

П. ок
3-13

ISSN 1028-6861

ЗАВОДСКАЯ
ЛАБОРАТОРИЯ
ДИАГНОСТИКА МАТЕРИАЛОВ

51

2015
МАЙ

INDUSTRIAL LABORATORY. DIAGNOSTICS OF MATERIALS

ЗАВОДСКАЯ ЛАБОРАТОРИЯ

ДИАГНОСТИКА МАТЕРИАЛОВ

№5 ТОМ 81
2015

ЕЖЕМЕСЯЧНЫЙ НАУЧНО-ТЕХНИЧЕСКИЙ ЖУРНАЛ ПО АНАЛИТИЧЕСКОЙ ХИМИИ, ФИЗИЧЕСКИМ, МАТЕМАТИЧЕСКИМ И МЕХАНИЧЕСКИМ МЕТОДАМ ИССЛЕДОВАНИЯ, А ТАКЖЕ СЕРТИФИКАЦИИ МАТЕРИАЛОВ

Основан в январе 1932 г., Москва
Учредитель: ООО Издательство "ТЕСТ-ЗЛ"

Адрес редакции:

119991, Москва, ГСП-1,
Ленинский пр-т, 49,
ИМЕТ им. А. А. Байкова, Редакция
журнала "Заводская лаборатория.
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E-mail: zavlabor@imet.ac.ru

Журнал включен в список изданий,
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Центральная научная библиотека
Уральского отделения
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426000, Уфа, ул. Пушкина, 109

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UDC 543.51:543.621

Analysis of Water using Mass Spectrometry with Inductively Coupled Plasma*Karandashev V. K., Leikin A. Yu., Khvostikov V. A., Kutseva N. K., Pirogova S. V.*

Different issues and limitations (sample preparation, matrix effect, spectral interferences) regarding the analysis of natural and drinking water by ICP-MS are discussed. Recommendations for overcoming those limitations are proposed. New experimental data on using robust plasma conditions for suppressing matrix effect are presented. The advantages of the combined application of mass spectrometry and atomic emission spectrometry which extend the line of analytes to be determined and enhance the reliability of the analysis are discussed

Keywords: *inductively coupled plasma mass spectrometry; matrix effect; sampling; samples of natural and drinking waters.*

UDC 543.054

Sample Preparation for Gas Chromatographic Determination of Potential Toxicants in Polymer Materials that Contact Food*Gorbunova M. O., Ketova Yu. V., Fedik N. S.*

Conditions of sample preparation and gas chromatography detection of volatile aromatic hydrogens (benzene, toluene, xylenes, ethylbenzene) and monoatomic alcohols (methanol, *n*-propanol, isopropanol, *n*-butanol and isobutanol) in polymer materials contacting with foodstuff are optimized. Extractants and optimal conditions of extraction which promote the most complete extraction of detecting compounds (concentration and volume of extractant, time of extraction and temperature rate) are specified.

Keywords: *gas chromatography; sample preparation; polymer material; volatile aromatic hydrocarbons; monoatomic alcohols.*

UDC 661.185.3:543.544.43

Gas Chromatography Control of Synthesis of N,N-Dimethylaminopropylamids of Fatty Acids*Zykov A. V., Krysanov V. A., Mokshina N. Ya.*

Natalytic-free interaction of methyl esters of fatty acids of coconut oil with an equimolar amount of N,N-dimethylaminopropylamine has been studied during twelve hours. Sample for analysis are collected once per hour. Identification of the reaction products has been performed using a Scion TQ mass spectrometer and NIST11 mass spectra library. The degree of the reaction completeness was assessed by determining the residual content of methyl esters by gas chromatography using as internal standard methyl heptadecanoate, the values of the relative standard deviation in the determination of methyl esters do not exceed 0.030. The analysis was carried out on a Bruker 451 GC with flame ionization detector (FID). The selected chromatographic conditions provided low duration of analysis (32 min) and the absence of peak overlapping. The correction factors are calculated proceeding from the results of analysis of standard mixture (Supelco) to compensate the response FID upon FAME determination. After 12-h catalytic-free synthesis a residual amount of methyl esters of the fatty acids was 10.8%. The obtained results are attractive for the experts in the field of organic synthesis of surfactants and can be used in estimating of the rate of conversion of methyl esters of fatty acids in the synthesis of N,N-dimethylaminopropylamides.

Keywords: *methyl esters of fatty acid; synthesis of N,N-dimethylaminopropylamides; gas chromatography.*

UDC 669.715:548.53

The Effect of Additional Alloying with Sc and Sc + Zr on the Strength Properties of Al-Mg₂Si Alloys*Rokhlín L. L., Bochvar N. R., Leonova N. P., Sukhanov A. V.*

The effect of Sc and Sc + Zr on the structure and properties of Al-Mg-Si alloys is studied using measurements of hardness, electrical resistivity, mechanical properties, light and electron microscopy analysis. Alloying of Al-Mg₂Si alloys with transition metals (Sc or Sc + Zr) results in their strengthening upon natural ageing and has no effect in the case of artificial ageing. The observed effects are explained using electron microscopy and local X-ray analysis.

Keywords: *aluminium alloys; alloying; hardness; strength; electrical resistivity; supersaturated solid solution; strengthening phases.*

UDC 539.5:669.14.018

On the Mechanism of Steel Cold Brittleness*Lebedev M. P., Makarov V. V., Petrov P. P.*

An application of a physical model developed on the basis of anisotropy of thermophysical characteristics of the grain and grain boundary to developing of new generation of steels operated in conditions of low natural temperatures is discussed. The expediency of using x-ray diffractometry in the study of temperature dependence of crystal lattice parameter in iron-based alloys is substantiated.

Keywords: cold brittleness; steel; lattice spacing; x-ray diffraction analysis; low temperatures; stress-strain state.

UDC 543.94;544.55;57.08;53.086

Plasmochemical Synthesis of Carbon-Containing Films on the Surface of Aluminum Microchips for Polymerase Chain Reaction*Ashina Yu. S., Suvorova A. O., Slyadnev M. N.*

A method of plasma-enhanced chemical vapour deposition (PECVD) modifying the surface of aluminum microchips for polymerase chain reaction in a real time mode (rt-PCR) is developed. Compounds of different classes — alkanes, alcohols, siloxanes — are used as plasma-forming substances. Properties of the films thus obtained were tested under PCR conditions using the developed model. The electrochemical impedance spectroscopy is used to study the permeability of the samples. The morphological properties are studied by scanning electron microscopy and energy dispersive x-ray microanalysis (EDXMA). It is shown that the most inert coatings, biocompatible under PCR conditions are obtained using hexamethyldisiloxane in PECVD as a plasma-forming substance.

Keywords: plasma-enhanced chemical vapour deposition; PECVD; polymerase chain reaction; PCR; scanning electron microscopy; SEM; energy dispersive X-ray microanalysis; EDXMA.

UDC 621.774.21,621.78.019.3

Method for Determination of the Optimal Heating Temperature upon Local Heat Treatment of a High Frequency Welded Pipe Joint*Tkachuk M. A., Bagmet O. A.*

A method of modeling the structure formation occurring upon heating and cooling of the metal in the zone of high frequency welded pipe joint is considered. A technique for determination of the optimal heating temperature upon local heat treatment (LHT) of the welded joint mode from normalization mode is developed. It is shown that for steel pipes of different chemical composition subjected to LHT of the weld in normalization mode, formation of a fine-grained ferrite-pearlite structure with the absence of defective areas of Widmanstätten ferrite in the weld adjacent zone upon cooling is a criterion for selecting the heating temperature in the single-phase γ -region.

Keywords: electric-welded pipes; high frequency welding; local heat treatment; welded joint; weld adjacent zone; microstructure.

UDC 620.191.33:539.376

Study of the Durability of Elastomeric Adhesive Joints in Aircraft Constructions*Terekhin A. V., Nepovinnikh V. I.,**Rusin M. Yu., Dumanskii A. M.*

Results of theoretical and experimental study of the durability of elastomeric adhesive joints of dissimilar structural elements of aircraft constructions are presented. An original experimental setup is designed to test adhesive joints of the system «metal – ceramics» for long-term strength in conditions close to operational. Experimental data on the durability of a Viksint U-2-28 sealant are obtained under conditions of shear deformation and elevated temperatures. Method of generalized coordinates is used to develop a mathematical model of the durability of elastomer adhesive joints operated at elevated temperatures.

Keywords: durability; long-term strength; adhesive joint; elastomeric sealant; rubber-like elasticity; adhesive fracture; ultimate behavior.

UDC 620.178.15

A New Method of Nano Hardness Determination*Moshchenok V. I., Doshchekina I. V.,**Lalazarova N. A., Demchenko S. V.*

A comparison of different methods of nano hardness determination (i.e., Oliver and Pharr, finite-element, ideal and surface nanohardness) is carried out. The most common Oliver and Pharr method provides hardness determination only at the maximum loading of the indenter living aside the elastic component of deformation and, moreover, is rather complex and labourious

method. The developed method applicable for any material provides calculation of the surface nano hardness within the whole range of indenter loading with allowance for elastic and plastic components of the strain because the calculation is carried out by the depth of indenter embedding.

Keywords: nanohardness; indenter; Oliver and Pharr method; finite elements; ideal and surface nanohardness.

UDC 620.162.2

Features of Metal Strain Resistance Determination under Controlled Loading*Potapov A. I., Dvoynikov D. A., Salikhanov D. R.*

Modernization of a cam-type rheometer consisting in equipping it with digital control electric drive and a system of data collection and processing on a PC is discussed. Modernization provided increased accuracy of speed reproducibility and reduced mechanical load on the kinematic transmission and nodes of the rheometer. The reliability of hardening curves of tested metals and alloys also increased. A new method of plastometric testing for upsetting square cross-section sample is developed. Comparative tests of the proposed and conventional cylindrical samples of carbon steels in a wide range of temperatures and strains showed the validity of the method and good convergence of the results obtained for both types of samples under similar conditions. The new technique simplifies the procedure of sample manufacturing from square cross-section billets.

Keywords: strain resistance; plastometer; controlled electric drive; testing procedure; square cross-section samples

UDC 620.172.2:678.7

Relaxation Behavior of Polymethylmethacrylate Based Organic Glass*Yakovlev N. O.*

Approximation of the relaxation curves of aviation polymethylmethacrylate (PMMA) Plexiglas (SO-120) in the range of resilient-highly elastic behavior of the polymer is proposed using a five-parameter asymmetric logistic function. Asymptotic limits of the beginning and the end of the stress relaxation for strains up to 1.7 %. It is noted that the strain-temperature dependence of the parameters of the considered function for PMMA organic glass and other polymers provide space-saving data representation in the reference books and passports regarding stress relaxation of the aforementioned materials.

Keywords: highly elastic deformation; polymethylmethacrylate; organic glass; stress relaxation; equilibrium strain curve.

UDC 519.24

Mathematical Method of Automated System-Cognitive Analysis (ASC): System Information Theory*Lutsenko E. V.*

A mathematical method of automated system-cognitive analysis (ASC analysis) implemented in its software tool — universal cognitive analytical system “Eidos-X ++” is considered. The mathematical method of ASC analysis is based on the system theory of information (STI) developed in the framework of the keynote idea of consolidating all the concepts of mathematics, in particular the information theory based on the theory of sets through total replacement of the concept of the set by a more general concept of the system and close monitoring of all the consequences of this replacement. A mathematical method that forms the basis of ASC analysis is nonparametric and allows comparable processing of hundreds of thousands of factors gradations and future states of the control object (classes) with incomplete (fragmented), noisy data of numerical and non-numerical nature, measured in different units.

Keywords: mathematical method; automated system-cognitive analysis; ASC-analysis; System information theory; “Eidos” intelligent system; information-measuring system.

UDC 519.24:621.3.04

On the Technical Diagnostics of the Quality of Diode Arrangements*Orlov V. I., Sergeeva N. A., Chzhan E. A.*

A problem of quality control of electronic components by the results of non-destruction testing is considered. An example of grouping diode arrangements proceeding from the results of burn-in testing is presented. We have shown that diodes of the same matrix have different properties and can be divided into two groups and propose to optimize the process of the diode manufacture within the framework of process specifications.

Keywords: diagnostics; electronic component; diode arrangement; grouping; burn-in testing; manufacturing instructions; nonparametric density estimation.