PLASTIC PROCESSING – SECTIN "C" – BOOK OF ABSTRACTS

1. R. Mola, S. Mróz, P. Szota, S. Sawicki

The analysis of the plastic deformation of two-layered magnesium – aluminium alloys (AZ31 – Al). The paper presents the results of physical modelling of the plastic deformation of the two-layered AZ31 - Al alloys. The AZ31 - Al feedstock was produced using the diffusion bonding method. Heating under pressure led to the formation of a continuous layer of the intermetallic phases at the bond interface of AZ31 - Al. A compression test was used to determine the plastic deformation of the two-layered AZ31 - Al alloys. Based on the analysis of the investigation results it has been found that, as the strain rate decreases and temperature increases, the intermetallic phase yields, and a distinct thinning of the intermetallic phase layer has occurred in the zone directly affected by the anvil.

2. S. Mróz, P. Szota, A. Stefanik

The theoretical and experimental analysis of the possibility of employing the groove rolling process for the manufacture of Mg/Al bimetallic bars. The paper presents the results of investigation into the possibility of employing the groove rolling process to produce round Mg/Al bimetallic bars. The feedstock were round 22,5 mm Mg/Al bars that had been produced using the explosive welding method. The average thickness of the aluminium layer amounted to 1,7 mm. The Mg/Al bars were rolled in the stretching rolling passes. The theoretical analysis was done using the Forge2011® computer program. Based on the theoretical and experimental analysis it has been found that one of the main rolling process parameters influencing the quality of bond between the bimetal components is the initial feedstock temperature.

3. K. Laber, H. Dyja, A. Kawałek, S. Sawicki

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

4. A. Kawałek

The effect of relative deformation on the energy-force parameters in the asymmetrical plate rolling process. The paper presents the results of asymmetrical plate rolling in the finishing rolling stand of a 3600 mill. The investigation was carried out for S690Ql steel sheets. Tests were conducted for two types of the asymmetric rolling process. In the first case, the asymmetry of the process was introduced by varying the speed of the upper working roll, while in the second case, two types of asymmetry were introduced simultaneously by reducing the rotational speed of the upper roll and reducing the diameter of the lower roll. Based on the obtained results it has been found that the simultaneous introduction of two types of asymmetry significantly reduces the energy-force parameters of the process, and regardless of relative deformation applied, it yields also a straight rolled plate.

5. S. Rusz, I. Schindler, P. Kawulok, R. Kawulok, P. Opěla, J. Kliber, Z. Solowski

Phase transformation and cooling curves of the mild steel influenced by previous hot rolling. Rods from mild steel S235JR were intensively rolled in the laboratory continuous mill. Specifically defined temperature of phase transformation A_r was determined from the free cooling curves measured by the temperature scanner. The A_r value increased from 763 to 786 °C with rolling temperature descending from 1 200 to 800 °C. The value of A_r = 730 °C was obtained at free cooling of the non-deformed rod of the same diameter 9,8 mm from heating temperature 1 000 °C. The obtained results were compared with continuous cooling transformation (CCT) and deformation continuous cooling transformation (DCCT) diagrams based on the dilatometric tests.

6. A. Gryc, T. Bajor, H. Dyja

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

7. V. A. Andreyachshenko, M. K. Ibatov, D. A. Issagulova

Initial porosity impact on equal channel angular pressing (ECAP) of TI–6AL–4V powder material. There is studied the technology of processing Ti-6Al-4V powder material with various initial densities using the method of equal channel angular pressing. The device with the 90, 120 and 135 degree angled joint channels was used for the study. The deformation was carried out at the room temperature. It was found that the most favorable stressed-and-strained state was formed in the instrument where the angle of channel joints was equal to 135 degrees. The maximum compression in the instrument is reached at 90 degree angle of the channel joints, but it needs a larger deformation force. To obtain pressed material it is recommended to use a high ECAP cycle for any configuration.

8. V. A. Andreyachshenko

Finite element simulation (FES) of the fullering in device with movable elements. In the paper there is studied stressed-and-strained state formed in a billet by fullering in a tool with movable elements. It is determined that compressing stresses prevail in the studied tool; they improve the quality of the processed billets. Even maximum main normal stresses have compressing characteristics at slight tensile stresses. Stressed-and-strained state was studied by using the computer simulation method which was performed in the DEFORM 3D software. The obtained results confirm the efficiency of the new tool in processing cylindrical billets.

9. J. Kliber

Advanced forming technology. Forming is usually the final stage of metallurgical production of steel (90 % of the 1,7 billion tons of total steel production in the world) and traditionally also largely of the products made of non-ferrous metals. Many procedures and methods exist and we will focus only on some of them. The aim is usually to achieve ultra-fine grained structure, the proper microstructure and (mechanical / electrical) properties in innovative materials. The presented article mentions only some examples.

10. S. Barannikova, A. Bochkareva, Yu. Li, A. Lunev, G. Shlyakhova, L. Zuev

Research of the plastic flow of electrolytically saturated with hydrogen (He) Al-Cu-Mg alloy. The effect of hydrogen embrittlement on the plastic flow of Al-Cu-Mg alloy was investigated (HE). The studies were performed for the test samples of aluminum alloy subjected to electrolytic hydrogenation in a three electrode electrochemical cell. It is found that the mechanical properties and plastic flow curves of aluminum alloy are affected adversely by HE. These are found to show all the plastic flow stages: the linear, parabolic and pre-failure stages. It is established that the hydrogenation enhances the localization of straining leads to significant changes in the characteristics distances between local straining zones. The patterns of localized plasticity appear to be useful for a detailed analysis of plasticity exhibited by aluminum alloys.

11. F. Vode, J. Burja, F. Tehovnik, B. Arh

Lumped parameter model with inner state variables for modeling hot deformability of steels. A novel method for description of stress-strain relationship for hot deformability of steels is presented. Laplacian transformation of stress-strain data obtained on cylindrical hot compression tests offer simple description of dynamical input/output relationship between strain (input) and stress (output). In this paper, strain/stress relationship is described

using transfer function of the third order. Parameters of transfer function are determined by numerical optimization for temperatures 1 000, 1 100 and 1 200 °C and logarithmic strain rates 10, 5 and 1 s^{-1}. Obtained relative model error is around 1 % for logarithmic deformations in the range $0,1 < \varphi < 0,8$.

12. X. D. Shu, J. Wei, C. Liu

Study on the control of end quality by one closed cross wedge rolling based wedge block. The paper presents a new method of one closed cross wedge rolling (CWR) based wedge block to achieve near net forming of CWR shafts. The modeling is performed by using the Finite Element Method (FEM) software DEFORM-3D. The metal flow rule of the shaft is clarified by analyzing the strain and displacement field of the shaft. The results demonstrate that the concave heart value of rolled part end will be reduced by about 70 % by one closed CWR based wedge block, comparing it with the case without wedge block. And also the rolling experiments are performed the result of which provides reliable theoretical basis for achieving near net forming of CWR.

13. M. Suliga

The influence of drawing speed on surface topography of high carbon steel wires. In this work the influence of the drawing speed on surface topography of high carbon steel wires has been assessed. The drawing process of f 5,5 mm wire rod to the final wire of f 1,7 mm was conducted in 12 passes by means of a modern Koch multi-die drawing machine. The drawing speeds in the last passes were: 5, 10, 15, 20 and 25 m/s. For final wires f 1,7 mm the three-dimensional analysis of the wire surface topography investigation was determined. It has been proved that the wire topography in the drawing process is characterized by a random anisotropy and the amount of directing the geometrical structure of the surface depends on the drawing speed.

14. S. A. Mashekov, A. E. Nurtazayev, E. Z. Nugman, A. S. Mashekova, M. L. Rakhmatulin, A. I. Poleshchuk

Influence of the stands construction on the vibration of the working and backup rolls of the longitudinal-wedge mill. New design of the mill is suggested in the work. MSC.VisualNastran 4D software of the finite element analysis was used for computer modelling of the longitudinal cold rolling process of the strip and it was calculated the stress-strain state and the vibration of the heavy-duty elements of the longitudinal-wedge mill (LWM) with bearings stands and without the bearings stands. As a result of modelling it was established that strips, rolled in the LWM without bearings stands, have longitudinal and transverse flatness, that is the consequence of the working rolls vibration. It was shown that strips, rolled in the LWM with the bearings stands, have not got any wavy surface. It was proved that during rolling in LWM the dangerous vibrations do not fall into the working space of the external loads, therefore construction of the new mill is good enough, in terms of strength at the vibrations.

15. Ľ. Ambriško, M. Cehlár, D. Marasová

The rate of stable crack growth (SCG) in automotive steels sheets. The main aim of this paper is determining the stable crack growth (SCG) rate for automotive steel sheets. The SCG was monitored using the non-contact videoextensometry technique. CT (Compact Tension) specimens of three steel grades were loaded by eccentric tension under two loading conditions. The SCG characteristics including rate depend on steel grade, on the rolling direction as well as on the loading rate. Linear relation between the SCG rate and δ_R-curve slope was determined.

16. A. Śliwa, W. Kwaśny, M. Sroka, R. Dziwis

Computer simulation of the aluminium extrusion process. The purpose of the work is computer simulation of the aluminium extrusion process using the Finite elements method (FEM). The impact of the speed of a punch falling on the material in the aluminium extrusion process was investigated. It was found that high stresses are created, leading to material destruction, if the punch is falling too fast. The design cycle is significantly reduced in multiple industrial applications if the FEM is applied, which enhances productivity and profits.

17. S. H. Zheng, X. D. Shu, J. Wei

Research on the dynamic recrystallization law of cross wedge rolling (CWR) asymmetric hollow shaft. To improve mechanical properties of asymmetrical hollow shafts parts, the dynamic recrystallization of asymmetrical hollow shaft can be obtained by cross wedge rolling (CWR) technology. The Finite element model (FEM) is established using the DEFORM-3D software, the distribution of the dynamic recrystallization volume fraction is illustrated, and the law of average grain size distribution is analyzed. The microscopy results indicate that the grain size at the central area of cross-section is larger than that at lateral area, and the grain of the central part can be obviously refined, the whole microstructure homogeneity is improved, which have provided theoretical foundation for further improving the quality and mechanical properties of CWR asymmetrical hollow shafts parts.

18. A. Kozhevnikov, I. Kozhevnikova, N. Bolobanova

Dynamic model of cold strip rolling. A dynamic model of the cold rolling process at the continuous rolling mill that combines the model of the electromechanical system and the model of the deformation zone has been developed. The paper presents the results of the study of kinematic parameters, force and energy parameters of the deformation zone with regard to the fluctuating nature of the process variables and to the dynamic processes running in the electromechanical system. It is shown that the variations in the stated parameters are of fluctuating unsteady nature, which has an adverse effect on operation of equipment and quality of finished products.

19. C. Xu, X. D. Shu

Influence of process parameters on the forming mechanics parameters of the three-roll skew rolling forming of the railway hollow shaft with 1: 5. This paper presents the new technology applied in a three-roll skew rolling railway hollow shaft. The three-roll skew rolling forming simulation is conducted in railway hollow shaft with 1: 5. The rotation condition of the three-roll skew rolling is deduced and the rolling force and rolling torque are calculated and validated. The influence of process parameters on mechanics parameter is analyzed, from which it concludes that the mechanics parameters of the skew rolling are obviously smaller than those acquired by the cross-wedge rolling when rolling the same size of the railway hollow shaft. The results of this study lay a theoretical foundation for the realization of accurately forming the three-roll skew rolling railway hollow shaft with short process and low cost.

20. M. Ullmann, K. Neh, T. Henseler, U. Prahl, R. Kawalla

Improved formability of ZAX210 Mg strips manufactured by twin roll casting and hot rolling. The continuous twin roll casting and subsequent rolling method is receiving attention as an integrated manufacturing process to obtain wrought magnesium alloys. In this research, ZAX210 magnesium alloy strip was produced from molten metal by a twain – roll strip caster and rolled in a hot rolling process on a quarto – reversing mill and the properties were analyzed. In order to specificaily set mechanical characteristics, the effects of grain size, texture and second phase size and distribution must be well understood. In this work the forming limit behavior of 2 mm strip was characterized over temperatures ranging from room temperature to 250 °C at a punch velocity of 1 mm/s. It is observed that the forming limit of ZAX210 strip has been shifted to twice as high strains ot 250 °C in comparison to AZ31 strip. At room temperatures, the forming limit is even four times higher. The same behavior was seen in cupping tests. The ZAX210 strip shows a much improved deep – drawing ratio. In addition to the aforementioned investigations 3-point-bending tests were performed, further confirming the previous results. In order to explain the forming behavior, the influences of microstructure and texture are discussed here.

21. B. S. Sun, C. W. Wang, Z. L. Zhao

Research on cold rolling of 41Cr4/20NiCrMo7 bimetal composite bearing ring. In order to improve the service life of bearing rings, a new method of cold rolling bimetal composite bearing rings was proposed in this paper.With Abaqus software,a finite element simulation model of the cold rolling of bimetal composite bearing rings was established. The law of the radial stress distribution, the diameter growth and the deformation of plastic zone during the cold rolling of bimetal composite bearing rings were analyzed. The results of these analyzes are helpful to study the deformation characteristics of the cold rolling of bimetal composite bearing rings. The results show that the bimetal composite bearing ring interface is well bonded and no segregation occurs during the process of cold rolling.

22. E. Klemeshov, V. Chukhlib, N. Devčić

Analysis of deformation of the billet during obtaining a crankpin of the crankshaft by free forging. The technological process of forging crankshaft forgings consists of a variety of forging operations and technological transitions. An important stage is the preparation of the workpiece, which

includes upsetting and drawing of the ingot. The main purpose of this study is investigation of metal shaping process during the manufacture of the crankshaft forgings with a crankpin, obtained by free forging, and also to determine the intervals of the rational forging parameters for free forging operations. The depth of indentation into the workpiece must not exceed 50% of its diameter, in view of the strong curvature. Also, the depth of indentation should not be less than 20%, since the scheme becomes inefficient. The thickness of the used die depends on the required length of the crankpin.

23. Y. Frolov, Y. Haranich, A. Baun, O. Grydin

Channel edge reinforcement at roll bonding process. The roll bonding process is being implemented here in order to create a partially bonded aluminum strip. The assumption is, that the channel edge reinforcement with a wire of same alloy leads to the reduction of the required strain and that this area is able to provide the higher peeling force. To gain important process data, it is helpful to simulate the consideration of a possible reinforcement in QForm FE Software. The attention was paid to the size ratio between the initial wire reinforcement and the channel. The consideration of a possible reinforcement was simulated in QForm.

24. S. Beitsun, M. Mikhailovsky, V. Shibakinsky

Control by thermal preparation of steel ladles. To decrease the thermal shock of the lining-up with the release and reduce of thermal losses of the melt is carried out the preliminary heating of ladles. Modern technical equipments allow to measure only the temperature of casing of ladle. Therefore was worked out a predictive model of changes in the enthalpy of the lining-up for effective control of the process of thermal preparation of steel ladles. The possibility of reliable control of the thermal state of lining of ladles is shown. Use of the offered criterion of efficiency enables to reduce the energy consumption for the preparation and operation of the ladles.

25. I. V. Dobrov, V. N. Ruban, V. Živković

Even milling during repair of surface of rolling of wheels of machines of railway transport. The analysis of technology of restoration repair of surface of rolling of wheels of railway transport on machine KG20 by the complete set of the shaped milling cutters is performed. On the basis of research of the process it is developed the design of shaped mills with number of knives $z = 17$ and the blade angle $\omega = 18$ which ensures uniform milling for the accepted dimensions of wheels.

26. I. V. Dobrov, V. N. Ruban, Z. Blaženković

New visual method of modeling of plasticity of the process of forming of swarf. The method involves studying the process of separating a layer of workpiece material from plasticine by the hammer. On the side surface of workpiece adjacent to the transparent wall of the matrix are strips of plasticine of a different color. The shape of the hammer corresponds to the shape of the cutter when planing. The analysis of digital filming of the process through a transparent wall shows the influence of the tool sharpening angles and the thickness of the separated material layer on the swarf formation process. It is shown that angle of the tool causes decrease of work of friction forces.

27. I. V. Dobrov, A. V. Koptiliy, N. Raguz

Influence of the method of applying of external forces on the parameters of sliding friction of bodies with flat surface of contact. On the basis of the experimental studies of sliding of body along the inclined plane with various length and width it is determined that with change of the position of the body on the inclined plane the position of the point of intersection of the line of gravity with its contact surface is changed. Analysis of the results of the research shows that the representation of body with a flat contact surface in the form of a material point excludes from consideration the influence of external forces on the friction surface.

28. I. V. Dobrov, A. V. Semichev, M. Kostelac

New method of modeling of kinematic parameters of the process of forging. It is developed the new method of modeling of kinematic parameters of the deformation zone during forging of the symmetric stock which is displaced inside of the matrix with clear side walls. It is video recorded the displacement of the color layer of the magnetized metal balls. Analysis of the video of the displacement of the color balls on the contact surface of the stock is showed that the layers of the material on the contact surface are stay on this surface during deformation and on the contact surface appear balls from the inside layers and from the side surface making three neutral sections.

29. R. P. Porgebnyak, I. Samardžić

Frequency characteristics of the drive of turning mill for processing of solid railway wheels. Special heavy railway wheel lathe are involved in the technological flow of mechanical machining of railway wheels in rolling works of metallurgical production. The load of the drive of the machine is significant and substantially non-stationary, which cause failures and destruction of transmission elements in the conditions of an unstable and significant allowance for processing. The complex and simplified to a three-mass calculation schemes with two degrees of freedom are made. Own and partial oscillation frequencies, connection and cohesion coefficients, forms of oscillation generalized parameter are determined. The forms of oscillation have significant amplitude on the faceplate and increase the unevenness of its movement.

30. N. V. Karyachenko, M. Dunder

To a question of transverse vibrations of ropes of freight-carrying rope devices with the mobile distributed and concentrated inertial load.. The problem of studying transverse vibrations of ropes with a mobile distributed and concentrated inertial load reduces to the solution of linear differential equations of hyperbolic type with a mixed derivative. The application of the classical scheme of separation of variables in the real domain of unknown functions to the solution of such equations is impossible. The solution of the differential equation of transverse vibrations of ropes of freight-transporting devices with a mobile distributed inertial load with lumped loads that do not have longitudinal movement is considered as a sum of two groups of standing waves.

31. Y. R. Esaulova, V. M. Laskin, A. Stoić

Restoration of wear on the mandrel by means of electrospark alloying. In the process of processing cold-rolled pipes, mandrels tend to wear out. After wear, the mandrel is again polished to a different size or a new one is made. The purpose of this scientific work is the development of technological processes for the restoration of worn mandrels by the method of electrospark alloying with subsequent finishing. To do this, we use the hard alloy layer on the lathe with a rotating head. Ten prismatic spring electrodes are installed in it. This swivel head allows a significant increase in the processing capacity and the continuity of the coating. Subsequent and finishing operations - smoothing and polishing of diamonds to reduce roughness after hardening.

32. Y. Haranich, Y. Frolov, G. Šimunović

Manufacturing of a heat exchanger plate via roll bonding. Roll bonding is well known process of manufacturing flat, layered composite materials. In this research it is supposed to develop roll bonding process of aluminum strips in order to obtain flat product with hollow channels along it. Such semi-product can be applied for manufacturing of heat exchangers. This study aimed on research of roll-bonding using polymeric wire as a mandrel. That mandrel is forming the inner channel between bonded Aluminum matrix layers. Application of polymeric materials here constrains process temperature, which is crucial factor of welding, hence, the study is focused on optimizing parameters of deformation in such way that pressure while deformation would be satisfactory for the bonding.

33. H. Makeieva, Ya. Frolov, D. Čurčija

Rolling of aluminium stripes reinforced with steel netting. This experiment studied the strain parameters of rolling an aluminium matrix when wire netting is inserted between aluminium layers. Multiple rolling processes were performed in which the temperature and pressure on the material were varied to produce bonding of matrix layers. During the study, the following main investigations were made: strain on areas of longitudinal and transverse cross sections of the composite was measured; stretching and ovalization of net wiring and changes in the net cell angles were determined; mechanical properties of composites along the rolling direction were tested. The experiments were summarized by following conclusion: strips with diagonally oriented reinforcing net showed the best results in the longitudinal tension tests.

34. G. G. Shlomchak

Tunnel process of rolling rheologically complex metals. In presented work laws of development of deformations in dynamically softening metals and alloys had been studied. Experimental analysis of anisotropy of softening in these metals had been implemented. A new procedure of rolling in two cylindrical rolls with super big reductions had been created. Spread of metal is excluded, what intensifies additionally softening of metal and the speed of metal flow in direction of the bigger main deformation. Using the methods of physical modeling the process had been implemented in laboratory conditions by means of rolling lead and lead alloys. The procedure is notable for unattainable earlier values of parameters: reductions up to 96%, angles of contact of the strip with rolls to 60˚. In capacity of natural tests aluminum, magnesium and zinc had been successfully rolled. The industrial mastering of proposed procedure is recommended to be implemented in lines of machines for continuous casting of metals and alloys.

35. N. V. Polyakova, M. N. Boyko, N. Stojčević

Ensuring quality of rolling mill rolls by the choice of rational structure of high chromium cast iron's surface layer. White high chrome cast iron due to high strength parameters is the most widely used for manufacture of two-layer hot rolling rolls. They are used in conditions of simultaneous exposure to high temperatures in zone of deformation, mechanical and thermocyclical loads, as well as – corrosion–active environments. The influence of the structural state of white high chrome cast on his tendency to electrochemical corrosion was estimated. It was found that to high temperature exposure has negative affects on corrosion resistance of high chrome cast iron in both the initial state and the worn state. The products of decomposition of austenite were defined as anodic areas and eutectic carbides – as cathodic areas. Hardening heat treatment aimed at obtaining a bainitic matrix structure significantly increases the corrosion resistance of high chrome cast iron.

36. Yu. Zubko, Ya. Frolov, O. Bobukh

Influence of MNECAE on the grain structure of aluminum alloy EN AW 1050. Recently, ways and methods of managing the structure and properties of metals and alloys using the metal forming are continuously developing. In presented study is determined the effect of multi-tread non-equal channel angular extrusion (MNECAE) on microstructure of EN AW 1050. MNECAE as a method of metal forming compounds elements of methods of intensive plastic deformation and extrusion. That technics of deformation allows to obtain a controlled structure heterogeneity in the final product. The fine grain structure take place in areas of plain shear strain concentration. The recrystallized grains were observed in area of deformation zone with tensile/compressive stresses. Thus the finished product has the gradient of structure and probably mechanical properties over the cross section.

37. S. Abramov, V. Grishin, M. Kostelac

Plastic texturing of the surfaces of the lamellas of the collector unit. As a result of carried out experimental and analytical studies of the finishing-shaping treatment of the lateral surfaces of the experimental lamellae of collector nodes, optimal regimes were determined which allowed to obtain the roughness of the surfaces of an arbitrary microrelief with a tolerance of 0.5 the size of the lamella according to the design documentation. As a result of the overclocking tests, the monolithic capacity of the experimental collectors was increased by 50%. It was possible to compensate for the deviation of the angle of the profile of the collector lamella of insertion of the roughness ridges within the range 5-10 μm, which corresponds to the angle 0°01'. After the roughness was applied, all other conditions being equal, the specific pressure between the plates doubled.

38. A. Melnychuk, V. Grishin, S. Abramov

Evaluation of critical internal stress zones in the detail*s* of bending die stamp. There was considered the evaluation of stresses model in shape-generating parts of bending die stamp. The construction of a die stamp three-dimensional working model was done. Was designed the mathematical model of stresses in applied program Solidworks Simulation, that include used contacts, forces and fixtures. Simulation was provided with the finite element method. The finite element method allows to take into account properties of the deformable zones of heterogeneity, including flat and curved surfaces, allows the calculation of complex configuration areas including multivariable provided technological impact of physical and mechanical properties of the materials. Was detected the areas of critical stresses that are proved by practical experience of the tooling exploitation at manufacture. It shows that provided research is positive. The results of research can be used for wearing prediction of shape-generating parts of die stamp.

39. V. M. Akhundov, M. M. Kostrova, I. Y. Naumova

Nonlinear deformation of an elastically reinforced cylinder under the influence of rotation at rigid fit. This article presents the results of solving the problem to deform a piecewise homogeneous cylinder under the action of rotation in a rigid fit. The cylinder is formed by an elastic matrix as the basic material with a doubly periodic arrangement of ring fibers with square sections made from a more rigid elastic material. The problem has been solved with the model for a piecewise homogeneous medium on the basis of general equations for the nonlinear theory of elasticity. We have applied the method of finite difference relations of the second-order accuracy, based on the results of the cylinder speed rotation.

40. I. Y. Naumova, M. M. Kostrova, V. M. Akhundov

Visualization of the deformation of fiber materials in large deformations. The current study reports on the visualization methodology applied for the units which represent the media of fibre-reinforced materials under conditions of large deformations. The units are visualized by the numerical solutions of the boundary problem, which shows the load on the materials in the deformed media. 3-D images of the deformed materials configurations are given with their nidirectional, bidirectional and three-directional schemes of reinforcement. These configurations are calculated with two level Akhundov's carcass theory employed for a piece of a homogeneous body. Relying on the developed software, one can perform visualization of reinforced material behaviour under deformation with the use of the calculations of a certain material inner fields at the sequential steps in the events of loading.

41. V. M. Akhundov, N. Devčić

Simulation of a piecewise homogeneous cylinder under the action of large deformations at rotation. We address the method of the numerical solution to work with the problem of nonlinear deformation of a cylinder, which is under the influence of the rotational motion around its axis. The structure of the cylinder is the elastic material, periodically reinforced with the square elastic fibers of more rigid nature in the circumferential directions. Based on the model of a piecewise homogeneous medium, the problem is solved by the method of finite differences for small and large deformations of the cylinder components. We have studied the problem with different amounts of the fibers at macroscopically flat deformations and macroscopically flat stressed states. The changes have been revealed in the configurations of ring reinforced elements, which assembles are conventionally represented by the cylinders under the increase of the rotation speed.

42. O. S. Maksakova, A. M. Dolzhanskiy, V. Živković

Activity analysis of the technical committee for standardization tc 136 "fasteners". At present, the development and implementation of normative documents harmonized with international and European standards, is one of the main tasks of standardization for Ukraine. Here the relevant areas of activity are distributed among technical committees for standardization similar to those of ISO and CEN. In particular, in the field of TC 136 "Fasteners" there are mechanical tests, fasteners, screw nails, surface finishing and coatings, steel wire, lines / ropes and chains, etc. The analysis revealed that today more then 100 international standards are accepted as national. The prospective directions of further standardization are revealed which are interesting for both Ukrainian producers and European consumers and customers.

43. Ya. D. Vasilev, R. A. Zamogilniy, E. Yu. Gorban

Determination the smallest thickness of the strip that can be rolled on specific mill. *Ukraine.*The cold rolling of the thin and extremely thin strip is realized at the large ratio values of the rolls radius R to the thickness of the strip h_0, to reaching 500-3000 and more. It has been established that the smallest band thickness h_{1nm}, which can be rolled at a given mill depends on the force interaction at the contact of the strip with the roll and also the rigidity modulus of the working stand, and also the dependence is proposed for its determination. The experimental verification of the proposed dependence showed that it ensures the prediction of the smallest thickness of the strip, which can be rolled at the particular mill with satisfactory accuracy.

44. Vasilev Ya. D., Zamogilniy R.A., Romanova D. V.

Investigation influence of strip thickness on the strength which acts on the rolls during cold rolling. . The cold strip rolling is carried out with small absolute reduction and with large contact stresses. The elastic deformations of the rolls and stripes have a large effect on the process power parameters,

and this effect increases with decreasing thickness of the rolled strip under these rolling conditions. The qualitative data are obtained on the effect of the thickness, yield strength, partial and total relative reduction of the strip on the lowest value of the rolling force P_{min}. Present results of the study can be used for optimizing the deformation modes in the cold rolling mills and improving the energy efficiency of the process.

45. Ya. D. Vasilev, R.A. Zamogilniy, D.V. Romanova.
The determination of the dimensional thickness range for production thin and ultra thin single rolling tinplate. The main trend in the development of the single-rolled tinplate at the present time is to reduce the thickness of the last from 0,18-0,20 mm to 0,10-0,15 mm. Using the interrelation between the thickness *h* and the total relative reduction ε_{Σ} during the rolling of tinplate and taking into account the practical values ε_{Σ} (ε_{Σ}< 0,92…0,94) was defined the optimal dimensional range of the thickness of the hot rolled steel has been determinate and recommend ate for the using in the production of thin and ultra-thin single-rolled sheet in workshops equipped by five- and six-stand continuous mills, as well as two stand compact reversible mills (CCM).

46. Ya. D. Vasilev, I. Sadmardžić
Theoretical study of the changing peculiarities of the rolling advancing with higher compressions in hard friction conditions. It was established experimentally that with increasing ε reduction, under severe friction conditions the lead *S* increasing continuously with increasing relative reduction during rolling. The dependence $S=\varphi(\varepsilon)$ is qualified as «anomalous» because it cannot be explained from the standpoint of the traditional theory of rolling. It is shown that in determining the neutral angle during rolling with the using a new model of frictional stresses, the «anomalous» dependence $S=\varphi(\varepsilon)$ obtained during rolling with increased compression under severe frictional conditions is not an anomaly. This is only regularity of rolling advancing with increased compression under severe friction conditions.

47. Ya. D. Vasilev, N. Devčić
The new model of the shear stress during rolling. The new model of frictional stresses during rolling is proposed, which takes into the account the features and regularities of the contact kinematics the strip with the rolls. In accordance to the new model, frictional stresses at the each zones of the deformation are defined like the product of the friction coefficient by the current values of the normal contact stresses and by the relative sliding speed of the metal along the tool. The using new model of the frictional stresses for solving problems in the theory of rolling has shown that the position of the maximum on the diagrams of normal stresses does not coincide with the position of the neutral section.

48. I. Lomov, O. Kazanovska, M. Dunđer
Classification of defects in welded mesh. Welded mesh is one of the most demanded types of steel wire products. The quality of steel mesh is standardized by standards. The production of the mesh inevitably encounters the manufacture of products with defects. At the moment there is no standard or other generally accepted document that classifies the defects of the welded mesh. This work analyzes the existing grid defects and classifies them. This work will be useful for enterprises producing of welded mesh.

49. Anatoly M. Dolzhanskiy, Y. A. Petl'ovanyy
Regularities of the deformation of small surface defects and increasing the accuracy of measuring their size in metallurgical products quality determining. The presence of surface defects, even of small sizes, often impedes metallurgical products appointment using. Significant in this case are the patterns of defect shaping due to characteristics of product deformation itself. The developed analytical model was verified experimentally for process of steel rod and wire drawing of these regularities definition. For this, an improved method of defects size measuring using high-resolution photographic equipment was applied, followed by computer image processing. The obtained data can be used in the production and research practice of metallurgical enterprises subdivisions.

50. A. M. Dolzhanskiy, O. A. Bondarenko, A. Stoić
Qualimetric determination of initial parameters rational level for quality improvement of metallurgycal objects. On the basis of the qualimetric approach, rational levels of technical and (or) technological and (or) organizational initial parameters that provide the highest possible objects quality level are revealed, made for instance, for the wire drawing process and electrometallurgical ferro-silicate-manganese manufacture. Taking into account the individual quality indicators, their weight coefficients and probable incompleteness of objects description, a generalized algorithm for optimizing control actions using correlation, regression, factor and bootstrap analysis was developed. The solution was obtained by carrying out a virtual experiment on the plans of orthogonal Latin squares of high orders.

51. A. M. Dolzhanskiy, O. A. Bondarenko, G. Šimunović
Dependence of quality complex indicator of metallurgical objects on the type of average weighted assessment of single indicators collection. Complex quality index of object is usually formed by individual quality indicators with their significance coefficients. Convolutions of the corresponding dependencies are usually represented by average weighted values: arithmetic, geometric, harmonic, quadratic, etc. In common case, the influence of the convolution type on the level and stability of the complex quality index is unknown in advance. Appropriate calculations for typical models of metallurgical objects have been performed using the example of wire drawing process and ferro-silicate-manganese production. It was revealed that the value of the complex quality index depends essentially on the type of convolution, and when choosing the best representative from a comparable set of objects, it is reasonable to use the average arithmetic weighted estimate.

52. V. Karpov, V. Zhdanov, I. Vitez
Structuration in copper gazars at interaction of multidirectional fronts of crystallization. Work is devoted to determination of regularities of structuration in samples of gazars at their crystallization from two refrigerators located in one form. The possible condition of fusion before his filling is presented to a form. Main types of casting of difficult products, their advantages, shortcomings and applicability for receiving castings from gazars are studied. Zones in samples of gazars depending on fusion eutectic degree are analyzed during his crystallization. Key parameters of process for obtaining porous structure of preparations, uniform in the sizes of a time, at axial orientation of fronts of crystallization, axial – radial, counter are revealed. Conditions for suppression of defective zones of a large time of merge, which arise in the meeting place of fronts of the gas-eutectic crystallization, are defined. Sizes of relative heat conductivity of gazars are measured and her dependence on degree of their porosity is established.

53. M. Ridzoň, M. Mojžiš, J. Bílik, P. Bella, Ľ. Parilák
Validation of drawing force in experimental drawing of seamless tubes with numerical simulation. For the experimental measurement of the drawing force, an experimental tool has been designed and developed which allows the simulation of the conditions for the production of tubes under real operating conditions. This tool was placed on tensile testing machine. During die drawing of E235 steel tube with input diameter Ø 31.8 x 2.6 mm, the outer diameter of the tube was reduced. The results from the experiment were compared with the numerical simulation, namely the drawing force and the output dimensions of the tube. The numerical simulation visualized the material flow in this process. Comparing the measured quantities with the simulated ones, there was a very good agreement between the simulation and the experiment, and so it is possible to optimize the production process using numerical simulation, leading to innovation of the product portfolio. Acknowledgements: This work was supported by the Slovak Research and Development Agency under the contract No. APVV-15-0319.

54. B. Arh, F. Tehovnik, F. Vode, J. Burja, S. Malej, B. Podgornik
Analysis of initial deformability of the austenitic stainless steels with a bending test. The as-solidified microstructure of austenitic stainless steels has a two-phase microstructure composed from γ-austenite and δ-ferrite. The initial workability of the as-solidified microstructure is better in the case of primary solidification of primary δ-ferrite, because it prevents the concentration of impurities in the residual interdendritic melt. The aim of the study was to determine, if the presence and shape of δ-ferrite grains does not worsen deformability during hot rolling. The hot bending tests was selected for the evaluation of the initial deformability of austenitic stainless steel with different volume ratio of δ-ferrite.

55. I. Mamuzić
Proporties of superplastically formed aluminium alloy. The efect of back pressure and forming pressure on thickness distribution cavitation, grain growth, surface topography and corrosion properties was studied in superplastically formed aluminium alloy 1205 pans. The operation of such shear surfaces also resulted in the formation of both steps at the surface of the deformed sheets and threadlike fibres at sliding grain boundaries.

56. G. Šimunović
Copper strips by internal oxidation and hot rolling. Cu-Al alloy strips were internally oxidised without using any oxidant powders by a surface oxidation method. Several of this internally oxidised alloy strips were stacked and bonded by rolling at high temperatures. The bonded strip was cold rolled to achieve tensile strengths of 480-540 MPa and yield strengths of 470-520 MPa with thermally stable mechanical properties.

57. J. Šipalo Žuljević
Deformation of aluminium alloy Al 20. During semisolid deformation of aluminium alloy Al 20, as the deformation strain increases the deformation stress first increases to reach a peak value than decreases to a minimum value after which the stress increases towards the and of the deformation.The deformation stress increases as the deformation rate increases at the beginning of the deformation.The degree of segregation is the highest at the middle deformation temperature.

58. I. Mamuzić
Extrusion process. To examine metal flow behaviour experimentally in the spreading extrusion process a round billet is spread by means of a spread rings and extruded through a die opening wider than the internal diameter of the container.In spreading extrusion the extrusion load is reduced by about 30 % in comparison with basic extrusion. As a result, the metal flow balance markedly worsens due to an increase in the size of the plastic deformation zone and frictional rosistance acting on the spread ring wall.

59. M. Kostelac
Banding in high chromium rolls. A mathematical model for black oxide layer thickness of a high chromium iron roll was established on the basis of the oxidation mechanism and oxide layer structure. It is shown that the black oxide layers formed on the roll surface induce the formation of cracks which propagate easily along M_3C and $M_7 C_3$ carbides resulting in their final separation from the roll surface during the rolling process.

60. V. Živković
Textures in hot rolled microalloyed steel. Textures development during thermomechanical processing of a newly developed ultrahigh strenghth microalloyed steel was investigated with particular attentation to though thickness texture gradient. A considerable texture gradient was evident particularly in the 1/2 depth compared to the other three position (surface 1/8 depth 1/4 depth). The recrystallisation texture of austente 1100 (001) transformed into 1100 (001) component in the ferrite indicated an increase in intensity with increase in depth.

61. M. Mojžiš, M. Ridzoň, P. Bella, Ľ. Parilák
The experimental measuring of drawing forces by cold drawing process of seamless precision tubes. This article deals with establishing and verifying a possibility of using a drawing machine when the maximal drawing force necessary for cold drawing process of seamless precision tubes with a plug is measured. The tube dimensions changed by the drawing process from outer diameter 31,8 mm and wall thickness 2,6 mm to tube dimensions of outer diameter 28 mm and wall thickness 2 mm. The measuring of drawing force was carried out on a three-phase analyser of electric nets and the results were compared with the results of theoretical calculation of drawing forces according to the change of cross section before and after drawing. The final result shows that the maximal drawing force cannot be exceeded even when the parameters such as volume of reductions and limit states of plastic deformation change. Acknowledgments: This work was supported by the Slovak Research and Development Agency under the contract No. APVV-15-0319.

62. P. Bella, P. Buček, M. Ridzoň, M. Mojžiš, Ľ. Parilák
Comparison of die geometry for cold drawing of multi-rifled steel tubes. Multi-rifled tubes, i.e. tubes with multiple inner grooving are used in heat exchangers and boilers, providing favourable heat transfer conditions due to turbulent flow of cooling medium. Therefore, strict requirements are placed on the geometry of inner rifling. In production of such tubes, cold drawing with free-to-rotate rifled plug is the final drawing operation to achieve required dimensions. A FEM-based numerical model of the process was prepared in order to optimize the geometry of the die. The results of numerical simulations with two types of die showed the difference in material flow and corresponding drawing force. Final dimensions of the tubes after drawing were compared with the customer`s requirements and a good agreement was found. Acknowledgements: This work was supported by the Slovak Research and Development Agency under the contract No. APVV-15-0319.

63. R. Ďurčík, J. Turňa, P. Buček, Ľ. Parilák
Numerical modelling of heat transfer during stretch reducing of seamless steel tubes. Stretch reducing of seamless steel tubes is a hot rolling process where the input temperature of hollow feedstock reaches 990 °C. Heat transfer to the rolls needs to be compensated by proper cooling of the rolls by water spraying. In our case, the stretch reducing process was modelled in FEM-based software and the solution obtained both by Lagrangian and ALE method. Tuning the simulation results on 806 °C surface temperature of the tube after stretch reducing has been performed by modifying HTC values between each pair of roll and corresponding tube segment according to the contact pressures calculated. Calculated roll surface temperatures have been compared to the values measured during actual rolling run, either by thermocouple or pyrometer method.

64. Yu. V. Li, S.A. Barannikova, L.B. Zuev
This paper is aimed at studying patterns of plastic deformation and fracture of the bimetal. The contactless method of registration of vectors fields displacement has allowed to obtain localization patterns of plastic deformation during uniaxial extension. Metallographic analysis of the connection boundary has confirmed its continuity and high quality. The stages of the plastic flow curves have been analysed. The propagation of the localization bands in bimetal corresponds to the stages of strain-hardening upon the tension of FCC, BCC and HCP pure metals and alloys.

65. D. Malindžák, B. Pandula
Heuristic model for production scheduling wide-strip rolling mill. In steelmaking plants for hot-rolled making sheets, the natural bottle neck is a warm wide-strip rolling mill, because there are only one and the other aggregates in the production process is more, but also due to its high price and capacity requirements, especially when the rolled product prevails thin sheets. For this reason, capacity planning and production scheduling is of great importance, both in terms of coordination with the planning of previous aggregates such as blast furnaces, continuous casting equipment, as well as successive directions such as splitting, plastics, zinc plating lines and the like, but in particular the determination of the size of batches of rolled slabs and their sequences in order to roll up the maximum number of sheets on the same rollers, minimize roller changes. In the case of warm wide –strip rolling mills, are generally applied for production scheduling so-called "campaigns, which integrate a large number of elementary rules /heuristics, technological rules, constraints, optimization criteria/. The article deals with the methodology of creating the production schedule, defining the rules, calculating the type and number of campaigns in the defined planning period, filling the campaigns, and campaigns sequence.

66. P. T. Iswanto, H. Akhyar, F. F. Utomo
Effect of almen intensity on fatigue behavior of aisi 304 by shot peening. Stainless steel AISI 304 is common material that widely used for extensive implant industry. Failure of material, especially for bone implant applications which affected by fatigue load. The purpose of the present experiment to improve fatigue crack growth resistance and a surface hardness in AISI 304 using shot peening metal treatment by variation of Almen intensities. In this experiment, AISI 304 were shot peening on surface failure fatigue specimen by giving air pressure on balls. Results of this experiment showed that shot peening with 0.005 Almen intensity was achieved 192.3% fatigue live with 127,700 cycles (Paris constant C, n is $1x10^{-11}$ and 3.5, respectively) from a non-treatment material. The surface hardness reached 429.63 kgf/mm^2.