SCIENTIFIC AND TECHNICAL JOURNAL "PROBLEMS OF MATERIALS SCIENCE"

N 4(48), 2006

CONTENTS

ABSTRACTS OF PUBLISHED ARTICLES

UDC 539.219.3:620.186.8

Analysis of the regularities of abnormal graun growth in submicrocrystalline metals and alloys containing disperse second phase particles. Perevezentsev V. N., Pupynin A. S. – Problems of Materials Science, 2006, N 4(48), pp. 5–12.

It makes possible to create the bimodal structure in submicrocrystalline materials with required fractions of fine and coarse grains by means of short-term annealing and consequently to modify strengthening and plastic properties of material. The main regularities of abnormal grain growth behavior are analyzed in SMC materials containing disperse second phase particles. The conditions of grain boundaries transition into nonequilibrium state for growing grain and kinetics of nonequilibrium grain boundaries migration during annealing are analyzed for different initial values of size deviation of growing grain from grain size of "matrix" Δd, density of dislocations in grain boundaries and volume fraction of second phase particles f_v. It is established that increase of Δd and decrease of Δ_{b0} and f_v lead to decrease of incubation period of abnormal grain growth. It is shown that the possibility of formation in submicrocrystalline materials bimodal structure is due to that anomalously growing grains "starting" at various moments of annealing at the final stage of the process reach approximately equal size.

Key words: abnormal grain growth, submicrocrystalline materials, bimodal structure, nonequilibrium grain boundaries.

UDC 669.15.26`24:539.4.016.3

Action of hardening temperature and heating time on phase-structural composition of spring chrome-nickel alloy. Skakov M. K., Petrov V. A., Mukazhanov E. B., Ahmedzhanov B. K. – Problems of Materials Science, 2006, N 4(48), pp. 13–18.

The peculiarities of variations in phase-structural composition of 47XHM alloy depending on temperature and heating time for hardening are studied. The alloy is shown to obtain two-phase structure after hardening in the temperature range of 1200 to 1300°C. The degree of homogeneity of solid solution, dissolution of reinforcing α-phase, and matrix grain size are found to increase with heating temperature for hardening. Optimal conditions for hardening of 47XHM alloy are determined.

Key words: alloy, hardening, microstructure, phases, growth of grains, electronic microscopy, X-ray-phase analysis.

UDC 621.777.27: 537.312.62

Structure and properties of Ni–Ti alloy after the equal-channel multiple-angle pressing. Matrosov N. I., Sennikova L. F., Chishko V. V., Pavlovskaya E. A., Andrievskaya N. F., Makarenko V. V. – Problems of Materials Science, 2006, N 4(48), pp. 19–27.

Structure, phase composition and their influence on properties of superconducting niobium-titanium alloy (Nb + 60 at%Ti) have been studied after the equal-channel multiple-angle pressing and after the equal-channel multiple-angle pressing combined with thermal treatment and deformation by the hydroextrusion method. Features of alloy 60T structure and hardening after the temperature-deformation treatment and combined deformation have been studied by optical microscopy — by using metallographic microscope „Neophot"; scanning electron microscopy — by means of scanning electron microscopy of the РЭММ-202 type in the regimes of secondary, reflected and absorbed electrons, as well as by means of electron transmission microscopy (electron microscope of the Tesla-BS 613 type). The electron-microscope investigations have revealed that the equal-channel multiple-angle pressing results in the formation of an isotropic submicrocrystalline structure making the nucleation of α-phase precipitations easier. The temperature-deformation treatment gives structure with a high (~10^{10} cm^{-2}) dislocation density and density of α-phase precipitation (8–13%) favorable for increasing the functional properties of the superconducting alloy. The effect of structure state on current-carrying capacity of the alloy has been studied for massive samples cut from billets in the initial state, after the equal-channel multiple-angle pressing deformation and past the temperature-deformation treatment involving operations of the equal-channel multiple-angle pressing and thermal treatment. As a result, there was a 4–5 times increase in the critical current. Under the combined

treatment (equal-channel multiple-angle pressing + hidroextrusion) with the increasing degree of monotonic deformation by hydroextrusion, the deformation hardening is more intensive. A change in microhardness characteristics for large (e = 9,84–17,66) accumulated plastic deformations as a result of treatment by combined method in the absence of thermal treatment is described by the Hall–Petch relationship, if in the simplified one-parameter approach a dimension of highly disoriented cell (subgraine).

Key words: Nb–Ti alloy, equal-channel multiple-angle pressing, structure, α-phase, microhardness, critical current, thermal treatment.

UDC 541.64:542.954:537.6

Synthesis of magnetic hard polyimid based nanocomposite material. Vasilyeva E. S., Didenko A. L., Kaidash E. A. – Problems of Materials Science, 2006, N 4(48), pp. 28–34.

The paper is devoted to study of magnetic properties of nanocomposite material based on polyimide matrix filled of iron and iron-cobalt alloyed ferromagnetic nanoparticles. Elastic films from polyimide nanocomposites were created with nanoparticles content from 5 to 20 wt. %.

The results of magnetic properties measurements for iron-cobalt alloyed nanoparticles is presented, particles size were about 25–30 nm and the cobalt content was from 0 up to 55 wt.%. The influence of nanoparticles chemical composition and it is weight concentration in the polyimide matrix on the composite material magnetic properties were measured by VSM method.

Magnetization of composite samples increase with the magnetic nanoparticles content increasing, in the same time coercitivity is quite less than coercivity of initial particles and independent from particles concentration. In order to improve coercivity of the composite films the thwart magnetic field were applied during of samples synthesis. It is allowed to create elastic film sample of polyimid-nanoparticles composite with high coercivity up to 970 Oe.

Key words: iron and cobalt based nanoparticles, metal-polymer composite materials, method of polymer based nanocomposite material synthesis, magnetic properties.

UDC 539.67:538.6

Influence of microdeformation and low magnetic field on damping properties of powder. Datsko O. I., Abramov V. S., Datsko I. O., Mankevich A. N., Chepelyansky A. Ya. – Problems of Materials Science, 2006, N 4(48), pp. 35–42.

Powders of various composition utilized in industry, medicine, house keeping have been used for investigations. It has been found that for powders influenced by microdeformation pulses the amplitude dependences of damped oscillation factor (damping factor) reveal monotonous drop with 1–2 maxima, while after the influence of low magnetic field the time dependences of damping factor first change instantaneously and then slowly during a long time revealing damped oscillations. The character of the dependences resemble those observed for metals. However in powders the mentioned dependences are related with the external friction of contacting powder particles in surface layers, in metals — with the internal friction in material matrix. In the both cases, they are mainly determined by the motion of dislocations interacting with stoppers.

Key words: powders, torsion pendulum, pulses of microdeformation and of low magnetic field, damped oscillations, external friction, microplasticity.

UDC 621.791.011:669.3:669.14.018.292

Study of composition, structure and mechanical properties of weld metal in welded joints of copper alloys and steels and of their effect on mechanical properties of welded joints. Vainerman A. E., Pichuzhkin S. A., Petrov S. N. – Problems of Materials Science, 2006, N 4(48), pp. 43–54.

Composition, structure, and mechanical properties of weld metal in welded joints of copper alloys and steels are studied. Mechanism of formation of crystalline and diffusion interlayers and æ-phase is suggested. Diffusion and crystalline interlayers are shown to possess high hardness and strength and low plasticity and impact elasticity.

Key words: copper alloy, steel, argon-arc welding, structure, chemical composition, mechanical properties.

UDC669.14.018.8:621.039.548.34

Mechanical properties of austenitic steels on neutron irradiation: the effect of various factors. Kursevich I. P., Margolin B. Z., Prokoshev O. Yu., Kohonov V. I. — Problems of Materials Science, 2006, N 4(48), pp. 55–68.

Derived on the basis of review and analysis of original data and those taken from literature are equations for description of yield point as a function of temperature, for calculation of increment in yield point and ultimate strength as well as for reduction of critical strains as a function of neutron fluency and irradiation/test temperature for type X18H9 austenitic steels. Equations for calculation of strain diagram parameters are also suggested.

Key words: austenitic steel, neutron fluency, strain diagrams, mathematical model.

UDC 669.15–194.56:621.039.548.34

Radiation swelling of austenitic steels: the effect of various factors. Processing of experimental data and formulation of basic equations. Vasina N. K., Margolin B. Z., Gulenko A. G., Kursevich I. P. – Problems of Materials Science, 2006, N 4(48), pp. 69–89.

The regularities of effects of various factors on swelling of austenitic steels are reviewed and analyzed. The major tendencies for the rate of gain in damaging dose, strain, level, and sign of stresses to have an effect on swelling are reviewed and determined. Experimental data base on swelling of type X18H9 and X18H10T steels was formed and mathematically processed. Equations describing swelling of these steels at different levels of damaging dose and irradiation temperature with regard to the rate of gain in damaging dose, acceleration of swelling under stresses, and deceleration of swelling with plastic deformation of material are obtained. Basic equations for calculation of stressed-strained state of structural members are formulated. A relationship between radiation swelling and creep is analyzed.

Key words: austenitic steel, radiation swelling, damaging dose, stressed-strained state, mathematical model.

UDC 669.15–194:621.039.52.034.6

Long-term strength of steel in a molten-metal heat-transfer medium on the basis of lead. Kudrjavtsev A. S., Markov V. G., Lavruhin V. S. – Problems of Materials Science, 2006, N 4(48) pp. 89–94.

The causes of reduction of long-term strength of structural materials contacting with molten lead are studied. The problems of prediction of long-term strength of structural materials working in reactor plant with molten-lead heat-transfer medium are reviewed.

Key words: molten-metal heat-transfer medium on the basis of lead, structural materials, prediction of long-term strength.

UDC 621.892

Diagnostics of wear of the carbon filled polytetrafluorethylene using the spectral analysis method of acoustic emission signals. Kozyrev Yu. P., Sedakova E. B. – Problems of Materials Science, 2006, N 4(48), pp. 95–100.

Tribotechnical tests of the carbon filled polytetrafluorethylene at two values of contact pressure are carried out. It is shown, that autocorrelation function of values of root-mean-square deviations of signals of acoustic emission contains casual and quasi-periodical components. Discrete Fourier transform for definition of a power spectrum of this autocorrelation function is used. After smoothing the received spectrum by the function containing 2 exhibitors, the method of diagnostics of wear of a material based on the width of the received power spectrum is offered.

Key words: wear, carbon materials, tribotechnical tests, a power spectrum, root-mean-square deviations, *pv*-factor.