ABSTRACT AND REFERENCES

MATERIALS SCIENCE

INFLUENCE OF PLASTICIZERS AND POLYSTYRENE MODIFIERS NATURE ON THE PROPERTIES OF POLY(VINYLCHLORIDE) PLASTICS AND COMPOSITES (p. 4-8)

Yurii Laruk, Volodymyr Levytskyi

Based on the studies, the influence of plasticizer and polystyrene modifier nature on the physicomechanical, thermophysical and physicochemical properties of PVC plasticates was determined. With the increase in the polystyrene modifier content, the surface hardness, Vicat softening temperature and value of composites elasticity increases and the degree of plasticizer release decreases. This is achieved by directed influence of the nature and content of the modifier and plasticizer on the morphology of PVC plasticates with the formation of a denser fluctuation grid, which is caused by the redistribution of intermolecular interactions in the system. Growth of physicomechanical and thermophysical parameters of PVC composites with an increase in the content of polymer-containing fillers (polystyrene-magnetite materials and polymer-silicate composites) due to an increase in technological compatibility between the components and the formation of interfacial layers with the direct participation of the filler macromolecules was revealed.

It is shown that the directed introduction of polystyrene modifiers, fine polymer-containing fillers and diesterphthalic plasticizers allows to influence the morphology of PVC materials and, thus, achieve the desired set of physicomechanical, thermophysical and physicochemical properties of composites for a specific practical application.

Keywords: poly(vinylchloride), modification, polystyrene, polymer-silicate composite, plasticization, acrylonitrile-butadiene-styrene plastic, filler, dibutyl phthalate.

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EROSION RESISTANCE OF COATINGS EXPOSED TO MICROIMPACTS (p. 8-13)

Victor Voevodin, Gennady Kartmazov, Vladimir Marinin

We have studied erosion of nichrome, titanium, titanium nitride, chrome, and chrome carbide coatings impacted by cavitation. The coatings are obtained by applying plasmatron, detonation, vacuum and arc as well as atomic and ionic sedimentation methods. Ultrasound cavitation was created in water; the fluctuation amplitude of the emitting vibrator surface was equal to 30±2 μm with the frequency of 20±2 kHz. The erosion was assessed by the gravimetric method with the precision of up to 0.015 mg. The kinetic curves on the dependence of the eroded mass quantity upon cavitation time have determined the velocity of coating deterioration as well as coating durability. The research has proved that coatings precipitated by plasmatron and detonation methods have low resistance to erosion and deteriorate 3–5 times quicker than steel of the 15H11MF variety because such coatings have a layered structure resulting from a discreet supply of material to the specimen and formation of intermediate brittle layers between the supplies. The result is low resistance of the interlayer boundaries and the coating as a whole. Vacuum and arc titanium, titanium nitride as well as atomic and ionic chrome, carbon-doped coatings have a certain mass loss resistance that exceeds steel durability up to 5–8 times. The research has proved that durability of atomic and ionic coatings depends on their microhardness, whereas coatings with microhardness of 8–10 GPa have an optimal resistance to erosion.

Keywords: coatings, plasmatron sedimentation, electric spark, vacuum and arc, atomic and ionic, cavitation, resistance (to erosion) / durability, interdependence, microhardness.

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STRENGTH OF NORMAL SECTIONS OF TWO-LAYER RUBCON-CONCRETE BENDING ELEMENTS OF BUILDING STRUCTURES (p. 14-20)

Oleg Figovsky, Yuri Potapov,
Aleksey Polikutin, Duy Phan Nguen

The results of experimental studies of the strength of the normal sections of rubcon-concrete two-layer bending building structures are presented in the paper.

Studies of two-layer rubcon-concrete bending structures were carried out in connection with the need for effective building structures, designed for use in corrosive media with reliable protection of steel reinforcement from the environment without special protective coatings (requiring repair during the operation).

As a result of studies, it was found that the strength of the normal sections of rubcon-concrete bending elements depends on the ratio of rubcon and concrete layer thicknesses, as well as the percentage of the longitudinal reinforcement. Thus, the strength of the normal sections increases with an increase in the reinforcement percentage and the rubcon layer thickness. It was found that with percentages of longitudinal reinforcement of up to 1.5 %, failure occurs on the tension zone (on reinforcement), with percentages of longitudinal reinforcement higher than 1.5 %, failure occurs on the compression zone (on concrete). It was revealed that with any reinforcement percentage and rubcon layer thickness, the strength of the normal sections of rubcon-concrete beams is higher than that of similar reinforced concrete.

The research results can be useful in the design and building of objects of the chemical and other industries, in which structures are exposed to various corrosive media. The developed structures allow to ensure reliable and durable operation of such buildings and facilities without overhauls for a longer period than the structures from conventional materials, such as reinforced concrete. Furthermore, the studied structures allow to save building materials since their carrying capacity is higher than that of analogs from conventional concrete.

Keywords: strength, bend, two-layer structures, polybutadiene oligomers, rubber concrete, rubcon.

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RESEARCH OF DEFECT DISTRIBUTION IN FIBRE RUBCON STRUCTURE BY MONTE-CARLO METHOD (p. 21-25)

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The Monte Carlo method to define quantitative characteristics of fiber intersections in the fiber rubcon structure taking into account the defined sizes of the samples was shown, adapted and applied in the paper. Dependence graphs of the amount of areas with dimensions smaller than the diameter of the allowable heterogeneity on the fiber percentage were presented. The studies were aimed at creating a material with the desired properties. The prerequisites to the study of this issue was the unsolved problem of the arrangement, distribution and sizes of congenital defects in the fiber rubcon structure. An analytical and mathematical justification of the optimal reinforcement ratio of rubcon with various types of fibers was obtained, a comparison of the results with experimental data was made. The results of the studies can be useful in the design stage of dispersion-reinforced composites, presuppose possible micro-defects content in the structure of materials, affecting the stress-strain characteristics of the material. Fracture pattern of samples depending on the type of the fiber used and its percentage was determined. It was proved that fiber rubcon meets the technical requirements for materials, operating in corrosive media by its stress-strain parameters and crack resistance, determined under the action of short-term compressive loads.

Keywords: rubcon, dispersion reinforcement, metallic fiber, mathematical modeling, Monte Carlo method.

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FORMATION OF METAL BEING ELECTRODEPOSITED SOLELY IN SPHERULITIC FORM (p. 26-29)

Oleg Girin, Ievgen Kolesnyk

The aim of the work was the experimental verification of validity of the phenomenon of phase formation through a stage of liquid state in metals being electrodeposited. The idea of the work is based on a known fact that at super-quick solidification of highly undercooled liquid metallic phase the spherulites appear. For the proof of existence of intermediate liquid phase of metal being electrodeposited it was planned to obtain the deposits in spherulitic form. The conditions for the formation of metal being electrodeposited in spherulitic form are discussed and realized. Practical realization of the idea mentioned above was accomplished by combined nickel and chromium alloying of iron being electrodeposited at high current density. As a result of the model experiment the samples of electrodeposited alloyed iron, consisting solely of spherulites, were obtained. The formation of metal being electrodeposited solely in shperulitic form, typical for the metal solidified from liquid state with very high rate in conditions of significant undercooling, proves validity of the phenomenon of phase formation of metals being electrodeposited through a stage of liquid state.

Keywords: metal being electrodeposited, spherulitic form, liquid state, surface morphology, electrodeposited iron.

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CHARACTERISTIC DEFECTS OF EXTRUSIONED POLYMERIC PROFILES AND METHODS OF THEIR ELIMINATION (p. 30-34)

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Products made of polymeric materials are becoming more common. At the same time, requirements for quality, accuracy of shape and sizes of products are increasing. Meeting the demand for domestic plastic products is impossible without improving the design and process parameters of equipment and polymer processing procedures. The aim of the research, described in the paper, is an analysis of the main factors affecting the quality of coextrusion formation of multilayer polymeric products and methods to eliminate defects. Production of pipes and gutters is carried out using coextrusion formation with subsequent calibration. The main defects that may occur in the polymeric profile production are «wave» defect, underfills, streaks, scratches, length distortion of the profile (saber), violation of adhesive interaction of layers and phase distribution boundary. The analysis of specific defects, their features and causes was performed. Most appropriate practical ways to eliminate defects using correction of process and design parameters were proposed. Correction of process parameters includes reducing or increasing the worm rotation rate, varying the worm temperature, temperature at the outlet of the working cylinder, temperature control in the first zones of the working cylinder (in the raw charging zone), increasing or decreasing pressure in the head. Design parameters subject to correction include the channel depth in the dosage area and compression zone length, head channel profile, length of calibration and cooling zones.

Keywords: extrusion, coextrusion, technology, formation, polyvinylchloride, profiles, defects, calibrator, adhesion, interlayer interaction.

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INFLUENCE OF VARIOUS FACTORS ON THE THERMAL CONDUCTIVITY OF NANOFLUIDS (p. 35-40)

Nikolay Shimchuk, Vladimir Geller

Influence of the main factors on the properties of nanolubricants, including the methods of their preparation, the size and shape of initial nanoparticles, their concentration, temperature, type and properties of the base fluids, the measuring procedure are considered. In this study, the results of experimental research of thermal conductivity of the model system isopropyl alcohol - nanoparticles Al2O3 are presented. All measurements were conducted over a temperature range from 270 to 370 K at different mixture compositions using two independent methods: the steady-state hot-wire method and the transient hot-wire method. The size and concentration of nanoparticles in the lubricant were determined by dynamic light scattering (laser correlation spectroscopy). The analysis of the obtained data show that thermal conductivity become considerably increased due to nanoparticles even at small nanoparticle concentration (at the Al2O3 volume concentration of 2.5 %, the thermal conductivity increases by 15–20 %). Based on the obtained data, the modified Maxwell model for thermal conductivity was developed.

Keywords: nanofluids, nanoparticles, thermal conductivity, experiment, models, calculation.

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STUDY OF POROUS SILICON SURFACE BY MASS SPECTROSCOPY METHODS (p. 41-45)

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Silicon surfaces of multicrystalline substrates before and after the formation of porous silicon on them, used in the production of photovoltaic cells were studied by mass spectrometry methods. An analysis of the elemental surface composition by mass spectroscopy of secondary ions at various manufacturing stages, including before and after electrochemical etching to create a porous silicon layer was conducted in the research. Clean surfaces before etching in an electrolyte based on hydrofluoric acid (HF: C_2H_5OH=10:1) were compared with surfaces after the etching process, both at secondary ion spectra, and in 2D-ion images of the multicrystalline substrate surface that have been obtained on the mass-spectrometer TOF5 SIMS using a current of secondary ions CH_3+. In particular, the presence of ion CH_3+, which can saturate the dangling bonds of the porous silicon surface, obtained due to the electrochemical technology using etchant solutions based on hydrofluoric acid with the addition of $((CH_3)_2NCOH)$ was checked. As can be seen from the above mass spectroscopy spectra, both oxygen complexes and hydrogen bonds are present on a clean silicon surface before etching. As shown in the 2D-ion image of the sample surface, the surface of the etched silicon contains a large number of secondary ions CH_3+. This is also evident from the spectra of secondary ion emission of the silicon surface before and after etching.

Keywords: porous silicon, electrochemical hydrogenation, multicrystalline substrate, mass spectrometry, photovoltaic cell.

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ON A UNIVERSAL FUNCTION OF CORROSION STRENGTH OF MATERIALS WITH REGARD TO THE INFLUENCE OF MECHANICAL STRESSES AND THE CONCENTRATION OF THE DIFFUSING SUBSTANCES (p. 46-49)

Talybly Latif Khalil oglu, Mamedova Hijran Ali kizi

In the literature, there are experimental studies, confirming the significant effect of the degree of concentration of the active components of corrosive medium on the corrosion process. These results are presented in tables and graphs that describe the dependencies of the time before corrosion damage on the mechanical stress and the concentration of the diffusing substances. Functional dependencies, describing these data are of limited use. However, establishing a more general analytical dependency is necessary to study the corrosion process mechanism. As a result of the analysis of experimental data, a universal function-formula of corrosion strength of materials, which allows to forecast the "material – corrosive medium" system properties with regard to the action of mechanical stress and concentration of diffusing substances was proposed. A system of experiments, allowing to determine the universal constants, which are contained in the proposed function was formulated. The results of processing the experimental data on corrosion damage, borrowed from the literature were presented. The proposed formula can be used as a universal function-characteristic of the "material - corrosive medium" system. It can also be used in constructing phenomenological theories of corrosion damage of materials.

Keywords: corrosion strength, mechanical stress, concentration of active substances, universal strength function, damage.

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INCREASING THE PROPERTIES OF STRUCTURAL FERRITE-PEARLITE STEELS (p. 50-58)

Yuriy Bublikov

We have studied the ways of increasing the durability of low-alloy structural ferrite-pearlite steels and researched their possible effective use in a grade composition. The statistic processing of an array of industrial smelts has proved possible increasing of the durability owing to both solid-solution strengthening of ferrite and, to a greater extent, dispersive and grain-boundary strengthening.

The suggested way of increasing the durability of low-alloy steels is based on the mechanism of carbonitride hardening through a complex steel microalloying with nitrogen alongside nitride-forming titanium and aluminum, instead of vanadium. Owing to nanodispersive carbonitride phases, such microalloying provides a fine grain microstructure of rolling and heat-treated cast and secures a high level of durability.

The research has proved that the forming of nanodispersive carbonitride phases requires optimal correlation of nitrogen (0.012–0.015 percent by mass for cast steels and 0.014–0.020 percent by mass for heat-deformed steels) and the suggested microalloying elements (titanium—0.015–0.025 percent by mass and aluminum—0.015–0.025 percent by mass).

Keywords: structural steels, ferrite-pearlite structure, yield point, carbonitride hardening, microalloying.

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