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The Use of Optical Microscopy to Evaluate the Tribological Properties

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Tribology is an important method for evaluating the coefficient of friction and wear of friction pairs of technical materials. The most commonly used modes are "pin on disc", resp. "ball on disc". Tribology can simulate the stress of two objects (the friction between the objects) under the real conditions. The output of the tribological test is a specific value of the coefficient of friction and wear rate. For a comprehensive evaluation of tribological properties is used the optical microscopy - to evaluate the size of wear of the pad (groove width) and of the pin (loss of material of the ball or roller). The use of modern sophisticated equipment allows to evaluate the coefficient of friction and wear also in various environments, such as in the process fluids.

Keywords: tribology, coefficient of friction, optical microscopy, process fluids

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Metallography Evaluation of IN 718 after Applied Heat Treatment

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INCONEL alloy 718 is a high-strength; corrosion-resistant nickel chromium alloy used at -253 °C to 705 °C for production of heat resistant parts of aero jet engine mostly. Mechanical properties of this alloy is strongly depended on microstructure and from presence of structural features such are gamma double prime (γ″), gamma prime (γ′) and delta (δ) phases. Mentioned phases precipitate at various temperature ranges and Nb content as well. Article deals with applying of heat treatment at 800°C for 72 hours and its influence on structure changes. For microstructure evaluation a techniques of scanning electron microscopy (SEM) were used.

Keywords: Inconel alloy 718, Gamma double prime and Gamma prime precipitation, Heat treatment or Re-heating of alloy, Microstructure evaluation

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Analysis of HVOF Coating on Molds Used for Refractory Fireclay Shapes

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Molds used for pressing refractory fireclay shapes are exposed to very strong abrasive wear, which is given by the combination of applied pressure of more than 60MPa and processed materials like alumina (Al_2O_3) and silica (SiO_2). Typical lifespan of molds is in several thousand cycles, our aim was to improve the lifespan 10 fold at minimum. To increase the lifespan of the critical parts of the molds, it was decided to use HVOF coating technology based on WC. This article evaluates the quality of the coating on the pins for pressing tools based on the technology used for deposition. An analysis was made on two sets of HVOF coated pins from different suppliers marked as a sample "A and B". Pins were analysed on tactile CMM with scanning system and samples from these pins were analysed on a multisensor CMM.

Keywords: HVOF Coating Thickness, Flatness, Mold Lifespan Increase

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Characterization of Porous Magnesium Prepared by Powder Metallurgy - Influence of Powder Shape

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Recently, demand for porous biodegradable load-bearing implants, called scaffolds, has been increasing. The interconnected porous structure allows transport of body fluids to healing tissue and ingrowth of new tissue into the implant. From the point of view of mechanical properties, magnesium based materials seem to be very promising for scaffold fabrication. Moreover, magnesium belongs to biodegradable and bioresorbable materials and magnesium ions support growth of bone tissue. In this study we prepared porous magnesium by powder metallurgy using ammonium bicarbonate as a space-holder material and focused on the influence of initial powder shape on sample microstructural, mechanical and corrosion characteristics. Based on obtained results we found out that the usage of spherical initial magnesium powder produced samples with more spherical pores in comparison with those of samples prepared from magnesium chips. Due to these microstructural differences samples prepared from spherical powder achieved higher values of mechanical characteristics.

Keywords: Powder metallurgy, porous magnesium, powder size influence.

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Identification of Stress and Structure Properties in Surface and Subsurface Layers of Nuclea Reactor Austenitic Steel

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The article deals with non-destructive measuring and evaluation of residual stresses and chemical properties of stainless steel sample and its possibility to affect functional properties of the material. X-ray diffractometry can accurately determine values of both residual stress and austenite percentage. Due that this method of measuring is non-destructive, it is possible to ensure measure repeatability and measured component is able to keep its original function. Monitoring of residual stresses in components can be useful in predicting damage incidences due to workload over lifetime of components and together with austenite volume it can also be used as evaluation parameter of suitability of applied manufacturing technological operations.

Keywords: Residual stress, austenite volume, stainless steel, X-ray diffraction

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Ultrasonic Testing of Girth Welded Joint with TOFD and Phased Array

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The article describes the fundamental physical principles of the ultrasonic defectoscopy TOFD (Time of Flight Diffraction) and Phased Array. There is a report from the ultrasonic testing of girth welded joint with ultrasonic flaw detector OmniScan MX2 16:64 PA from the company Olympus NDT. In welded joint were artificaly made three defetcts. Two lack of sidewall fusion (on the left and right side of welded joint) and one crack in axis of welded joint. Both ultrasonic testing were designed in software ESBeamTool 5 from the company Eclipse Scientific, which simulates the geometrical ultrasonic beams spread. At the end, data from both ultrasonic testing were evaluated. The same procedure will be used for the design of ultrasonic inspection TOFD and Phased Array at girth welded joints of gas pipelines.

Keywords: NDT, Ultrasonic testing, TOFD, Phased Array

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Temperature Dependence of the Internal Friction Measured at Different Excitation Voltages

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Internal friction reflects the ability of the material irreversibly dissipating mechanical energy oscillations. That means, the material of high internal friction ability is able to significantly reduce the vibration amplitude. Dispersion of mechanical energy in the material is just the one of the ways of energy transformation for example conversion of mechanical energy to heat energy. This article is focused on the analysis of the internal friction changes depending on the temperature. For experimental measurements was used AZ91 magnesium alloy. Measurements were performed at different excitation voltages. In experimental measurements was used only ultrasonic resonance method. This method is based on continuous excitation of oscillations of the test bar, and the entire apparatus vibrates at a frequency which is close to the resonance.

Keywords: Internal friction, Resonance Method, Magnesium Alloy

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Effect of cutting fluids on the tool life in turning and milling of construction steel

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Using cutting fluids often enables an increase of cutting tool life. A large amount of cutting fluids produced in the European Union exists on the market of Czech Republic. It is quite difficult for purchasers of cutting fluids to acquire reliable test data about the performance of the fluids in industrial conditions and choose the best cutting fluid, the use of which will guarantee the longest tool life. In this regard comparative tests of cutting fluids were conducted at the laboratory of the Department of Machining and Assembly of the Technical University of Liberec to determine the effect of cutting fluids from different producers (from England, Germany, Norway and Switzerland) on tool life in turning and milling.

Keywords: Machining, Cutting fluid, Wear

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Non-destructive Magnetic Evaluation of Ground Surfaces Made of Bearing Steel of Variable Hardness

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This paper deals with non destructive magnetic evaluation of ground surfaces of variable hardness based on Barkhausen noise (BN) technique. Except magnetic investigation, obtained BN signals are correlated with metallographic observation, microhardness readings as well as residual stress measurements. The results show that regime of heat treatment – annealing after hardening significantly affects the possible concept for monitoring surfaces after grinding. Conventionally heat treated surfaces of hardness 62 HRC indicate the typical surface thermal softening induced by grinding cycle whereas samples of lower hardness exhibit rehardening effect associated with the progressive decrease of Barkhausen noise responses along with the developed grinding wheel wear.

Keywords: Heat treatment, grinding, Barkhausen noise

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Preparation of Magnesium-zinc Alloy by Mechanical Alloying

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Mechanical alloying is one of the ways how to prepare nanostructured and amorphous metallic materials. In this paper we used this method to prepare Mg-Zn alloy containing 50 wt.% of zinc. Powders produced by milling in a planetary ball mill were consequently compacted by the SPS method, a very fast method which prevents grain coarsening. The prepared samples were subjected to a closer examination - microstructure, phase composition, hardness and short-term thermal stability were studied. We found out that the prepared powder consisted of Mg and Mg_7Zn_3 phases, which were very fine and homogeneously distributed. After the SPS compacting, the metastable Mg_7Zn_3 phase decomposed and new phases (Mg, MgZn, $MgZn_2$, Mg_2Zn_{11}) formed. The compacted sample possessed relatively inhomogeneous microstructure and hardness about 260 HV5. Investigation of the short-term thermal stability was accomplished by annealing at temperatures up to 300 °C. We observed changes in hardness – it regularly decreased up to 200 °C and then it slightly increased.

Keywords: Mg-Zn alloy, mechanical alloying, SPS

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Coating Surface Roughness Measurement Made On Coining Dies

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The paper describes the surface roughness measurement of functional parts of tools for minting coins. The coining dies were coated with three types of coatings – CrN, TiCrN and WC/C. Roughness of the coining die surface is a very important factor for the quality of a struck coin. The quality of specific coatings on the coining die surface was evaluated by a contact (Hommel Tester T500 roughness measurement device) and contactless method (microscope Sensofar PLu neox) by using optical interferometry and confocal microscopy. Results from the shop measurement gained by using the roughness measurement device were compared to the laboratory measurements gained by using microscope. Moreover, results were illustrated in the graph. Measured values were identical. Only the CrN coating showed bigger difference. Minimum roughness value was measured on the coining die with the TiCrN coating. The WC/C coating reached the maximum roughness value. 3D visualization method of surface roughness using software Gwyddion proved inappropriate for burnished surfaces.

Keywords: roughness, coining die, roughness measurement device, optical interferometry, confocal microscopy

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Measurement of Wear Metals in Engine Oils by Atomic Absorption Spektrometry Method

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The article describes a method of measuring engine oil wear metals by Atomic Absorption Spectrometry (AAS), which is an analytical method used to determine the concentrations of various elements in the sample. Atoms of different elements absorb different wavelengths of light in proportion to the quantities in which they are represented, as an analytical measurement property is performing absorption of radiation by free atoms of the reference element. AAS method with flame atomization allows measuring the concentration of about 60 elements of the periodic table in a solution with a sensitivity from hundredths to hundred μg.ml^{-1}. It is used in the analysis of samples of different origins. This method makes up a significant part of monitoring low levels of toxic elements in environmental samples, which is very good to be used for its high sensitivity and selectivity. The aim of the study was the evaluation of the composition of wear particles tested oil samples by AAS, which is highly accurate and a fully automated tribotechnical diagnostics method. The intensity of each line radiation gives information about the content of investigated metals in the tested samples of motor oils, which enable us to identify not only the place from which abrasion arises, but also reveals the cause of the critical condition of the mechanism.

Keywords: Atomic Absorption Spectrometry, Absorbance, Engine Oil, Wear Particles, Tribotechnical Diagnosis

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Application of Discriminant Analysis in Monitoring the Wear Particles in the Engine Oil

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Multi-dimensional analysis does not include the conventional statistical techniques used in the operating reliability of the machine, where it is much more appropriate than the one-dimensional analytical method. The article deals with monitoring the wear particles in the tractor Zetor 8641 Forterra to pherograph creating pherographical footprint, in which the engine is in critical condition. The experimental part focuses on the trend curve fitting wear evaluated from individual particle analysis tests conducted to permit the monitoring of internal combustion engines (especially diesel). Theoretical assumptions about the relationships between selected parameters of motor oils and knowledge of individual material components allow to reliably determine the accrued failure due to the increase of wear metals in the oil and signal the increased engine wear in a timely manner and to draw attention to the approaching critical condition of the machine. By applying multi-dimensional statistical data in the measurement of wear metals enabled uncovering the links and structure of the tribodiagnostic parameters and sampling the oil, which also helps to determine deeper conclusions depending on the material identification impurities.

Keywords: Discriminant Analysis, Engine Oil, Wear Particles, Tribotechnical Diagnosis, Trendy Wear

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Microstructure Control of Secondary A 231 Cast Alloy Used in Automotive Industry

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The application of Al-Si alloy castings has gradually increased in many mechanical components in the last years, especially for cars and rail vehicles, thanks to the great potential of these materials as replacements for ferrous alloys. Controlling the microstructure of secondary aluminium cast alloy (Al-scrap and workable Al-garbage) is very important, because these alloy containing more of additions elements, that forming various intermetallic phases in the structure. The mechanical properties are strongly depending on the morphologies, type and distribution of the structural parameters. Microstructure control was realized with combination of different analytical techniques (light microscopy, scanning electron microscopy (SEM) upon deep etching and energy dispersive X-ray analysis - EDX).

Keywords: Al-Si cast alloy, mechanical properties, SEM, deep etching, X-ray analysis

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The Usage of Backscattered Electrons in Scanning Electron Microscopy

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Secondary and backscaterred electrons are the most common signals used for imaging in the scanning electron microscopy. Generally, SE are used to obtain topographical contrast while BSE show differences in chemical composition (so called Z-contrast).The aim of the present work is to show possibilities and techniques to obtain not-so-common information using BSE, as e.g. orientation contrast, residual stress, different allotropic modifications, etc.

Keywords: Scanning Electron Microscopy, BSE, Structure.

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Defect Detection in Pipelines during Operation Using Magnetic Flux Leakage and Phased Array Ultrasonic Method

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The present article is focused on the non-destructive testing (NDT) inspection of pipelines during operation namely Magnetic Flux Leakage (MFL) method and Phased Array ultrasonic (PA) method. MFL inspection technique is electromagnetic test method primarily used to detect flaws or defects in high-permeability of ferromagnetic metals such as carbon steel tubing, plate, wire rope and tubular parts. PA ultrasonic method is an advanced NDT method that is used to detect component failures i.e. cracks or flaws and thereby determine component quality. Due to the possibility to control parameters such as beam angle and focal distance, this method is very efficient regarding to the defect detection and speed of testing. In this article real pipeline defect was identified by MFL method in the internal pipe inspection. This defect was fully mapped by Phased Array ultrasonic method in the terrain. 3D model of defect in the tested material was created from measured data and obtained by PA method. The real dimensions of the defect determined from measurements by the method of MFL and PA are compared.

Keywords: Non-destructive Testing, Magnetic Flux Leakage, Phased Array, Gas Pipeline Inspection

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Preparation and Characterization of NiTi Shape Memory Alloy Preparedby Powder Metallurgy

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Some perspective materials are characterized by shape memory effect and NiTi alloy belongs to their main representatives. NiTi is an approximately equiatomic alloy of nickel and titanium and it possesses interesting properties, such as superelasticity, pseudoplasticity and good corrosion resistance. Hence, it is used in different branches of industry (aerospace, medicine, engineering etc.). Common manufacturing melting methods of this alloy are vacuum arc remelting (VAR) and vacuum induction melting (VIM) methods. However, these methods have some disadvantages. The VAR process must be repeated several times to achieve sufficient homogeneity of manufactured ingots. During the VIM process the melt can be contaminated by carbon originated from graphite crucible. Therefore, powder metallurgical methods have been extensively investigated in last years as an alternative to the common processes. In this work, NiTi samples were prepared by the thermale xplosion mode of self-propagating high-temperature synthesis (TE-SHS). Chemical and phase composition, as well as microstructure and hardness of the prepared samples were studied. Afterwards, the samples were heat treated and the influence of the annealing on the studied characteristics was investigated.

Keywords: NiTi alloy, powder metallurgy, SHS

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Analysis of the Defects Causes in Rolled Brass Sheet

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The aim of this paper is to identify the causes of defects in rolled brass sheets which appear in the final stage of the blank production. These defects cause the increase in the production cost of the blank, which is undesirable. The analysis methods were used, such as spectroscopic chemical analysis, microstructural analysis using light and electron microscopy and the application of selected mechanical tests. Based on the analysis results, the analysis and cause determining and type of qualification occurring defects was realized.

Keywords: defect, brass, analysis, microstructure, REM

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Evaluation of composite structures by light microscopy and image analysis

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A composite is a material which is made up of two or more distinct materials. Composite materials are generally used for buildings, bridges and structures such as boat hulls, swimming pool panels, race car bodies, shower stalls, bathtubs, storage tanks, imitation granite and cultured marble sinks and counter tops. As a result of absorption of liquids usually occurs a change in volume, which is referred to as swelling. This process can give rise to physical and chemical properties of polymers.NIS - Elements 3.0 was used to evaluate the microstructure of composite materials with different contents of ferrite powder filler. Using NIS - Elements 3.0 assessed the number of particles Sr ferrite surface area and perimeter Sr ferrite particles and the volume fraction of Sr ferrite in the microstructure.

Keywords: composite, polyethylene, image analysis, chemical resistance, powder filler

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Microstructure Analysis of Welded Joints after Laser Welding

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Titanium alloys are widely used in aerospace and automotive industries. They are used to implement some parts of machines, also in the chemical industry, power industry, arms industry, shipbuilding, in implantology and biomedical engineering. Extent of use of this material is mainly due to high corrosion resistance, especially in aggressive environments. These are materials with a low ratio of the weight in relation to the mechanical properties. That is, while maintaining the desired mechanical properties of structures made of titanium is lighter than the standard stainless steel.Unfortunately, the properties of titanium, in particular at temperatures higher than the affinity of the nitrogen and oxygen in the air, has an effect on some types of processing. In particular, the heat treatment as cutting or welding, due to the fact that the reaction of titanium and oxygen is highly exothermic. Therefore, the parts of the titanium produced in an inert atmosphere.

Keywords: Laser welding, CO_2 laser, titan grade 2, microstructure

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Structural Description of Powder Metallurgy Prepared Materials

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The compaction of powder metals and alloys is very difficult field due to preserving of unique properties of initial materials. One of few possible method of succesful compaction is plasma sintering. To describe detailed structure os powder metallurgy materials, it is necesary to use advanced microscopy methods such as SEM and TEM. In this study, the structure of NiAl intermetallic compaoud is described. The material was at first produce by reactive sintering from pure elements. Subsequently, the NiAl porous master alloy was milled and compacted by spark plasma sintering (SPS) technique.The particle size of NiAl powder was compareable to the grain size of compact material, which exhibited low porosity. It was proven that the interconnection on NiAl particles is performed by thin layer of nanocrystalline oxides.

Keywords: SPS, intermetallics, powder metallurgy

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Material Research of a Decorative Bronze Circle from the Hallstatt Culture Period

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The paper deals with material research of a bronze circle from the Hallstatt culture period. The structure of bronze was observed with an optical microscope and scanning electron microscope. The structure corresponds to wrought tin bronze after recrystallization annealing. One original repair of the crack in the material which was done by cast bronze, was determined. The bronze contains a big amount of sulphide inclusions, which are oriented in a direction of forming material. Chemical composition of the alloy and non-ferrous inclusions were determined by the EDS analyser and minority elements were determinated by the XRF spectrometer . The bronze contains 9 to 10 wt. % Sn with minority elements Pb, Ni and Fe. XRD and SEM were used in order to identify nonequilibrum Cu-Sn phases. The results were compared with EBSD analysis. The nonequilibrium phase $Cu_{39}Sn_{11}$ was reliably determined by EBSD analyser.

Keywords: archaeological bronze, nonequilibrium phase, SEM-EDS, EBSD, XRD

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Abrasive-free Ultrasonic Finishing of Metals

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The aim of the research was to compare a classical (turning) machining and an abrasive-free ultrasonic machining (bufo) at three different materials. The surface was evaluated on the basis of an Olympus LEXT 3100 measuring of a surface roughness and hardness HV5. An ultrasonic set I – 4 consisted of the ultrasonic generator, power output 630 W and working frequency 22 kHz ± 10%, was used for the research. Main results are: increasing of the hardness HV5 of the machined surface, lowering of the roughness parameters Ra at the application of the abrasive-free ultrasonic machining, lowering of the roughness parameters Rz was not statistically proved at the application of the abrasive-free ultrasonic machining. It is possible to say according to a visual observing of the steel sample surface that a corrosive resistance was increased at the application of the abrasive-free ultrasonic machining.

Keywords: Hardness, Machining, Microscopy, Surface Roughness, Testing

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Setting of Causes of Adhesive Bonds Destruction by Means of Optical Analysis

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A research analyses an influence of an adhesive surface treatment on an adhesive bond strength. Constructional adhesives used for bonding in an automotive industry were used for the research. A significant factor for evaluating the adhesive bond failure is the research of bonded areas by means of an optical analysis. An even layer of the adhesive in the bond is connected with it. The adhesive bonds diagnostics is difficult. It is necessary to control a quality of the production at the production process. A significant factor lowering the resultant strength of the adhesive bond is its creation. One of possibilities of the adhesive bond diagnostics is to use a method of an optical analysis. An uneven layer of the adhesive belongs among main causes of a failure / considerable decrease of the strength of the adhesive bond.

Keywords: Adhesive layer, Diagnostic, Failure area, One-component epoxy, testing

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The Effect of Asymmetry on Vertical Dynamic Response of Railway Vehicles

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An experimental and analytical study on the effect of asymmetry on vertical dynamic response of railway vehicles has been conducted. The experimental study featured a typical vehicle model of laboratory scale and a real railway vehicle wagon. The experiment was used to gain insight into the effect of asymmetry on vertical dynamic response and to validate an analytical model of the vehicle-track interaction. This paper presents the results from the study and shows that mechanical asymmetry changes the behaviors of the system. The current contribution introduces a methodology of analytical solution of vertical dynamic response of the railway vehicle. Moreover, a mathematical model according to the physical system considered was developed under MATLAB environment.

Keywords: vehicle asymmetry, railway vehicle, analytical model, experiment test

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Monitoring of the Structure and Quality of Aluminium Castings in Moulds of Gypsum Mixtures

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The paper deals with the production of dimensionally accurate castings of aluminum alloys in moulds of gypsum moulding mixture. This manufacturing process is very important for the production of castings for radio technology. Castings have high dimensional accuracy and high - quality of surface. Production of aluminum alloy castings in moulds of gypsum mixtures belong to a group of non-traditional methods of casting and foundry practice, this method is used for the production of special castings. Moulds and cores from gypsum mixture have specific application not only in the production of aluminum alloy castings but cast alloys with low melting temperature (tin, zinc, lead). In these days this method produces dimensionally accurate parts with high surface smoothness such as those used for radio-communication systems or propeller small blowers. Under the conditions of the Czech foundry at our institution, the Department of Engineering Technology - TU of Liberec, we devote this method for many years. The main attention is paid to the methodology for the production of gypsum moulds and their heat treatment and the correct choice of the chemical composition of the aluminum alloy in order to obtain high-quality castings.

Keywords: Structure, Quality, Aluminium alloy, Mould of gypsum mixtures, Castings.

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Application of Microscopy and X-ray Diffraction in Optimization of the Production of NiTi Alloy by Powder Metallurgy

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This paper describes the dependence of microstructure of NiTi shape memory alloy on the conditions of non-conventional powder metallurgy processing routes – reactive sintering of compressed Ni+Ti powder mixture and mechanical alloying with consequent compaction by Spark Plasma Sintering. First method was chosen as the process enabling to yield the high-purity NiTi alloy, while the second one aimed to reach the ultrafine-grained microstructure. The microstructure and phase composition of the products are compared in this work. The positive effects of high heating rate (> 300 K.min-1) and high temperature (at least 900 °C) on the reactive sintering process were recognized. Microstructure of the product is composed by NiTi matrix with dispersed Ti_2Ni particles. Similar microstructure can be also obtained by mechanical alloying for at least 120 min and consequent compaction by Spark Plasma Sintering.

Keywords: powder metalurgy, NiTi, mechanical alloying, reactive sintering

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Analysis of aluminium alloys AlSi7Mg0.3 and AlMg3 by means of X-Ray Diffraction

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Material crystal compositions and their phase structures have become the necessary and important part of the materials research and advanced technology in recent decades. Each property and information about material phase structure is more or less immediate way depending on the structure and crystal composition. Prerequisite of any technological breakthroughs in this area is therefore detailed information on the structural parameters of materials.

Keywords: X-ray diffraction, thermal expansion, material properties

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Effect of Low Pressure Application during Solidification on Microstructure of AlSi Alloys

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This study investigated the effects of squeeze parameters on the properties of squeeze castings and the optimum parameters for producing squeeze castings from Al-Si alloy. It also compared the properties of the squeeze castings with those of chill castings. Squeeze castings were made from AlSi7Mg0.3 alloy using pressures of 15-22.5-30MPa with the alloy poured at 680, 700, 720 and 740°C into a die preheated to 150, 200 and 250°C. Squeeze time was 10s. At the pressure effect during crystallization there is possible to observe the refinement of eutectic silicium with the increasing pressured. Eutectic Si is excreted in clusters in comparison with non-influenced structure. There comes to increasing of failure strength and mainly of elongation. The hardness of investigated samples was not changed markedly. At the pressure of 15 MPa there comes to inadequate pressure influence, what causes the creation of shrinkage in the longitudinal part of the sample. This decreases the mechanical properties.

Keywords: microstructure, low pressure, alloy AlSi7Mg0.3

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Non-destructive Testing of Split Sleeve Welds by the Ultrasonic TOFD Method

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This article deals with the non-destructive ultrasonic testing of split sleeve butt joints by ultrasonic methods. Split sleeve is used to repair gas pipelines with gas leakage. The new ultrasonic methods TOFD and Phased Arrays are compared considering to the selected butt weld configuration. To compare testing methods, ES Beam Tool software was used to prediction of ultrasonic beam spread through weld joint. TOFD technology was selected to butt weld section testing according to the beam spread simulation results. The results of ultrasonic testing by TOFD method were compared with results of macrostructural analysis of weld joint. Controlling the suitability of testing method to planar defect identification, the artificial defects were prepared and tested. The appropriate setting of measuring technique can be predicted from experimental results.

Keywords: Ultrasonic testing, TOFD, Split Sleeve, Defects

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Setting of Angle of Soil Flow on Ploughshare at Traditional Processing of Soil

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The soil is a considerable abrasive medium which exerts on tools processing the soil in a negative way. The main problem connected with using the soil processing machines is their wear owing to particles embedded in the soil. The ploughshare is one of the most loaded parts of the ploughing body and huge requirements are put on it. The aim of the research is to set an angle of a soil flow and connected wear of the ploughshare at the traditional processing of the soil. It is possible to further issue from ascertained pieces of knowledge at a production/renovation of the ploughshares with new functional surface. The statistical analysis evidenced that the angle of the soil flow on the ploughshare surface was the same with the angle of the ploughshare head. It followed from the measurements that the optimum angle for depositing the oblique overlay which is necessary for the creation of the serrated edge is in the interval 35 ± 4°.

Keywords: Composite, Functional surface, Optical analysis, Steel, Wear

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Microstructure Evolution of Al-Mn-Si-Fe Alloy Studied by In-situ Transmission Electron Microscopy

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Equal channel angular pressing is one of the techniques of severe plastic deformation, which produce materials with sub-micrometric grains. Materials with grains under 1 μm are of great importance for industrial applications thanks to enhanced strength at lower temperatures and formability at elevated temperatures. One of the possible ways how to enhance microstructure stability of aluminium alloys at elevates temperatures is addition of small amount of zirconium. In our study, heat treatment at 450 °C leads to precipitation of Al_3Zr phase. After ECAP these particles postpone recrystallization above 400 °C. However, in the material without Al_3Zr particles the recrystallization resistance is comparable thanks to impact of α-Al(Mn,Fe)Si phases. More over, initial microhardness after ECAP is higher for the alloy, which was not heat-treated at 450 °C before ECAP, thanks to higher dislocation density and solid solution strengthening by Mn atoms.

Keywords: Aluminium alloys, ECAP, TEM, recrystallization, precipitation.

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Effect of Extrusion on Mechanical Properties and Structures of Zn-Mg Alloys for Biomedical Applications

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Zn-Mg alloys, in which Mg is an alloying element, are proposed for medical applications as a promising biodegradable material for temporary implants in orthopedics or traumatology. They can be used to replace nonfunctional or damaged tissues. When the healing process of tissues is finished, the Zn-Mg alloys are gradually decomposed in a human body and a reoperation is therefore unnecessary. Their mechanical properties must be similar to the characteristics of human bones. Large grains are typical for the structure of cast alloys. Pure Zn and Zn-0.8Mg alloy were cast and subsequently extruded at 300°C. The structure and mechanical properties (Vickers hardness, compressive and tensile strength tests) of the cast alloys were compared with those of the extruded alloys. Pure Zn and Zn-0.8Mg alloy after the extrusion had a fine-grained structure and showed better values of mechanical properties in comparison with the cast alloys.

Keywords: Biodegradable material, Zn-Mg alloys, Extrusion

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Structure and Properties of Zn-Mg Alloys for Medical Implants

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Polymeric materials are used in modern medicine for the fixation of fractured bones. Their function is only temporary - they serve as substitutes till they are replaced by human tissue (without additional reoperation). Their disadvantage is that they possess low mechanical strength and hardness. As an alternative to polymeric materials, the metallic fixation components are being developed. Their advantage is the higher value of strength, toughness and hardness. Zinc alloys represent a new trend in this technological field. They also meet the requirements for biocompatibility and their mechanical properties approach the properties of human bones. In this paper, the structural and mechanical characteristics are described. The only alloying element in the zinc alloys examined was magnesium in the range 0-8.3 wt. %. The mechanical properties were discussed in the relation to the microstructure and the phase composition of the alloys. The results showed that the mechanical properties of binary Zn-Mg alloys increase with the growing content of Mg with the maximum achieved at the eutectic composition. Higher magnesium content strongly deteriorates the mechanical properties of these alloys.

Keywords: Biodegradable material, Zinc, Mechanical properties, Structure

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Technology of Laser Forming

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The presented article describes the unconventional technology - bending and forming by laser. This technology is alters the tension in the material, which subsequently change the shape of formed parts. Article also describes four mechanisms of deformation after the impact of the laser beam on the material: The first mechanism - mechanism of temperature gradient, the second mechanism - buckling mechanism, the third mechanism - pressing mechanism (Borten) and the fourth mechanism - mechanism of phase transition. The experimental part focuses on the metallographic evaluation of samples from three different areas of the laser micro forming. Article describes in detail the technological parameters used during the development of the experiment and includes a summary of results. Article contains images of the structures detected in the heat affected zone.

Keywords: Laser forming, laser bending, CO_2 laser, carbon steel

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Efect of Selected Elements on the Microstructure of Secondary Al-Si Alloys

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This paper deals with influence on segregation of iron based phases on the secondary alloy AlSi7Mg0.3 microstructure by chrome and nickel. It is impossible to remove iron from melt by standard operations, but it is possible to eliminate its negative influence by addition some other elements that affect the segregation of intermetallics in less harmful type. Realization of experiments and results of analysis shows new view on solubility of iron based phases during melt preparation with higher iron content. By experimental work were as an iron correctors used three different amounts of AlCr20 and AlNi20 master alloys. Addition of these master alloys had a significant impact on the shape of intermetallic phases and mechanical properties.

Keywords: secondary AlSi7Mg0.3 alloys, intermetallic phases, iron correctors, AlCr20, AlNi20

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Production of Al-Si-Fe-X alloys by powder metallurgy

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The aim of the present work was to study the effect of chromium and nickel on the Al-Si alloy, which contained certain amount of iron, and to describe, how these alloying elements affect mechanical properties at room and elevated temperature. Nickel and chromium were chosen as alloying elements due to the low solubility and diffusivity in aluminium matrix, which improve mechanical properties and thermal stability at elevated temperature. Measurements were made on the cast alloys, rapidly solidified alloys and compact alloys. Rapidly solidified alloys were produced using a melt spinning process. Compaction of prepared ribbons was carried out using Spark Plasma Sintering. The microstructure of the products was examined using optical microscopy and X-ray diffraction. Vickers hardness was measured to determine mechanical properties.

Key words: aluminium alloys, rapid solidification, melt spinning, Spark Plasma Sintering

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Application of Mesh-free Methods in Transient Dynamic Analysis of Orthotropic Plates

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The requirements for reducing the weight and increasing the strength and carrying capacity of the plane and space structures are constantly growing. The one of the way how to meet demands is to use the layered shell composite structures. They could be applied not only in mechanical engineering (containers, pressure vessels, etc.) but also in the civil engineering (cooling towers, roofs, etc.). The article deals with computation procedure of shell and plates using meshless methods. A mesh-free local Petrov-Galerkin (MLPG) method is applied to solve laminate plate problems described by the Reissner-Mindlin theory. Two projection methods are developed to generate the shell surface using the Lagrangian mesh-free interpolations. The bending moment and the shear force expressions are obtained by integration through the laminated plate for the considered constitutive equations in each lamina. The Reissner-Mindlin theory reduces the original three-dimensional (3-D) thick plate problem to a two-dimensional (2-D) problem. Results of transient dynamic loads in the composite plates using MLPG solution are presented here.

Keywords: Composite Materials, Mesh-free Methods, Transient Dynamics, Orthotropic Plates.

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Monitoring of precipitation process in AZ31 and AZ91 magnesium alloys by internal damping measurement

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Internal damping is able to monitor the microstructural changes in solid materials and these changes can be based onvarious mechanisms. In this investigation a same heat treatment was carried out on AZ31 and AZ91 magnesium alloys, aimed at detection of microstructure changes of material after homogenization annealing and also the process of precipitation was continuously analyzed by the internal damping measurement. Internal damping was measured as a function of temperature in AZ31 and AZ91 magnesium alloys by ultrasonic resonance spectroscopy. The internal damping spectrum was measured in the temperature range from 50 °C up-to 390 °C. Peaks of internal damping occurred in temperature range from 250 °C up-to 350 °C on AZ91 magnesium alloy. Also the mictrostructure analysis was carried out at the diferent stages of the internal damping measurement which showed creation of continuous precipitate in the maximum of the internal damping peak. The creation of the peak is caused by absorbation of energy by the process of continuous precipate nucleation and growth in the volume of material grains.

Keywords: Internal Damping, Magnesium Alloy, Continuous Precipitate

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Heat-Affected Zone of Plasma of Laser Cut Materials

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Permanent evolution of new high-strength and difficult-to-machine materials as well as production of precise and shaped products have made the engineering practice to advance towards development of technologies to allow such materials to be machined without major difficulties. In such cases, advanced machining technologies are gaining ground whose principle is based on application of physical, or combined physical and mechanical methods of forceless material removal rather than mechanical work such as conventional cutting operations. In most cases, such methods involve conversion of the energy supplied to heat which, more or less, affects the base material being machined. The most frequent technologies of this kind include machining by cutting using a plasma beam or a laser beam. The plasma beam machining and laser beam machining are both based on melting the material at extremely high temperatures. Such extremely high temperatures cause formation on an area in the base material where the structure of the material is changed by the heat down to various depths. The objective of the experiments described in this paper is to determine the size of the heat-affected zone and to identify the changes in the structure of selected types of material and their effects on further machining.

Keywords: plasma cutting, laser cutting, heat-affected zone, structure of base material

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The Effect of Niobium Addition and Heat Treatment on the Phase Structure of Fe3Al – Type Intermetallic Alloys

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The iron aluminides seem to be a promising materials for high-temperature applications. They have a wide range of positive properties, but unfortunately also some negative (for example low ductility at room temperature or sharp drop in strength above 600°C). The addition of third element into the alloy can be the way to improvement of the properties. Nb, Zr or Ta seem to be appropriate elements. The niobium addition to the Fe-Al matrix leads to the formation of Laves phase. If the Laves phase is presented in an appropriate shape, it could enhance high temperature mechanical properties. These properties are dependent on the structure of alloy – mainly on second phase distribution and type.Two alloys with different content of niobium were investigated. The influence of niobium content and heat treatment on the structure and mechanical properties of the alloys were studied. The phase composition was determined using scanning electron microscopy (SEM) equipped by energy dispersive analysis (EDX) and electron backscattered diffraction detector (EBSD). This paper is the first part of study and it deals with description of the alloy structure and phases in the investigated materials.

Keywords: Fe3Al – type iron aluminides, Nb addition, phase structure, heat treatment

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SEM and EDS Analysis Used in Evaluation of Chemical Pre-treatment Based on Nanotechnology

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The most important aim of chemical pre-treatment is the removal of contaminants, corrosion products etc. from the material surface and obtaining such a basic material surface, which will provide sufficient corrosion resistance of the base material and suitable conditions for the adhesion of paints or other finish coatings to steel material. When selecting the method of chemical pre-treatment of the base material surface it should be considered whether the degree of preparation provides the required level of cleanliness of the surface and also the surface roughness and surface profile for the coating to be applied to the base material after chemical pre-treatment. The paper focuses on SEM and EDS analysis used in evaluation of chemical pre-treatment based on nanotechnology. These chemical pre-treatments are excluded on low carbon steel sheet. On the surface of low carbon steel sheet were excluded coatings of chemical pre-treatments (Fe phosphate, coating based on nanotechnology) and has been studied character of excluded layers on electron microscope.

Keywords: SEM, EDS analysis, chemical pre-treatment, phosphating, nanopassivation.

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Change of Internal Friction on Aluminium Alloy with 10,1 % Mg Dependence on the Temperature

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The article is focused on the analysis changes dependence on the temperature on the aluminium alloy with 10,1% Mg, 1,32% Si and 0,43% Mn by internal friction. Internal friction is a property of the material is measured on the ultrasonic resonant aparature at a frequency about f = 20470 Hz. The measured temperature range was from 50 °C up to 420 °C. Precisely measurement of the internal friction can be monitored ongoing structural changes and various mechanisms that prevent these changes.

Keywords: Internal Friction, Aluminium Alloy, Resonant Frequency, Temperature

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Analysis of surface integrity of parts after non conventional methods of machining

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This paper deals with analysis of surface integrity of steel after electro discharge machining (EDM), water jet machining, (WJM) laser beam machining (LBM) and plasma beam machining (PBM). The paper discusses surface integrity expressed in surface roughness, sample precision expressed in perpendicularity deviation as well as stress state. This study also demonstrates influence of the various non conventional methods on structure transformations and reports about sensitivity of the different non conventional methods of machining with regard to variable thickness of machined samples.

Keywords: Equation, Manufacturing Technology, Pictures, Tables, Template

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Picture Analysis of Failure Areas of Particle Composites

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Properties of polymeric materials are often optimized by various types of fillers. Optical analyses be means of a microscope can reveal undesirable phenomena which come into being during a preparation of composite systems – they can define areas of filler clusters, an excessive occurrence of air bubbles, which lead to an initiation of cracks. The optical analysis can reveal a low interaction among mutual phases of the composite at the same time, e.g. a low wettability of fillers by a matrix. The paper describes possibilities of using optical analysis at polymeric microparticles composites with the filler on a basis of waste with the matrix from the epoxy resin. The optical analyses identified the air bubbles in failure areas of the composite systems – the average area of the pore in 2D plane corresponded 5 381 μm^2.

Keywords: Epoxy resin, Failure, Microscope, Waste

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Quantitative Evaluation of Microstructure of Graphitic Cast Irons

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The paper deals with some problems of quantitative metallography which includes evaluation of microstructure by etalons, measurement of structural parameters by coherent test grids and automatical image analysis. Some advantages and disadvantages of these methods are shown in this contribution on the example of evaluation of microstructure of graphitic cast irons. The automatical image analysis enables to eliminate some disadvantages of evaluation of microstructure by etalons and by coherent test grids but it has also some negatives.

Keywords: Quantitative metallography, Microstructure, Image analysis, Graphitic cast irons

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Structure and Mechanical Properties of Mg-Based Alloys for Elevated Temperature Applications

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Magnesium alloys are progressive light-weight materials with a great potential in automotive and aerospace applications in which they enable significant weight and fuel savings. However, the main drawback of the most widely used AZ type magnesium alloys (Mg-Al-Zn) is a very poor thermal stability. The AZ alloys cannot be applied in components exposed to temperatures exceeding 120°C, because of a rapid drop of mechanical characteristics at above this temperature. There are two approaches to improve the thermal stability of Mg alloys. The first one consists in alloying with rare earth metals and the second one involves simoultaneous additives of aluminium and alkaline earth metals (Ca, Sr). In the present study, microstructures, mechanical properties and thermal stability are characterized for advanced commercial Mg alloys, WE43 (MgY4Nd2RE1Zr) and AJ62 (MgAl6Sr2) developed for elevated temperature applications. It is semonstrated that thermal stability of both kinds of alloys significantly exceeds that of the commercial casting AZ91 (MgAl9Zn1) alloy.

Keywords: Magnesium, Mechanical Properties, Thermal Stability

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New Inspection Technologies for Identification of Failure in the Materials and Welded Joints for Area of Gas Industry

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Contribution presents new principles of inspection technology for examination of integrity of the gas pipelines material and its welded joints. Information is linked with real output from measuring on gas pipelines and results are compared to conventional NDT methods. Visual control is done as a first non-destructive test in 100% extent for all welds. It must be executed well in advance before all the other tests in order to remove superficial defects and irregularities, which could prevent correct application and evaluation of other tests. It is used to detect superficial defects and geometrical irregularities, especially cracks on the surface of weld or in the heat affected area, elevation of weld, undercuts in transitions to base material, defects in the root of weld, if it is accessible from pipe's inner side, including inadmissible offset of weld surfaces from pipe's outer side and their continuity of transition to the weld. The following are the tests to detect internal defects radiographically, respectively by an ultrasound and tests to detect superficial cracks for branches, necks and fillet welds.

Keywords: Gas industry, NDT, Phased Array, OmniScan

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Variability of Local Corrosion Attack Morphology of AISI 316Ti Stainless Steel in Aggressive Chloride Environment

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AISI 316Ti is Cr-Ni-Mo austenitic stainless steel stabilized by Ti, recommended for construction of various industrial and medicine devices. In spite of its high Pitting Equivalent Resistance Number (PREN=23.688) it underlies local corrosion namely pitting in aggressive chloride environment. Appearance and extent of AISI 316Ti corrosion damage in a particular chloride solution depends strongly on temperature and surface treatment. One part of tested specimens is surface untreated the second part is treated by nitric acid passivation. Specimens are immersed for 24 hours at the temperatures of 30, 50 and 80 °C in 0.3M $FeCl_3$ solution to induce pitting. Pitting corrosion morphology (shape and size of corrosion pits) is observed viewed from above and in profile as well, by optical metallographic microscope and scanning electrone microscopy SEM. Shape and size of corrosion pits is compared in dependence on temperature and surface finish of specimens.

Keywords: Pitting corrosion morphology, AISI 316Ti stainless steel, Immersion test, Aggressive chloride solution, Nitric acid passivation

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Vanadium and Chromium Impact to Microstructure of AlSi10MgMn Alloy with Elevated Iron Content

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In Al-Si alloys iron as an impurity causes decreasing of mechanical and foundry properties of castings. Nowadays is paid attention to adding different elements into aluminium alloys to increase the properties of final castings. Some elements eliminates iron by changing iron intermetallic phase morphology, decreasing its extent and by improving alloy properties. Also there is a possibility of using lower amounts of more elements, what can lead to change of morphology and to improve casting properties at the same time. The contribution is devoted to vanadium and combined vanadium and chromium impact to AlSi10MgMn alloy with high iron level. This effect is evaluated through microstructural analysis using different etchants. Colour metallography is also used to find the better and faster identification of the intermetallic phases.

Keywords: Secondary Al alloys, Iron influence, Vanadium, Mutual V and Cr influence, Microstructure

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