn-Mg. It is set quantitative dependences and features of influencing of basic alloying elements on mechanical and casting properties of experimental alloys.

134. N. R. Bochvar, N. P. Leonova, E. V. Lysova, L. L. Rokhlin; *A. A.Baikov Institute of Metallurgy and Materials Science of Russian Academy of Sciences, Moscow, Russia*
Investigation of Phase Composition and Mechanical Properties of Al-Mg Alloys with Ce and Y Additions. Effect of Ce and Y on phase composition and mechanical properties of the Al-Mg alloys with 7 - 9 % Mg was studied. The light and scanning electron microscopy, X-ray diffraction method and tensile tests of the alloys were used. Results of the investigation enabled to construct partial isothermal sections of the Al-Mg-Ce and Al-Mg-Y phase diagrams at 430 and 275 °C in the Al-corner areas. Dependence of the mechanical properties on test temperature was established. The alloys were tested in cast and wrought conditions. Mechanical tests showed enough high strength properties for the alloys of the 5XXX series: UTS > 500-600MPa, TYS > 350 - 400 MPa, elongation ~ 10 %.

135. T. V. Dobatkina, L. L. Rokhlin, N. I. Nikitina, I. E. Tarytina; *A. A. Baikov Institute of Metallurgy and Materials Science of Russian Academy of Sciences, Moscow, Russia*
Properties of the Mg-Ce-Y-Base Alloys at Room and Elevated Temperatures. Following the previous work where a favor effect of Ce addition on aging process in the Mg-rich alloys containing Y were revealed in this investigation mechanical properties of the Mg-Ce-Y were studied. The investigation confirmed a possibility to improve mechanical properties of Mg-base alloys containing Y by addition of Ce. As a result, the strength properties of the Mg-Ce-Y alloys surpassed those with only Y amongst the rare-earth metals. In the wrought alloys the highest strength properties were observed after ageing immediately after extrusion. In this condition alloy Mg-9 % Y-1,5 % Ce showed at 20 °C UTS 354 MPa, TYS 306 MPa, E 2,6 %, as compared with at 20 °C UTS 323 MPa, TYS 256 MPa, E 5,1 % for the alloy Mg-9 % Y.

136. L. L. Rokhlin, T. V. Dobatkina, I. G. Korolkova, M. N. Bolotova; *A. A. Baikov Institute of Metallurgy and Materials Science of Russian Academy of Sciences, Moscow, Russia*
Phase Relations in the Al-rich Al-Cr-Sc Alloys. Aiming to assess a possibility to use scandium and chromium together as alloying elements to Al-base alloys the Al corner of the Al-Cr-Sc phase diagram was studied. In equilibrium with Al solid solution only compounds of the binary systems Al-Sc and Al-Cr were revealed. Determination of the joint solubility of Sc and Cr in solid Al showed that each of them did not actually change the solubility of other. Joint solubility of Sc and Cr in solid Al decreased with lowering temperature suggesting a possibility to improve properties of the alloys due to the solid solution decomposition. Partial sections of the Al-Sc-Cr phase diagram were constructed. The work was supported by Russian Foundation for Basic Research (RFBR) No 05-03-32245.

137. I. G. Brodova, Ya. V. Vitrov, V. V. Astaf'ev; *Institute of Metal Physics, Ural Branch of Russian Academy of Sciences, Yekaterinburg, Russia*
Formation of Supersaturated Solid Solution in Al-Mg-Mn Alloys with Zr and Sc. As an object of investigation the Al-5 mass % Mg-1,5 % Mn-0,5 % Zr and the Al-5 % Mg-1,5 % Mn-0,5 % Zr-0,5 % Sc alloys used, which were produced using the method of centrifugal casting with two-sided cooling (the disk with the diameter of 80 mm and a thickness of 3,0 - 0,6 mm). The effect of solidification conditions (a cooling rate and a overheating above the liquids temperature) on the formation of aluminum-based solid solution supersaturated with Zr and Sc was considered. It was shown that the alloy with Sc has the fine grain-structure with a size of 5 mkm and the high microhardness of 910 MPa.

138. J. Medved, P. Mrvar, M. Vončina; *Faculty of Natural Sciences and Engineering University of Ljubljana, Ljubljana, Slovenia*
Thermal Analyses of $AlCu_4$ Alloy. At the precipitation - hardenable aluminium alloys are often required specific hardness and strength of wrought and cast alloys, so we often use specific operations. These alloys are called heat treatable alloys. One essential attribute of a precipitation-hardening alloy system is a temperature-dependent equilibrium solid solubility characterized by increasing solubility with increasing temperature. One case of aluminium alloy systems with precipitation hardening presents AlCu4 alloy. The alloy was examined with the triple simple thermal analysis (TSTA), the simultaneous thermal analysis (STA), the computer simulation using Thermo-Calc program and with the metallographic analyses. We determined the energy of the primary and eutectic phase at the solidification and melting and the energy of the precipitates Al_2Cu that were clearly seen in the curves of simultane thermal analyses.

Non ferrous alloys

139. A. P. Yakovlev, A. Yu. Beregovenko, V. S. Lukyanov*, P. E. Markovsky;** *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine; *"Motor-Sich" PJSC, Zaporozhye, Ukraine; **Institute for Metal Physics, National Academy of Science of Ukraine, Kiev, Ukraine*
The Influence of Thermomechanical Treatment on the Dissipative Capacity of Titanium Alloys. The paper presents the results of the experimental investigation of the effect of thermomechanical treatment (TMT) and additional annealing on the dissipative capacity of VT3-1 (Ti-Al-Cr-Mo) and VT-8 (Ti-Mo) titanium alloys. VT3-1 Alloy was treated according to two regimes: TMT1 (summery plastic deformation – 50 %, 1233 K) and TMT2 (summery plastic deformation 60 - 70 %, 1173 K), whereas VT8 - to one regime (TMT1). TMT and additional annealing (863 K, 2 h) have produced the increase of the decrement of vibration (characteristic of dissipative capacity) up to 57 % for VT3-1 and up to 28 % for VT8 alloys. The efficiency of thermomechanical treatment was estimated using the vibration strength criterion $\sigma_a \cdot \delta$ (σ_a - stress amplitude, δ - decrement of vibration).

140. G. G. Pisarenko, A. V. Voinalovich, Y. M. Golovanev, I. M. Vasinyk; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*

Investigation of the Degradation of Structure of Constructional Materials Using the Characteristics of the Microinhomogeneity of Surface Layers under Fatigue. As a result of the research, the following conclusions can be made: a) on the stages 5, 20 and 60 %-exhaustion of durability of the specimen of titanium alloy under loading, cyclic increase of microstructure strain homogeneity takes place; b) independence of structural microinhomogeneity evolution of material for different cyclic loading levels has been confirmed; c) correlation of thin structure evolution with singularities of kinetic dependencies of generalized parameter of material basic properties. This is corroborated by the results of deformation analysis in discrete points of loaded surface.

141. F. F. Giginyak; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*

Assessment of Viscoelastic Properties of Titanium Alloys. The results of studying viscoelastic properties of some titanium alloys under conditions of cyclic loading and combined stress state are presented. The applicability of a elastoviscoplastic model to the structural materials studied is experimentally confirmed.

142. V. I. Vlasenko, T. Yu. Yakovleva; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*

Cyclic Loading Impact on the Structure Stability and Mechanical Characteristics of Titanium Alloys and Welds. The experimental results and analysis of Vibratory Stress Relief (VSR-treatment) impact on plastic deformation processes in titanium alloys and their welds are presented. It is shown that a $5 \cdot 10^4$ cycle loading with an amplitude approximately close to the endurance limit results in an increase in mechanical characteristics (cyclic and static creep limits) as well as stabilization of its structure (a decrease in mobile dislocation density and lengths of dislocation segments, pinning of interstitial impurity). These processes along with the residual stresses relief provide enhancing the dimension stability of products treated in time.

143. D. Živković, Ž. Živković, D. Manasijević, N. Štrbac, I. Mihajlović; *Technical Faculty University of Belgrade, Bor, Serbia and Montenegro*

Importance of Lead-Free Solder Materials in Global Environmental Protection. The European directive (WEEE and RoHS - restriction of hazardous substances) proposed 2006 as the new date from which on the use of lead should be banned in electronics and electric equipment. Regarding the important issue of global environmental protection, measures such as Lead-Free solder material for electrical parts, development of soldering process, and collection and recycling of products are to be emphasized. There are two primary driving forces that affect the requirements of lead-free solders for electronics and microelectronics application: health concerns due to the toxicity and health hazard of lead and the heightened demands on the level of performance of solder joints due to the increased density and complexity of circuitry, driven by market demands. Throughout the world, manufacturers are changing the Sn-Pb eutectic, used for mounting printed circuit boards, to lead-free solders. Therefore, a great deal of effort has been put into the development of different lead-free solder alloys, recently. Some new lead-free soldering alloys are presented in this paper, in the frame of their 'environmental-friendly' characteristics.

144. V. I. Mazur, S. V. Bondarev, L. V. Ziborova; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*

Thermal Analysis of Titanium Alloy Alloyed With Aluminium, Boron and Copper. Singularity of formation of titanium alloy alloyed with aluminium, boron and copper was studied. The samples were examined by using thermal analysis, which defined the temperature range of solid-phase transformations. The effects of these transformations during thermocycling on a structure were researched. The changes of microhardness of a α-solid solution were fixed. The morphology and arrangement of intermetallides, unlike of the borides, are defined by condition of eutectoid transformations. Thermal treatment impacted on a durability of alloy.

145. I. Yu. Khmelevskaya, V. Ya. Abramov*, N. M. Aleksandrova, D. V. Borovkov, S. Yu. Makushev**, N. A. Polyakova**, N. N. Popov***, S. D. Prokoshkin;** *Moscow Steel and Alloys Institute, Moscow, Russia, *SIKIET, Moscow, Russia, **IMFM CSIICHERMET of I. P. Bardin, Moscow, Russia, ***RFYC-ASIIEF, Sarov, Russia*

Ti-Ni-Nb(-Zr) Shape Memory Alloys with Wide Martensitic Hysteresis. The alloys: 45 at % Ti-45 at % Ni-10 at % Nb (1) and 42,6 at % Ti-46,5 at % Ni-8,0 at % Nb-2,9 at % Zr (2), which are used for thermomechanical couplings (TMC) were investigated. It was shown that high-temperature thermomechanical treatment (HTMT) at 800 °C, $\varepsilon = 0{,}3$ creating dynamically polygonized substructure leads to improvement of functional properties of Ti-45%Ni-10%Nb alloy in comparison with the conventional quenching: the shape recovery rate increases by 10% and the recovery stress reaches 1000 MPa in comparison with quenching. Doping of Zr leads to improvement of functional properties and widening of hysteresis of martesite transformation. The HTMT leads also to decreasing of the recovery stress relaxation temperature on cooling lower -20 °C for alloy 1 and lower – 50 °C for alloy 2. A rather high shape memory effect (SME) also induces a two-way SME (TWSME) in Ti-Ni-Nb alloys which value reaches $\varepsilon_{tw} = 1$ to 2 % when the SME inducing strain is higher than 5 %. Such TWSME value is enough for the TMC self-dismantling during deep cooling.

146. E. P. Ryklina, I. Yu. Khmelevskaya, S. D. Prokoshkin; *Moscow State Institute of Steel and Alloys (Technological University), Moscow, Russia*

Two-Way Shape Memory Effect Training in Nickel-Titanium Alloy. Paramount functional properties of near-equiatomic Ti-Ni alloys are One-Way SME and Two-Way SME (TWSME). The TWSME realization is connected with internal stress fields. The sources of these fields are such structure elements as dislocation substructure and dispersed particles of precipitated phases. The TWSME manifestation in Ti-50,7 % at. % Ni alloy after various regimes of thermomechanical treatment including strain aging are studied. The influence of the indicated factors on the evolution of the TWSME value was studied, as follows: the strain aging time in connection with stages of precipitation process; the load value; the load time. The influence of the indicated factors on the reverse transformation range and residual (unrecoverable) strain are also presented.

147. S. A. Nikulin, A. B. Rojnov, O. G. Perepelkina, N. V. Lyshenko; *Moscow State Steel and Alloys Institute (Technological University), Moscow, Russia*

Structural Factors of Zirconium Fuel Cladding Embritllement in Loss of Coolant Accident Conditions. Loss of coolant accidents (LOCA)

in nuclear reactors lead to the loss ductility and embitterment of zirconium fuel claddings as a result of their high-temperature oxidation in steam and the subsequent fast cooling. Microstructure of fuel claddings made of different modifications of E110 and E635 alloys is quantitatively analyzed after high-temperature oxidation in steam and the subsequent cooling, simulating loss of coolant accidents in nuclear reactors. It is shown, that depending on a chemical composition of zirconium alloy, after identical modes of high-temperature oxidation and cooling, change thickness of oxide film and stabilized by oxygen α-layer, the size and density of hydrides, and does not change the grain size.

148. L. Kosec, B. Kosec, M. Bizjak, Z. Kampuš*, V. Martinčič;** *Faculty of Natural Sciences and Engineering University of Ljubljana, Ljubljana, Slovenia,*Faculty of Mechanical Engineering University of Ljubljana, Ljubljana, Slovenia, **ETI Elektroelement d. d., Izlake, Slovenia*

New Material for Fusible Elements of Low Voltage Fuses. The present technology of production of fuses in slovenian firm ETI Elektroelement d.d and the action thereof are adapted to the existing ecologically harmful low melting alloy of tin and cadmium SnCd20, which ought to be replaced by one or more ecologically safe alloys with technological and application properties as similar as possible to the existing ones. We have found that the stated problems can be successfully solved by the low melting alloy of tin, bismuth and antimony named ETI-Sn-Bi-Sb, which is ecologically safe, and by its technical and physical properties corresponds to the requirements of the use for fusible elements of low voltage fuses. The low melting alloy ETI-Sn-Bi-Sb containing from 4,0 % to 17,0 % by weight of bismuth and from 1,0 % to 3,0 % by weight of antimony, the rest being tin. The above-disclosed low melting alloy is produced in the form of definite or infinite wire of a round or square longitudinal section of dimensions (diameter or side length) from 0,5 mm to 3,0 mm.

149. M. Dobrescu; *University Politehnica of Bucharest, Bucharest, Romania*

Studies Concerning Titanium Alloys Hardening. One of the main problems in service is the law hardness of titanium alloys. In the paper are shown in comparison some possibilities of titanium alloy hardening and the results of the researches. In the case of low cost titanium alloy Ti-1.5Al-4.5Fe-6.8Mo and especially for surface hardness improving the main methods mentionedin the paper are: a) precipitation hardening, b) alloying hardening, c) hardening by heat treating, d) hardening by impurities action, e) hardening by thermo-chemical treatments, f) hardening by grain refinement

Welding, microstructure and properties of welds

150. V. A. Degtyarev, B. S. Shul'ginov; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*

Estimation of Fatigue Limit Stresses for Weldments from Test Results on Specimens Free of Residual Stresses. The authors have analyzed fatigue test results on welded joints with high residual stresses (RS) for different stress ratios. It has been established that taking account of steady-state residual stresses leads to the transformation of the mean stress curve (MSC) into a single point corresponding to the fatigue limit, with the fatigue limit stress at this point being equal to the material yield strength σ_y and the mean stress to the difference between σ_y and the limit cycle amplitude. This explained the reason for a 45° slope on the MSC of the welded joints considered, that is the independence of limit cycle amplitude on mean stress.

151. V. T. Troshenko, K. A. Yushchenko*, B. A. Gryaznov, V. S. Savchenko*, Yu. S. Nalimov, L. V. Chervyakova*; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine; *E. O. Paton Electric Welding Institute, National Academy of Science of Ukraine, Kiev, Ukraine*

Cyclic Strength of EI893 Alloy Rotor Blades of the Turbine Stage Restored by Electric Welding. The authors consider the effect of electric welding on the cyclic strength of turbine rotor blades made from EI893 chromium-nickel alloy. It is proved that there are zones on the blade body safe for repaire.

152. V. V. Kovalenko, *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*

Fractograpy Investigation Welding Joint Aluminium Alloys AK6-D16, AK6-B95 Make By Butt Resistance Welding. The aim of that work is the fractografic investigation of welding joint of various aluminium alloys (AK6-D16, B95-AK6) for the quality-rating device of butt resistance welding of various aluminium alloys. Fractografic analysis are making on the fracture weld joints cracking surface along weld zone. Analyze of the fractures samples AK6-D16 permit to establish, that employment of butt resistance welding for that alloys guarantee ductile fracture type of breaking with 6 - 8 μm medium sized facet. Particular analysis of a fracture surface morphologic shows for attendance in a fracture zone intermetallic inclusion a die up to 3 microns. In segregation zone break type change to qvasicleavage. However volume of quasicleavage does not more exceed two percent. For the junction of alloys AK6-B95 distinctive a ductile fracture. The mean size of facets makes 12,5 microns. In the weld scam structure brittle cracks, pores, dimples that are causes of a brittle fracture are absent.

153. T. Vuherer, V. Gliha, A. Godina, Z. Burzić*; *Faculty of Mechanical Engineering University of Maribor, Maribor Slovenia, *VTI Beograd, Beograd, Serbia and Montenegro*

Influence of the Microdefect in Coarse Grain Heat Affected Zone on the Crack Initiation and Propagation. In our study coarse grain (CC), heat affected zone (HAZ) material with stress concentration and small defect is investigated by using the rotary bending test. For simulation of artificial CG HAZ thermal cycle welding simulator and furnace were used. Cooling speed was the same as at a real welding. Artificial CG HAZ microstructure was martensitic and coarse (grains of approx. 200 μm). Small defects were prepared by Vickers indentation (d = 220 μm and h approx. 25 μm). Defects geometry was measured by special optical method. Stress concentration (1,74) due to the weld toe was achieved by using corresponding groove. Crack initiation and propagation at were investigated. The study shoves the influence of defects and residual stress in CG HAZ on crack initiation and fatigue strength.

154. M. K. Kulekci, F. Mendi*, I. Sevim, O. Basturk;** *Faculty of Tarsus Technical Education Mersin University, Tarsus, Turkey, *Faculty of Technical Education Gazi University, Ankara, Turkey, **Faculty of Engineering Mersin University, Mersin, Turkey*

Fracture Toughness of Friction Stir Welded Joints of $AlCu_4SiMg$ Aluminium Alloy. The objective of paper was to determine the fracture toughness of friction stir welding (FSW) joints of EN AW-2014 ($AlCu_4SiMg$) aluminium alloy, and to compare the fracture toughness of FSW with that of conventional metal inert gas (MIG) process. FSW of aluminium alloy was performed on a conventional semiautomatic milling machine. Defect free FSW welds were produced on alloy plates at constant tool rotation and traverse speed of 1600 rpm and 200 mm/min, respectively. The results of Vickers hardness and Charpy impact tests were used to evaluate the fracture toughness of welded joints. Low heat input, absence of melting and filler metal resulted in better fracture toughness for FSW joints

155. R. Samur; *Teknik Egltim Fakultesi Marmara Universiteal, Istanbul, Turkey*
Investigation of hot Cracking, Microstructure and Mechanical Properties of TIG Welded Different Aluminum Alloys used in Aerospace Industry. The aluminum alloys that are different from the other wrought aluminum alloys with respect to their weldability, namelu 2024 (AlCu), 6061 (AlMgSi) and 7075 (AlZnMg), are often used in aerospace industry today. These alloys are combined in butt form with different welding parameters through TIG welding method. All the samples were heat treated before the tests. The micro-structural changes occurring at the joint areas of the aluminum materials of different chemical compositions combined through different welding parameters were examined with Scaning Electron Microscope (SEM). To indentify the mechanical properties, micro-hardness measurements were made. Tension tests were applied on the specimens obtained from the welded regions. The values obtained from the mechanical tests and the micro-structural changes obtained from micrographs were analyzed.

Nano and amorphous alloys

156. V. I. Mazur, A. Yu. Shport'ko; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Influence of Heat Treatment on the Nanostructure of Liquid Al-10,6 Si Alloy. XRD in situ study of liquid Al-10,6Si alloy after different heat treatment has been carried out. It was found that character of interatomic interaction is changed Si-Si (720 °C) to Al-Si (above 780 °C). Jump-like change of close order parameters of liquid alloy at 720,780 and 830 °C has been fixed. That effect is connected with structural transformation of the melt. Crumbly-packed Al-Si clusters appear above 780 °C. They have metastable tetragonal η-face like arrangement of atoms.

157. V. I. Mazur, E. I. Demchenko, A. Yu. Shport'ko; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Structure Formation during High-Rate Solidification of Al-10,6Si Alloy. The structure and phase composition of rapidly cooled film of alloy Al-10,6 % Si were studied. The method of receive of fine films was developed and basic parameters were determined. The films with different rate of solidification and with different geometrical shape (width and thickness) were obtained. The estimated cooling rate was about 10^5 - 10^6 K/s. The samples of the films were examined by X-ray diffractometer. X-ray diffraction pattern showed interference only supersaturated α-solid solution, which contains 10,6 % Si.

158. A. I. Mikhalyov, A. I. Derevyanko, T. E. Vlasova; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*
Computer Design of Geometrical Phase Transition at Cooking Nanomaterials. A computer model structure of corn's evolution, appearing in the process of receipt of nanomaterials by cooking, is developed. Third finishing phase of cooking, characterized by the rapid fading of compression volume and intensive growth of corns is considered. The computer design showed that intensification of corn's growth was consequence of fractal properties of structural formation in nanomaterials and samesinchronization of the nanoparticles, final chaotic vibrations.

159. G. Abrosimova, A. Aronin; *Institute of Solid State Physics of RAS, Chernogolovka, Russia*
Structure of Nanocrystals in Ni- and Al-based Alloys. The nanocrystalline structure formation in Ni- and Al-based glasses at heating has been studied. The nanocrystal size depends on the alloy composition. Nanocrystalline structure in Al-based alloys was found to be defect free. The nanocrystalline structure in Ni-Mo-B alloys may consists on some nanocrystalline phases: Ni nanocrystals are defect free, the nanocrystals of Ni(Mo) solid solution contain a lot of stacking faults and other defects. The degree of nanocrystals perfection is conditioned by a possibility of formation of different defects. The difference in nanocrystal perfection was found to be connected both with size factor and with energy of stacking fault formation.

160. A. Aronin, G. Abrosimova, Yu. Kabanov, D. Matveev, V. Molokanov; *Institute of Solid State Physics of RAS, Chernogolovka, Russia*
Magnetic Structure and Properties of Bulk Amorphous and Nanocrystalline $Fe_{72}Al_5Ga_2P_{10}C_6B_4Si_1$ Alloy. Structure, domain structure and magnetic properties of as-quenched and annealed bulk $Fe_{72}Al_5Ga_2P_{10}C_6B_4Si_1$ amorphous alloy have been studied. Crystallization of the alloy was found to lead to formation of a nanocrystalline structure. After the crystallization the structure is nanocrystalline, the nanocrystal sizes are up to 50 nm. The coercive force and the saturation magnetization of as-quenched samples were found to be 1 Oe and 130 emu/g. The variations of the magnetic structure and properties correlate with the phase composition of the nanocrystalline structure. After heat treatments at temperatures higher then 1000 K nanocrystalline structure decomposed.

161. A. M. Glezer, I. P. Bardin*; *G. V. Kurdyumov Institute for Physical Metallurgy, Moscow, Russia, *State Science Center for Ferrous Metallurgy, Moscow, Russia*
Melt Quenched Nanocrystals: Structure, Properties, and Application. The systematic analysis of structure and properties of amorphous and nanocrystalline alloys formed by melt quenching and subsequent heat treatment of amorphous precursor has been done. The general classification of resulting structures has been given. The features of dendritic and cellular mechanism of rapid crystallization of melt have been considered. The type and parameters of forming defects of structure has been analyzed in details. The main characteristics of martensite and diffusive phase transformations in amorphous and nanocrystalline melt quenched materials has been detected. In particular, order-disorder transition, solid solution decomposition, thermoelastic and athermal martensite transformation has been studied.

162. K. V. Grigorovich, P.V. Krasovskii, Yu. V. Blagoveshenskii; *A. A. Baikov Institute of Metallurgy and Materials Science of RAS, Moscow, Russia*
New Approach to the Fractional Gas Analysis of Nanopowders. Quality of nanopowders depends significantly the content of gas forming

impurities such as water, nitrogen and oxygen because of very significant specific surface value up to 100 m^2/g. The paper deals with the application of an improved procedure (FGA) for oxide speciation in nanopowder materials by temperature ramped technique on commercially available instruments. The results of the technique are correlated to those of the chemical analysis and X-Ray analysis. Using the FGA method and original software developed the contents of different oxygen forms in nanopowders were determined.

163. V. G. Pushin, R. Z. Valiev*, Y. T. Zhu;** *Institute of Metal Physics, Ural Division of RAS, Yekaterinburg, Russia, *Ufa State Aviation Technical University, Ufa, Russia, **Los Alamos National Laboratory, Los Alamos, USA*

Devolopments in Nanostructured TiNi-based and Ni_2MnGa-based Shape Memory Alloys. We presented here a brief review of our recent results concerning new shape memory materials based on alloys of two practically most important system, namely Ti-Ni-Me and Ni-Mn-Ga. For the first time, high strength nanostructured shape memory alloys were obtained using several different methods of severe plastic deformation (SPD) and superrapid melt spinning (SMS). The formation of amorphous, nano- and submicrongrained crystalline structures was shown to be possible upon SMS and SPD. It was established that a special place among these techniques belongs to the process of controlled nanocrystallization in situ.

164. B. Karpe*, B. Kosec*, M. Bizjak*, J. E. Amengual.*, L. Kosec*, G. Lojen***, M. Šuler*;** *Faculty of Natural Sciences and Engineering University of Ljubljana, Ljubljana, Slovenia, **Universitat Politecnica de Catalunya, Barcelona, Spain, ***University of Maribor, Faculty of Mechanical Engineering, Maribor, Slovenia*

Optimization of the Cooling System for the Melt-Spinning Device for Rapid Metal Solidification. In the following article we will describe optimization of the melt–spinning device for rapid solidification of metals, with the emphasis on numerical modelling of the heat transfer within the cooling rotating wheel, as the most important cooling system component. In the framework, tehnical solution and engineering of the cooling system will be represented. Because of the analogy in the heat transfer between melt–spinning and roll-casting process, existent cooling system for roll-casting process will be used as a base and modified for the puropose of melt–spinning technology. Within the scope of study, we will analyze the influential parameters, which are to be of the greatest significance for heat and mass transfer in the process and have direct or indirect influence on geometry, microstructure and mechanical properties of the rapid solidified thin metal ribbons.

165. M. Bizjak, L. Kosec; ** *Faculty of Natural Sciences and Engineering University of Ljubljana, Ljubljana, Slovenija*

Rapidly Solidified Al-Ni-RE Alloys with Nanoscale Particles. In the frame of the present work, Al-5Ni-3RE (RE- Rare Earth) alloy ribbons were manufactured and the temperature stability of these rapidly solidified Al-Ni-Co-RE alloys was examined (RE-rare earth metals). The type of structure formed by the aluminides or other intermetallic phases is extremely important during this process. However, the effect of the precipitates on the mechanical and other properties of the alloy is far more important. The initial microstructure of the rapidly solidified Al-Ni-Co-RE alloy and the resulting microstructure after subsequent heating were analyzed. The morphology of the as-cast structure, as well as the microstructural characteristics of ribbons, were analysed by transmission electron microscopy (TEM) and scanning electron microscopy (SEM). A thermal stability of these alloy ribbons has been investigated by a combination of scanning electrical resistivity measurements and differential scanning calorimetry (DSC).These alloys have good mechanical properties. Furthermore, the coarsening kinetics is very slow thereby ensuring, good thermal stability.

Application and degradation in service

166. G. V. Stepanov, V. V. Kharchenko, A. I. Babutsky, S. V. Romanov*, N. A. Feofentov, I. V. Kravchenko**;** *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine,* *Machine and Construction Safety Association, Kiev, Ukraine, **Yuzhno-Ukrainsk Nuclear Power Plant, Yuzhno-Ukrainsk, Ukraine

Life Calculations for Header - PGV-1000 Steam Generator Connector Weld Joints under NPP Service Conditions**.** The procedure for calculating the life of header - steam generator connector weld joints is proposed. The proposed approach to the calculation of damage accumulated during static cyclic elastoplastic loadings of structural components based on the account of real stress-strain states, the running-out of the material plasticity reserve, operating conditions (corrosive effects of environment and high temperatures), local stress concentrations, and residual stresses after welding can be used for their substantiated conservative life assessment. The analysis of life calculation results for the "hot" header - steam generator connector weld joint shows that its service life can be extended by optimizing the operating conditions.

167. A. P. Gopkalo; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*

Life Assessment of Internal Combustion Engine Parts. Results of experimental investigations into the thermal fatigue of materials of pistons and heads of cylinder assemblies for internal combustion engines are presented. It is shown that construction of thermal fatigue curves in terms of the relative load value (the ratio between the acting load and the yield strength) in the material vs. cyclic lifetime also permits predicting its fracture mode, namely, the quasi-static fracture mode associated with changes in the initial component geometry and the fatigue one related to thermal fatigue crack initiation and propagation. Recommendations are given on the choice of materials intended for operation under conditions of cyclic temperatures and load variation and on the modification of their service conditions.

168. M. Zrilić, M. Rakin, Lj. Milović, Z. Burzić*, V. Grabulov*; *Faculty of Technology and Metallurgy, University of Belgrade, Belgrade, Serbia and Montenegro, * Military Technical Institute, Belgrade, Serbia and Montenegro*

Experimental and Numerical Evaluation of Steamline Behaviour using Local Approach. Results of the experimental and numerical comparative analysis of steamline pipes has been presented. New pipes and the pipes used for more than 117 000 hours at 540 °C under pressure of 42 bars have been simultaneously tested. This testing has been carried out due to frequent failures of the equipment components exposed to elevated temperatures, such as steam pipelines, make it necessary to pay particular attention to the analysis of the materials used for manufacture of the equipment. The most frequent failures were those connected with occurrence of cracks, particularly expressed in case of steel 14MoV6 3. Local approach to fracture has been developed for complete understanding of fracture mechanism. This approach combines theoretical, experimental and numerical solutions.

169. I. Vitez, M. Oruč*, D. Krumes, I. Kladarić; *Mechanical Engineering Faculty in Slavonski Brod, University of Osijek, Slavonski Brod, Croatia, *Metallurgycal Institute "Kemal Kapetanović", Zenica, BiH*

Damage to Railway Rails Caused by Exploitation. Under contemporary conditions of railway exploitation rails are exposed to a constant increase of speed and loading on the vehicle axles and to constant stress increase in welded railway tracks. Therefore modern railway rails production technology and above mentioned requirements in European Community have demanted a completely new look at the philosophy and content proposals of the new European standards for manufacture and delivery railway rails (series pr EN 13674 and other recommendations). This paper elaborate an overlook of the new requirements which are mainly given in EN 13674-1/2004, criteria for choice of steel grade and damages to railway rails caused by exploitation especially on the head of rails.

170. M. Badida, E. Lumnitzer, M. Románová; *Faculty of Mechanical Engineering Technical University of Košice, Košice, Slovakia*

Development and Application of Sound-Proofing Materials made from Recycled Cars. The paper is devoted to the research of sound-proofing properties of materials from recycled cars. The Authorized Group of Environmental Acoustics in the faculty of Mechanical Engineering at the Technical University in Košice has developed a measuring stand based on Kundt tube on which the acoustical parameters of materials are verified before their application in praxis. In this paper we are presenting some of the applications for these recycled materials for example sound-proofing barriers for traffic communications or acoustic cabins in working environments with high noise level.

171. M. Popović, D. Brnadić; *Testing d.o.o. Karlovac, Karlovac, Croatia*

Metallographioc Analysis of Steels in Boiler Plants. In this work the results of metallographic analysis and mechanical properties of steel components in thermoenergetic plants during and after their application. Metallographic analysis was carried out by means of replica and mechanical properties are determined using tensile testing machine. The impact energy was performed by Charpy method using DVMK specimens in according to DIN 50 115 Std at room temperature. Hardness was tested by transfer electron device type EMT 1101 and in laboratory conditions by means of Brinell method. On the basis investigation on practical conditions could be establishment the base data failure of steel materials used in boiler plants.

172. B. Kosec; *Faculty of Natural Sciences and Engineering University of Ljubljana, Ljubljana, Slovenia*

Failures of Dies for Die-Casting of Aluminium Alloys. Die-casting dies for casting of aluminum alloys fail because of a great number of different and simultaneously operating factors. Material selection, die design, and thermal stress fatigue due to the cyclic working process (heat checking), as well as to low and inhomogeneous initial die temperature contribute to the failures and cracks formation on/in dies for die-casting of aluminium alloys. In the frame of the presented investigation work the intensity and homogeneity of the temperature fields on the working surface of the testing die were checked through thermographic measurements, and failures and cracks on the working surface of the die were analysed by the non-destructive metallographic examination methods.

173. J. V. Tuma, R. Celin; *Institute of Metals and Technology, Ljubljana, Slovenia*

The Use of Stainless Steel for Phosphoric Acid Storage. A 93 % phosphoric acid storage tank was constructed in Luka Koper. The tank was made of 7-mm ground hot-rolled plates of 316 L stainless steel. The capacity of the tank is 750 m^3, with a diameter of 11 m and a height of 8,3 m. Shell plates were welded manually using the shielded metal-arc and gas metal-arc processes. Before the erection, welding-procedure tests according to EN 288-3 were carried out. During the construction several non-destructive examination methods were used, such as visual examination, radiographic testing and liquid penetrant examination. After the entire tank and roof structure was completed a hydrostatic leak test was carried out. The surfaces of all the welds on the internal vessel surface were ground and the roughness checked on site. The surfaces of the base material and ground welds were passivated and tested for resistance to corrosion with electrochemical measurements.

174. D. Kmetič, B. Arzenšek, F. Tehovnik; *Institute of Metals and Technology, Ljubljana, Slovenia*

The Microstructure Degradation of Power Plant Components. For the most important power plant components, where the steam temperature is 540 °C, steels with microstructure of high tempered martensite are used. Older power plants, which operates at lower steam temperature, steels with a ferrite and pearlite or ferite and bainite microstructure are used. These steels have a worse resistance to creep deformation. Processes of microstructural degradation are diffusion controlled and are related to time and temperature. After the long time operation the degradation of microstructure affects on mechanical properties of steel, especially to the resistance of creep deformation. Due to microstructure damages the destruction of components can occur.

Miscellaneous

175. E. V. Chechin; *Pisarenko Institute for Problems of Strength, National Academy of Sciences of Ukraine, Kiev, Ukraine*.

Metal Economy in Strength Analysis of Structures Using the Energy-Based Method (with Consideration of Strain and Low-Temperature Hardening). A metal-saving energy-based method has been devised, which takes into account the margins of plasticity, strain- and low-temperature hardening, and fracture toughness of materials in the determination of allowable stresses being the keystone in strength analysis. Owing to the theoretically justified mechanism of taking the above complex of material characteristics into account, a differentiated ad rather essential, though safe, increase in the allowable (design) stresses at normal and cryogenic temperatures has been realized. Taking into consideration the huge (approximately 700 millions of tons) present-day volumes of the world output of steels and alloys, their saving when replacing the stress-based method by the energy-based on the strength calculation practice for various structures - can be of the order of several millions of tons annually.

176. K. Jelšovska, B. Pandula*; *Faculty of Electrical Engineering and Informatics Technical University of Košice, Košice, Slovaka, *BERG Faculty Technical University of Košice, Košice, Slovaka*

Nuclear Magnetic Resonance Spectral Function and Moments for Proton Peirs in Powdered Paramagnetic Substances $MnSO_4 \cdot H_2O$ and $NiSO_4 \cdot H_2O$. The NMR spectrum is determined by interaction of resonating nuclei between each other particles of the substance. These

interaction depend on the spatial arrangement of particles and their motion. Parameters characterizing interactions between the paramagnetic ions Me^{2+} (Me = Mn and Ni) and the protons of crystalline water in powder $MnSo_4 \cdot 1H_2O$ and $NiSo_4 \cdot 1H_2O$ were derived from the temperature dependences of the second moment of the NMR spectra. The parameters characterizing the local magnetic field acting on the proton pairs were calculated and compared with those obtained from the analysis of the shape of the NMR spectrum.

177. V. Jovišević*,*, M. Soković**, B. Kosec***;** **Faculty of Mechanical Engineering University of Banja Luka, Banja Luka, Bosnia and Herzegovina, **Faculty of Mechanical Engineering University of Ljubljana, Ljubljana, Slovenia, ***Faculty of Natural Sciences and Engineering University of Ljubljana, Ljubljana, Slovenia*

Explosive Cladding Technology In The Process Of Hydraulic Cylinder Production. This work treats the technologies for glide-pairs forming using bronze cladding and using the sheet-bronze explosive cladding technique over the glide surfaces of a steel hydraulic cylinder. In the work the microhardness, microstructure and the bond strength of the interface of a bi-metallic joint on the cross-section of the testing hydraulic cylinder were investigated. A parallel results survey of the application of these two technologies is shown based on metallographic and mechanical investigations of the interface between the CuSn bronze and TS5 steel cylinder.

178. M. V. Borodii; *Pisarenko Institute for Problems of Strength, National Academy of Science of Ukraine, Kiev, Ukraine*

Strain Hardening Prediction for Cyclically Unstable Materials. We analyzed data on cyclic deformation of various materials carbon and stainless steel, pure metal and alloy which differ by their cyclic properties, and revealed the linear dependence between the level of their additional nonpororsional strain hardening and mechanical characteristics. The models for taking into account the cycle path and stress state effect in prediction of material strain hardening and lifetime under nonproportional cyclic loading condition are proposed. In order to take into account the cycle shape we use a coefficient of cycle nonproportionality and material parameter sensitivity to nonproportional loading, while the stress state type is accounted for by using the coefficient of stressed state type and the respective material parameter of sensitivity to the type of stressed state. The prediction results of strain hardening and lifetime obtained using phenomenological models demonstrate satisfactory effectiveness.

179. V. Z. Kutsova, A. Yu. Kutsov, M. A. Kovzel, A. V. Kravchenko, A. V. Zhivotovich; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*

Structure and Properties of High-Chromium Irons after Testing on Wear Resistant. Wear resistant of High-Chromium iron in both as-cast and teat treated condition was investigated. The structure changes were studied in process of shock-and-abrasive testing. The bainitic hardening provides with maximum value, perlite hardening - with minimum and as-cast High-Chromium iron - with intermediate of wear resistant of iron.

180. A. V. Rabinovich, G. N. Tregubenko, M. I. Tarasev, Y. A. Bublikov, A. V. Puchikov; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*

Theoretical Grounds and Technology of an Optimum Microalloying of an Electrosteel by Nitrogen, Titanium and Aluminium. In the given paper physicochemical mechanism of macro- and microstructure formation in steels hardened by carbonitrides has been investigated. Effectiveness of structural steels microalloyed by Ti-Al-N has been showed. It has been showed that microalloying by Ti-Al-N leads to considerable grain refinement and mechanical properties increasing. Peculiarities of melting, casting and solidification processes at electrosmelting conditions have been analyzed. Production technique for structural steels microalloyed by Ti-Al-N with reduced metal withdrawal coefficient has been designed and approved at DSS plant conditions.

181. O. Y. Mirosnichenko, G. M. Khvedchena, V. V. Mombelli; *National Metallurgical Academy of Ukraine, Dnepropetrovsk, Ukraine*

Glasses Forming, Properties and Crystallization in the System TiO_2-$PO_{2.5}$. Glasses forming, properties and crystallization in the system TiO_2-$PO_{2.5}$ are investigated. At cooling rate of melts 200 $K \cdot s^{-1}$ glass are formed in an interval of concentrations 50 - 58 mol. % TiO_2. With increase of TiO_2 content are chemical stability and density of glasses increase. Molar volume, and also volume of one mole of oxygen ions in glass, are temperature started deformations and electric conductivity decreasing. Depending on composition, temperatures and duration of heat treatment in glasses proceed the surface or is simultaneous the surface and volumetric crystallization. The temperature started crystallizations and crystallizing stability of glasses increase at rising of TiO_2 concentration. Crystallization products phase composition (the basic phases - rutile and $TiO_2 \cdot P_2O_5$) is determined.

182. B. Kosec, M. Brezigar*, M. Bizjak, L. Kosec, V. Černe*, M. Soković, M. Ličen*;** *Faculty of Natural Sciences and Enineering University of Ljubljana, Ljubljana, Slovenia, *Iskra Avtoelektrika d.d., Šempeter near Gorica, Slovenia, *University of Ljubljana, Faculty of Mechanical Enineering, Ljubljana, Slovenia*

Heat Treatment of Steel Forgings for the Automotive Industry. In the Slovenian company Iskra Avtoelektrika they manufacture, with the processes of cold forming, a great number of different steel forgings for the Slovenian and European automotive industry. During their exploitation the cold formed steel forgings are exposed to the high mechanical and temperature loads. The corresponding mechanical and temperature properties of the steel forgings are achieved by a heat treatment process. The aim of our investigation work is to present the optimisation of a device for heat treatment in Iskra Avtoelektrika with emphasis on continuous control of working temperature and atmosphere composition. As a practical example will be presented the optimisation of the heat treatment procedure for typical cold formed steel forging from the Iskra Avtoelektrika production proramme. The efficiency and quality of the treatment will be analysed with the use of: chemical analysis, microhardness measurements and metallographic examination methods.

183. P. Mrvar, J. Medved; *Faculty of Natural Sciences and Engineering University of Ljubljana, Ljubljana, Slovenia*

Characterization of Solidification Melable Cast Alloy with Indefinite Graphite. In present work, we dealt with the characterization of solidification and microstructure of melable alloy with indefinite graphite. We used the following examination methods: "In situ" simple thermal analysis, simultaneous thermal analysis, optical and electron microscopy. Based on the heating curves of both samples, from the as-cast cylinder as well as from "in situ" ETA, we showed the martensite transform into austenite, what occurred in the temperature range between 632 °C and 795 °C. At the cooling curves, the transformation of austenite into martensite has not been observed. Using the TTT diagram, we determined

the start temperature of austenite transformation into martensite (M_S), which is approx. 280 °C. With optical and electronic microscopy, we determined the microstructure constituents of the examined alloy. It composed by: primary crystals of austenite $\gamma_{p,}$ graphite eutectic (γ + G), and ledeburite ($\gamma + Fe_3C$). Because austenite isn't stable at room temperature, it underwent the diffusive-less change into martensite, but there was some retained austenite.

184. M. Miščević-Radišić; *Tube Rolling Mill, Sisak, Croatia*
Testing of Steel Seamless Tubes for Pressure Tanks at Increased temperatures. Tubes for boiler manufacture and power plants must withstand high loading at increased temperatures to 550 °C. They have to meet high yield point, crawling values, aging resistance and corrosion. At steel seamless tubes from carbon and alloyed steel yield point Rp0,2 was tested at increased temperatures according to DIN EN 10216 - 2 on electric breaking machine INSTRON TYPE 1196.

185. D. Jakšić; *Works of Light Metals, Šibenik, Croatia*
Optimal Metallurgical Parameters for Bend of Al-Alloys Group 6000. The goal of the paper is to determine optimal metallurgical parameters - values of initial material for pressed products from Al-alloys in the group 6000 (Al-Mg-Si). By the change of preparation conditions properties and structure of all alloys meeting needed bend are determined.

186. M. Knap, J. Falkus*, J. Lamut, A. Rozman;** *Faculty of Natural Sciences and Engineering, University of Ljubljana, Ljubljana, Slovenia,* **AGH University of Science and Technology, Krakow, Poland, **Metal Ravne, Ravne na Koreškem, Slovenia*
Prediction of Chemical Composition Influence on Jominy Test Using Neuronal Nets. Jominy test measurements for different steel grades were carried out in Metal Ravne. Chemical composition of chosen steel grade can also vary, so almost 20.000 data sets (hardness, position and 26 elements), were then taken into consideration. The program Statistica Neural Networks (SNN) was used for predictions, with hardness as output value. It was shown that quite good results can be expected when predictions for similar steel grades were made, and also which element or group of elements has major influence on quench characteristic.

Non metallics

187. V. G. Zajtsev; *Dnepropetrovsk National University, Dnepropetrovsk, Ukraine*
Optimal Control by Process with Free Boundary. In article the problem of optimal control by some ecological process with free boundary when it is required to operate the concentration of environmental contamination caused by a dot source of pollution is considered. As managing influence it is possible to consider neutralizer of concentration of pollution. Thus, the limited absorbing ability of environment is taken into account, and the opportunity of change of it can be caused only by internal influence. In work the constructive approach to the numerical decision of problems of optimal control for nonlinear the parabolic equations with the free boundary. It may be reduced to sequence of the decision of point-to-point nonlinear regional problems for direct process and sequence of linear regional problems for the connected system is offered. The numerical analysis of a modeling example shows serviceability of the specified approach.

188. F. Dorčáková, V. Jan, J. Dusza; *BERG Faculty Technical University of Košice, Košice, Slovakia*
Indentation and Compressive Creep Tests for Determination of Glass Viscosity. The indentation and compressive creep of the Sc-Mg-Si-O-N g1ass have been investigated. Creep experiments have been performed in the temperature range from 840 °C to 910 °C, a flat cylindrical indenter (hot pressed SiC) has been used for indentation test. The strain-time relationship was registrated and viscosity as a function of temperature and the glass transition temperature (T_g) were determined in oxynitride glass. Values of viscosity and T_g obtained from compressive creep were 0,5 orders of magnitude resp. 12 °C lower than from the indentation creep. Measurements performed with cylindrical indenter can be modified by a proportionality factor.