

ЗАВОДСКАЯ
ЛАБОРАТОРИЯ
ДИАГНОСТИКА МАТЕРИАЛОВ

12

2015
ДЕКАБРЬ

ЗАВОДСКАЯ ЛАБОРАТОРИЯ

ДИАГНОСТИКА МАТЕРИАЛОВ

№ 12 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.

СОДЕРЖАНИЕ

КОЛОНКА РЕДКОЛЛЕГИИ

Махутов Н. А. Управление ресурсом безопасной эксплуатации объектов техно-сферы 5

АНАЛИЗ ВЕЩЕСТВА

Кошель Е. С., Барановская В. Б., Губанова Т. Ю. Прямой дуговой атомно-эмиссионный анализ оксидов иттрия, гадолиния и неодима 8
Медведевских С. В., Медведевских М. Ю., Сергеева А. С., Карпов Ю. А. Обеспечение метрологической прослеживаемости результатов определения воды в функциональных материалах и чистых веществах 13
Кулиев К. А., Вердизаде Н. А., Абаскулиева У. Б. Экстракционно-фотометрическое определение титана с 2,6-димеркапто-4-трет-бутилфенолом и гидрофобными аминами 18

ИССЛЕДОВАНИЕ СТРУКТУРЫ И СВОЙСТВ

ФИЗИЧЕСКИЕ МЕТОДЫ ИССЛЕДОВАНИЯ И КОНТРОЛЯ

Титов В. А., Акатьев В. В. Исследование полимеризации пленкообразователей методом физического маятника 23
Эстемирова С. Х., Печищева Н. В., Кожина Г. А. Определение размера частиц ультрадисперсных порошков твердых растворов манганитов $(Nd, Gd)_xCa_{1-x}MnO_3$ методом фотонной корреляционной спектроскопии 26
Лидер В. В. Рентгеновские методы осевого фазового контраста и осевой голографии 32

МЕХАНИКА МАТЕРИАЛОВ: ПРОЧНОСТЬ, РЕСУРС, БЕЗОПАСНОСТЬ

Лепов В. В. К 45-летию Института физико-технических проблем Севера СО РАН Григорьев А. В., Лепов В. В. Оценка ресурса железнодорожной техники, эксплуатируемой в экстремальных условиях Севера 42
Махарова С. Н., Яковлева С. П., Васильева М. И., Сивцева А. В., Яковлев В. Г. Влияние условий получения алмазно-абразивных композитов с матрицей из железоуглеродистых сплавов на их свойства 48
Яковлева С. П., Махарова С. Н. Связь деформационного рельефа и свойств ферритно-перлитной стали с наносубмикронной структурой 54
Голиков Н. И., Литвинцев Н. М. Изменение механических свойств и структурных показателей металла конструкций, эксплуатируемых в условиях Севера 60
Иванов А. М. Ударная вязкость сварного образца из стали 09Г2С после термообработки и равноканального углового прессования 65

ОЦЕНКА СООТВЕТСТВИЯ. АККРЕДИТАЦИЯ ЛАБОРАТОРИЙ

Халафян А. А., Темердашев З. А., Якуба Ю. Ф., Киселева Н. В., Гугучкина Т. И., Антоненко М. В. Позиционный анализ как метод оценки согласованности экспертных оценок 69
Указатель статей (по разделам) за 2015 г. 79
Авторский указатель за 2015 г. 84

Адрес редакции:

119991, Москва, ГСП-1,
Ленинский пр-т, 49,
ИМЕТ им. А. А. Байкова, Редакция
журнала "Заводская лаборатория.
Диагностика материалов®".

Тел./факс: (499) 135-62-75,
тел.: (499) 135-96-56
e-mail: zavlabor@imet.ac.ru
<http://www.zldm.ru>

Журнал включен в список изданий,
рекомендованных ВАК при защите
докторских диссертаций.

© ООО Издательство «ТЕСТ-ЗЛ», «Заводская лаборатория. Диагностика материалов», 2015

Перепечатка материалов журнала
«Заводская лаборатория. Диагностика
материалов» допускается только
с письменного разрешения редакции.
При цитировании ссылка обязательна.

ЗАВОДСКАЯ®
ЛАБОРАТОРИЯ
ДИАГНОСТИКА МАТЕРИАЛОВ

CONTENTS

ABSTRACTS

EDITORIAL COLUMN

- Makhutov N. A. Resource Management for Safe Operation of the Technosphere Facilities 5

ANALYSIS OF MATERIALS

- Koshel E. S., Baranovskaya V. B., Gubanova T. Yu. Direct Atomic-Emission Analysis with Arc Excitation of Yttrium, Gadolinium, and Neodymium Oxides 8
- Medvedevskikh S. V., Medvedevskikh M. Yu., Sergeeva A. S., Karpov Yu. A. Metrological Traceability of the Results of Water Determination in Functional Materials and Pure Substances 13
- Kuliyev K. A., Verdizadeh N. A., Abaskuliyeva U. B. Extraction-Photometric Determination of Titan (IV) with 2,4-Dimercapto-4-*tert*-butylphenol and Hydrophobic Amines 18

TESTING OF STRUCTURE AND PARAMETERS

PHYSICAL METHODS OF TESTING AND QUALITY CONTROL

- Titov V. A., Akatiev V. V. Study of Polymerization of Filming Agents Using Method of Physical Pendulum 23
- Estemirova S. Kh., Pechischeva N. V., Kozhina G. A. Determination of the Particle Size of Ultrafine Powders of Manganite Solid Solutions (Nd, Gd)_xCa_{1-x}MnO₃ by Photon Correlation Spectroscopy 26
- Lider V. V. X-Ray Methods of In-Line Phase Contrast and Holography 32

MECHANICAL TESTING METHODS

- Lepov V. V. The 45th Anniversary of the Institute of Physico-technical Problems of the North, Siberian Branch, Russian Academy of Sciences 41
- Grigor'ev A. V., Lepov V. V. Assessment of the Service Life of Rail Equipment Operating in Extreme Conditions of the North 42
- Makharova S. N., Yakovleva S. P., Vasil'eva M. I., Sivtseva A. V., Yakovlev V. G. The Impact of Production Conditions on the Properties of Diamond-Abrasive Composites with a Matrix of Iron-Carbon Alloys 48
- Yakovleva S. P., Makharova S. N. Correlation of the Deformation Relief and the Properties of Ferrite-Pearlite Steels with Nano-Submicron Structure 54
- Golikov N. I., Litvintsev N. M. Change in the Mechanical Properties and Structural Characteristics of the Metal Structures Operating in the North 60
- Ivanov A. M. Toughness of Welded HS Steel Specimen Subjected to Heat Treatment and Equal Channel Angular Pressing 65

CERTIFICATION OF MATERIALS AND ACCREDITATION OF LABORATORIES

- Khalafyan A. A., Temerdashev Z. A., Yakuba Yu. F., Kiseleva N. V., Guguchkina T. I., Antonenko M. V. Positional Analysis as a Method to Assess the Consistency of the Expert Estimates 69
- Article List 2015 79
- Authors' List 2015 84

UDC 543.423

Direct Atomic-Emission Analysis with Arc Excitation of Yttrium, Gadolinium, and Neodymium Oxides*Koshel E. S., Baranovskaya V. B., Gubanova T. Yu.*

Analytical capabilities of direct arc atomic-emission determination of impurities in rare earth oxides (Y₂O₃, Cd₂O₃, Nd₂O₃) are assessed using a "Grand Extra" high resolution spectrometer ("WMC-Optoelectronics," Russia) in optimized conditions of analysis. The similarity of the physico-chemical properties of rare earth elements interfere with the analysis of pure rare-earth metals and their oxides. Multicircuit spectrum, matrix effects, spectral interference affect the analytical signal and complicate matters. We have specified optimal conditions of analysis and parameters of the spectrometer and determined the detection limits of and threshold concentration of the determinable elements (Nd, Eu, Dy, Ho, Gd, Er, Tm, Yb, Y). An advanced technique of arc atomic emission analysis of yttrium, gadolinium, and neodymium oxides for the content of rare earth impurities within the concentration range 0.001–0.1 wt % which provides improved metrological characteristics is developed.

Keywords: atomic-emission analysis; arc excitation source; rare earth metals; yttrium; gadolinium; neodymium.

UDC 543.613:669.2:53.089.68

Metrological Traceability of the Results of Water Determination in Functional Materials and Pure Substances*Medvedevskikh S. V., Medvedevskikh M. Yu.,**Sergeeva A. S., Karpov Yu. A.*

A problem of water content determination in creation of pure substances and novel functional materials with low water content is considered. Composition, metrological characteristics and prospects of application of the State primary standard of mass fraction and mass (molar) concentration of water in liquid and solid substances and materials GET 173–2013 are presented. Examples of developing measurement procedures based on thermogravimetric and chemical methods are considered.

Keywords: pure substances; functional materials; water content; standard; mass fraction; substances with low moisture content.

UDC 541.43.542.61:543.420.62

Extraction-Photometric Determination of Titan (IV) with 2,4-Dimercapto-4-*tert*-butylphenol and Hydrophobic Amines*Kuliyev K. A., Verdizadeh N. A., Abaskuliyeva U. B.*

Spectrophotometric methods are used to study complexing of titan (IV) and 2,6-dimercapto-4-*tert*-butylphenol (DTBPh) with hydrophobic amines present. Aniline, N-metilaniline and N,N-dimetilaniline are used as hydrophobic amines. Mixed ligand complex are formed in weak acidic media (pH_{opt} = 1.3–3.2). Maximum light absorption of complexes is observed at 430–440 nm. Relative molar absorption coefficients range within (2.6–2.8) × 10⁴. Composition and molar absorption coefficients, pH values optimal for extraction of the mixed-ligand complexes thus formed, and peaks of their light absorption are determined. Results of the study are used to develop extraction-photometric procedures of titanium determination, which have been tested in the analysis of different objects.

Keywords: titan; extraction-photometric method; determination.

UDC 678–419

Study of Polymerization of Filming Agents Using Method of Physical Pendulum*Titov V. A., Akatiev V. V.*

Method of physical pendulum is used to study transformation of the mechanical properties of filming layer upon drying and polymerization. A distinctive feature of hardware implementation is that the physical pendulum relied on half cylinder rolling on a fixed plane. The sample of filming agent is located between the plane and supporting half-cylinder. Statistical effect of integrated energy losses of the rolling cylinder empirically derived in conditions of periodic force impact on the studied film during the formation of solid coating starting with solvent evaporation up to the onset and full completion polymerization is considered. A conclusion is made about the sensitivity of the method to the composition of filming agents at different stages of film formation. Methodical recommendations regarding using the technique in the study of mechanical and structural features of film-forming materials are specified.

Keywords: physical pendulum; oscillatory motion; quality factor; film forming agent; polymerization; viscoelasticity.

UDC 620.186.82, 549.748

Determination of the Particle Size of Ultrafine Powders of Manganite Solid Solutions $(\text{Nd, Gd})_x\text{Ca}_{1-x}\text{MnO}_3$ by Photon Correlation Spectroscopy

Estemirova S. Kh., Pechischeva N. V., Kozhina G. A.

The prospects of using photon correlation spectroscopy (dynamic light scattering method) in determination of the particle size in ultrafine powders of perovskite-like rare earth manganites milled in a high energy planetary mill are discussed. The main attention is paid to stabilizing of the powder in a dispersion liquid before measurements. Benzalkonium chloride exhibited the best stabilizing properties compared to other tested surfactants. The powder susceptible to agglomeration is subjected to ultrasonic treatment for 1 h. The results of the particles size measurement obtained by dynamic light scattering are compared with data of x-ray diffraction analysis.

Keywords: photon correlation spectroscopy; x-ray diffraction; particle size; the size of the coherent scattering region; rare earth manganites.

UDC 535.41, 53.082.5

X-Ray Methods of In-Line Phase Contrast and Holography

Lider V. V.

A comparative description of x-ray in-line phase-contrast methods — the method of phase contrast and holography — is presented. The difference between the experimental realizations of those methods is determined as a rule by the distance between the object under study and detection plane. It is shown that this parameter makes the two methods differ from each other both in experimental conditions and image reconstruction procedure, and in applications as well as. The methods of obtaining phase-contrast projections, reconstruction of two- and three-dimensional images and application of those methods to the study of condensed matter are considered. The method of x-ray in-line phase contrast with hard x-ray radiation in a near field is analyzed in detail. The method proved to be efficient in a wide range of applications in biomedicine and material science. The use synchrotron radiation extend the range of applications.

Keywords: x-rays; phase contrast; holography; coherence; interference.

UDC 620.163.4:621.135.2

Assessment of the Service Life of Rail Equipment Operating in Extreme Conditions of the North

Grigor'ev A. V., Lepov V. V.

Steel locomotive wheels are permanently subjected to static, dynamic and fatigue loading on service. The life time of the wheels operating in extreme conditions of the North is reduced by several times. Thus we have tested the wheel steel for the impact toughness and assessed accumulation of damages with allowance for the contact fatigue in conditions close to low climatic temperatures of Central Yakutia. Proceeding from the obtained estimate of the damage accumulation a method of calculating the life time of a locomotive tire is developed.

Keywords: fracture; damage; locomotive tire; impact toughness; lifetime.

UDC 620.171:621.921.34

The Impact of Production Conditions on the Properties of Diamond-Abrasive Composites with a Matrix of Iron-Carbon Alloys

Makharova S. N., Yakovleva S. P., Vasil'eva M. I., Sivtseva A. V., Yakovlev V. G.

Diamond-metal powder mixtures obtained by explosive pressing with subsequent heat treatment of the compacts are studied. It is shown that the use of the energy of explosion at the stage of powder molding shows good returns in production of high-performance diamond-materials, including, but not limited to that on widespread iron-carbon binders. A specific character of the explosive impact results in activation of the material of the binder which then comes out in intensive hardening upon further high temperature treatment. Shock waves provide favorable thermobaric conditions which ensure better integrity of the diamond component compared to that provided by conventional sintering methods. We obtained the samples of abrasive diamond composites with a wear resistance corresponding to the level of wear resistance of industrial diamond pencils, consumption of rough diamonds being twice as low.

Keywords: diamond powder; diamond-metallic composite; explosive compacting; structure; hardening; wear resistance.

UDC 620.17:669.15:620.186.8

Correlation of the Deformation Relief and the Properties of Ferrite-Pearlite Steels with Nano-Submicron Structure

Yakovleva S. P., Makharova S. N.

Microstructure changes and the strength of low alloyed steel are studied after volume nanostructuring using conditions of "warm" (300 – 500°C) equal channel angular pressing (ECAP). A correlation of nano-submicrocrystalline structure which provides a high-strength of ferrite-pearlite steels and evolution of the roughness and microstructure of deformation relief is revealed. Grinding of structural components of the steel is shown to form favorable conditions for strain-induced self-organization of the structure upon subsequent loading thus shifting localization of the deformation to the later stages compared to coarse-grained state of the material.

Keywords: low-alloyed steel; nanostructuring; equal-channel angular pressing (ECAP); mechanical properties; deformation relief; roughness.

UDC 620.163.3:621.774

Change in the Mechanical Properties and Structural Characteristics of the Metal Structures Operating in the North

Golikov N. I., Litvintsev N. M.

The mechanical properties and structural parameters of metal constructions after their long-term operation in extreme conditions of the North are studied. The characteristics of the base metal of the pipeline outlet 273 mm in diameter, a vertical cylindrical tank with a storage capacity of 700 m³ made of low carbon steel St3sp, and ring welded joint gas of 530 mm gas pipeline made of low alloyed steel 09G2S are determined. It was shown that changes in the steel structure observed after their long-term service are attributed to the fatigue and corrosion fracture and precipitation of carbides. The degree of changes in the mechanical properties of steel metal structures after their continuous operation is also assessed.

Keywords: structural steels; mechanical properties; metal construction.

UDC 620.163.4:672.3

Toughness of Welded HS Steel Specimen Subjected to Heat Treatment and Equal Channel Angular Pressing

Ivanov A. M.

The problems of brittle fracture of the welded joint of low-alloyed steel are studied using method of severe plastic deformation and equal channel angular pressing in combination with quenching. Data on the toughness of Menage samples (09G2S) with welded seams studied at a temperature of 233 K are presented. The higher rates of fracture resistance under shock bending and low temperature are shown to be determined and attributed to the type of welded joints with X-shaped cutting edges of blanks in combination of quenching and equal-channel angular pressing

Keywords: steel; toughness; welded joints; hardening; equal channel angular pressing; fracture.

UDC 519.237+663.22

Positional Analysis as a Method to Assess the Consistency of the Expert Estimates

Khalafyan A. A., Temerdashev Z. A., Yakuba Yu. F., Kiseleva N. V., Guguchkina T. I., Antonenko M. V.

Various methods of assessing the consistency of the expert estimates which depend on the procedure of measuring the properties of the objects are analyzed. A possibility of using the method "Reliability and positional analysis" in assessing the degree of convergence of the expert evidences when the results of expert estimates are presented as a rating scale is demonstrated. Case study of wine tasting showed that the considered method of multivariate data analysis can be used to assess the consistency of expert assessments through the calculations of α Cronbach's statistics as an integral numeric criterion of the reliability of the expert report. It is noted that the assessment of the expert consensus is an important issue given the fact that peer review is a subjective process which depends not only on the individual characteristics of objects to be assessed, but also on the physical and emotional state of the experts faced with a variety of random uncontrollable impacts. The analyzed method enables one to detect not only the objects characterized with the most divergent opinions of the experts, but also to fetch out the experts having the opinion inconsistent with the majority of colleagues. The results of using the method in the framework of "STATISTICA" software to assess the consistency of experts estimates in wine tasting are presented.

Keywords: expert assessment; reliability and positional analysis; product quality; wine tasting; Cronbach's α .