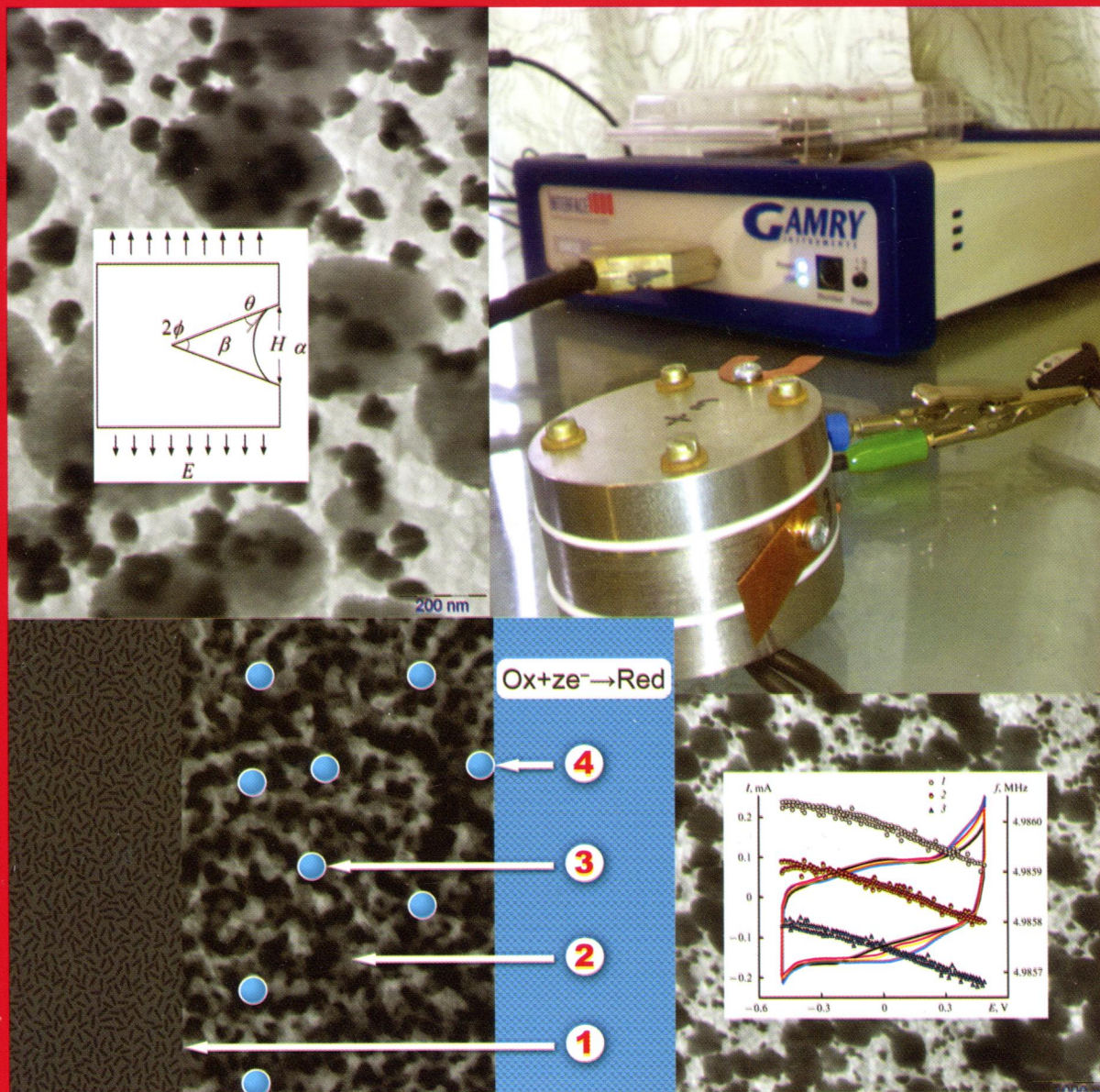


Успехи ХИМИИ



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Создание и физико-химическое исследование новых материалов

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Russian Chemical Reviews

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Creation and physicochemical study of advanced materials at Saint Petersburg State University

V.L.Stolyarova

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Thermodynamic aspects of materials science

1

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Since materials science deals with the physicochemical properties of materials, it needs a support of thermodynamics, which predicts the general regularities for physicochemical properties of matter. This review considers solid materials whose thermodynamic description is especially complicated. Recent advances provide better understanding of the anisotropy of the chemical potential and, on this basis, the anisotropic chemical affinity, which governs all physicochemical processes in solid materials. The review summarizes novel approaches and thermodynamic equations and demonstrates how they are used in materials science. The solubility, creep and corrosion of materials are analyzed as examples. A newly discovered phenomenon, namely, the effect of the strain sign on the rate of corrosion under stress (*e.g.*, a difference in the corrosion rates on the convex and concave sides of a bent metal plate) is described and explained thermodynamically. The thermodynamic theory of the strength of materials developed in recent years is presented with characterization of crack properties, mechanisms of the crack propagation and estimation of the ultimate stress. The development of this area required introducing a novel thermodynamic potential that formed the basis of the strength theory.

Bibliography — 47 references.

Composite electrode materials based on conducting polymers with inclusions of metal nanostructures

14

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The review deals with the electrochemical and chemical methods for the preparation of nanocomposite metal-polymer materials based on conducting polymers and the key factors affecting the structure and the electrochemical properties of the obtained composites. The experimental data on the catalytic activity of metal-polymer electrodes in some electrochemical reactions are analyzed. Approaches to the theoretical description of electrochemical processes on heterogeneous metal-polymer electrodes are discussed and examples of experimental testing of performance of the proposed theoretical models are given.

Bibliography — 335 references.

K.N.Semenov,^a N.A.Charykov,^b V.N.Postnov,^a V.V.Sharoyko,^a I.V.Murin^a

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This review is the first attempt to integrate the available data on all types of phase equilibria (solubility, extraction and sorption) in systems containing light fullerenes (C₆₀ and C₇₀). In the case of solubility diagrams, the following types of phase equilibria are considered: single fullerene (C₆₀ or C₇₀)–solvent in polythermal and isobaric conditions; C₆₀–C₇₀–solvent, single fullerene–solvent(1)–solvent(2), as well as multicomponent systems comprising a single fullerene or an industrial mixture of fullerenes and vegetable oils, animal fats or essential oils under polythermal conditions. All published experimental data on the extraction equilibria in C₆₀–C₇₀–liquid phase(1)–liquid phase(2) systems are described systematically and the sorption characteristics of various materials towards light fullerenes are estimated. The possibility of application of these experimental data for development of pre-chromatographic and chromatographic separation methods for fullerene mixtures and application of fullerenes as nanomodifiers are described. Bibliography — 87 references.

Mass spectral thermodynamic studies of oxide systems and materials

60

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The innovative development of the methods for the synthesis and operation of promising materials at high temperature requires information on evaporation processes and thermodynamic properties of oxide systems. High-temperature mass spectrometry is the optimal experimental method for gaining this information. The review considers and describes systematically the experimental data of the last 20 years on the high-temperature behaviour of oxide systems and materials based on them obtained by mass spectral thermodynamic studies. The published data on the evaporation processes and thermodynamic properties of oxide materials for high-temperature technologies are discussed from the standpoints of the acid-base concept and model views comprising statistical thermodynamic approaches. Bibliography — 248 references.

Membrane materials based on polyheteroarylenes and their application for pervaporation

81

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Studies of transport properties of membrane materials are required for solving the fundamental problems and for analyzing the applied aspects of the theory of membrane separation processes, in particular, development of energy- and resource-saving environmentally benign technologies. The review integrates the experimental data on the separation of practically significant mixtures using membranes based on polyheteroarylenes, which are thermally stable and mechanically durable polymers. First of all, the analysis covers publications that give detailed description of the physicochemical properties of the membranes and interpretation of mass transfer during membrane separation (pervaporation) of liquid mixtures using polyheteroarylene-based membrane materials. The dependences of the transport parameters of pervaporation on the process conditions and on the method used for manufacture or modification of membrane materials are discussed. The data presented may be useful for the development of the theory of membrane processes with a glance to the chemical nature and physicochemical features of the polymer membrane materials.

Bibliography — 151 references.