1. NANOPHYSICS

1.1. Phenomena and Effects

2.1.1.1. Electron transport mechanism in composites based on polybenzimidazole matrix with graphite nanoparticles. /V.A. Kuznetsov, A.N. Lavrov, B.Ch. Kholkhoev, V.G. Makotchenko, E.N. Tkachev, V.F. Burdukovskii, A.I. Romanenko/. Proceedings of NAS RA. Physics. – 2020. – vol. 55. – #1. – pp. 78-85. – rus.; abs.: rus., arm., eng.

The paper presents an experimental study of the electron transport in composite samples based on an insulating matrix of polybenzimidazole with graphite nanoparticles as a conducting filler. Based on a qualitative analysis of the temperature dependences of electrical resistance obtained for the samples with different filler concentrations, it was established that the electron transport occurred by tunneling between conducting filler particles, with the variable-range hopping conduction taking place at low temperatures. Fig. 4, Ref. 17.

Keywords: electron transport, composite samples, insulating matrix, graphite nanoparticles, electrical resustance

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2.1.1.2. Quantum model of a trapezoidal limiting potential profile in a spherical nanocrystal. /H.S. Nikoghosyan, S.L. Harutyunyan, V.F. Manukyan, G.H. Nikoghosyan/. Proceedings of NAS RA. Physics. – 2019. – vol. 54. – #4. – pp. 471-477. – rus.; abs.: rus., arm., eng.

Considered is a limiting potential model for a spherical quantum dot with three variation parameters - well depth, external and internal radii. The stationary s-states are calculated by the exact solution and in the WKB approximation. For states with $l \neq 0$, an approximate consideration is applied, subject to the conditions of semiclassicality. As a result, the energy values of the lower bound states are presented at fixed external and varying internal radii in wells of various depths. The dependence of the energy gap between the levels in the well on the variation parameters is demonstrated. Fig. 1, Ref. 14.

Keywords: limiting potential model, spherical quantum dot, external nd internal radii, lower bound states, energy gap

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2.1.1.3. Nucleation mechanism and nanostructures' total energy calculation in CdTe-ZnTe-HgTe material *system.* /A.K. Simonyan, K.M. Gambaryan, V.M. Aroutiounian, M.K. Gambaryan, G.A. Avetisyan/. Proceedings of NAS RA. Physics. – 2019. – vol. 54. – #4. – pp. 478-484. – rus.; abs.: rus., arm., eng.

The continuum elasticity model is applied to quantitatively investigate the growth features and nucleation mechanism of quantum dots, nanopits, and joint QDs-nanopits structures in CdZnHgTe quasiternary material system. It is shown that for the CdZnHgTe solid solution deposited on CdTe substrate, at the critical strain of $\varepsilon^* = 0.006$ and $\varepsilon^* = 0.009$, the sign of island's critical energy and volume is changed. It is assumed that at $\varepsilon = \varepsilon^*$ the mechanism of the nucleation is changed from the growth of quantum dots to the nucleation of nanopits. Obviously, at small misfits ($\varepsilon < \varepsilon^*$) the bulk nucleation mechanism dominates. However, at $\varepsilon > \varepsilon^*$ when the energy barrier becomes negative as well as a larger misfit provides a low-barrier path for the formation of dislocations, the nucleation of pits becomes energetically preferable. Fig. 5, Ref. 15.

Keywords: continuum elasticity model, nucleation mechanism, quntum dots, critical strain, energy barrier

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2.1.1.4. Rashba spin-orbit interaction in semiconductor nanostructures (review). /B.G. Ibragimov/. Azerbaijan Journal of Physics. – 2020. – vol. 26. – #2. – pp. 3-9. – eng.; abs.: eng.

The work reviews the theoretical and experimental issue related to the Rashba spin-orbit interaction [1] in semiconductor nanostructures. The Rashba spin-orbit interaction has been a promising candidate for controlling the spin of electrons in the field of semiconductor spintronics. The work focuses on the study of the electrons spin and holes in isolated semiconductor quantum dots and rings in the presence of magnetic fields. Spin-dependent thermodynamic properties with strong spin-orbit coupling inside their band structure in systems are investigated. Additionally, specific heat and magnetization in two-dimensional, one-dimensional ring and quantum dot nanostructures with spin-orbit interaction are discussed. Fig. 4, Ref. 68.

Keywords: spin-orbit interaction, Rashba effect, two-dimensional electron gas, one-dimensional ring, quantum wire, quantum dot, semiconductor nanostructures

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1.2. Properties of Materials and Structures

2.1.2.1. Rheological properties of nanocomposites based on bifunctional clinoptilolite and ethylene/ hexene copolymer. /I.V. Bayramova/. Azerbaijan Chemical Journal. – 2020. – #2. – pp. 83-89. – eng.; abs.: eng., az., rus.

The results of a study of the influence of temperature and shear stress on the rheological properties of ethylene/hexene copolymer and its clinoptilolite-filled nanocomposites are presented. Rheological measurements were carried out in the temperature range of 190–250 ^{0}C. The dependence of shear rate on shear stress, effective melt viscosity on shear rate, and melt viscosity on temperature in Arrhenius coordinates is studied. Using the universal temperature-invariant viscosity characteristics of nanocomposites allows make approximate calculations of effective viscosity close to the conditions of their processing by extrusion and injection molding by extrapolation to the region of high shear rates. Fig. 4, Tab. 1, Ref. 12.

Keywords: viscosity, shear rate, shear stress, nanocomposites, polymer melt, clinoptilolite

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2.1.2.2. Zinc-containing nanocomposites based on high-pressure polyethylene. /T.M. Guliyeva/. Azerbaijan Chemical Journal. – 2020. – #2. – pp. 34-38. – eng.; abs.: eng., az., rus.

The effect of nanofiller additives containing nanoparticles of zinc oxide stabilized by a polymer matrix of maleinated polyethylene, obtained by a mechanochemical method, on the properties of composites based on high-pressure polyethylene was studied by X-ray phase and thermographic analyzes. The improvement of the strength, deformation and rheological parameters, as well as the thermo-oxidative stability of the obtained nanocomposites was revealed, which is apparently due to the synergistic effect of the interaction of zinc-containing nanoparticles with maleic maleinated polyethylene groups. It is shown that polyethylene based nanocomposites can be processed both by pressing and by injection molding and extrusion, which expands its application field. Fig. 2, Tab. 2, Ref. 15.

Keywords: polyethylene, zinc-containing nanofillers, maleinized polyethylene, physicol - mechanical properties, X-ray phase and thermographic analyzes

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2.1.2.3. Effect of bentonite concentration on properties and regularity of crystallization of nanocomposite materials based on the mixtures of high and low-density polyethylene. /F.A. Mustafayeva, N.T. Kakhramanov, N.B. Arzumanova, N.Ya. Ishenko, I.A. Ismayilov/. Azerbaijan Chemical Journal. – 2020. – #1. – pp. 53-58. – eng.; abs.: eng., az., rus.

The results of research of the effect of bentonite concentration on the regularity of crystallization and the nature of changes of ultimate tensile strength, tensile yield strength and elongation at break of nanocomposite materials basrf on the mixtures of high and low density polyethylene are presented. Fig. 2, Tab. 2, Ref. 9.

Keywords: crystallization, dilatometry, specific volume, polymer blend, high-density polyethylene, lowdensity polyethylene, bentonite

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2.1.2.4. Metal-containing nanocomposites based on isotactic polypropylene and ethylene-propylene-diene rubber. /N.A. Alimirzayeva/. Azerbaijan Chemical Journal. – 2020. – #1. – pp. 41-45. – eng.; abs.: eng., az., rus.

The work summarizes the data of studies on the effect of nanofiller additives containing copper oxide nanoparticles stabilized by a high-pressure polyethylene matrix obtained by the mechanochemical method on the physico-mechanical, rheological properties and crystallization of thermoplastic mixed elastomers on the basis of isotactic polypropylene and ethylene propylene diene rubber. The work presents the prospects of using these additives to elastomers that provides for producing a fine-spherical layered structure of the composition characterized by improved melt flow rates, rheological, physicomechanical properties, and thereby expand the scope of application obtained nanocomposites. Fig. 3, Tab. 1, Ref. 12.

Keywords: metal-containing nanocomposites, isotactic polypropylene, ethylene propylene diene rubber, copper oxide nanoparticles, physico-mechanical, rheological properties, crystallization

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2.1.2.5. Influence of single-walled carbon nanotubes on dielectric relaxation and electric conductivity of a smectic A liquid crystal with positive dielectric anisotropy.

/T.D. Ibragimov, A.R. Imamaliyev, G.F. Ganizade/. Azerbaijan Journal of Physics. – 2020. – vol. 26. – #3. – pp. 3-6. – eng.; abs.: eng.

The effect of single-walled carbon nanotubes (SWCNTs) on the dielectric and conductivity properties of a smectic A liquid crystal 4-nitrophenyl-4'-decyloxybenzoic acid has been studied. It is shown that the additive of SWCNTs with concentration of 0.5% leads to a decrease in the order parameter of 5CB. In this case, the clearing point is raised, the longitudinal component of the dielectric permittivity decreases while the transverse component increases. The incipient percolation effect promotes to the dominance of hopping electron conductivity over ionic conductivity, leading to an increase in specific conductance. Fig. 3, Ref. 9.

Keywords: smectic A liquid crystal; single-walled carbon nanotubes, dielectric permittivity; electric conductivity

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2.1.2.6. Dielectric, conductivity, and electro-optic properties of liquid crystal 5cb doped by single-walled carbon nanotubes. /T.D. Ibragimov, A.R. Imamaliyev, G.F. Ganizade/. Azerbaijan Journal of Physics. – 2020. – vol. 26. – #2. – pp. 10-14. – eng.; abs.: eng.

The effect of single-walled carbon nanotubes (SWCNTs) on the dielectric, conductive, and electro-optic properties of nematic liquid crystal 4-cyano-4'-pentylbiphenyl (5CB) has been studied. It is shown that the additive of SWCNTs with concentration of 0.5% leads to strong interaction between SWCNTs and molecules, which increases the order parameter of 5CB. As a result, the clearing point is raised, the longitudinal component of the dielectric permittivity increases while the transverse component decreases. The incipient percolation effect promotes to the dominance of hopping electron conductivity over ionic conductivity, leading to an increase in specific conductivity. In this case, the elastic splay constant of 5CB is enhanced and, accordingly, the threshold voltage of the S-effect increases. A decrease in the Van-der-Waals interaction between molecules decreases viscosity. As a result, the flip-flop motion of molecules becomes easier and the switching time reduces. Fig. 9, Tab. 1, Ref. 8.

Keywords: liquid crystal, single-walled carbon nanotubes, dielectric relaxation, electric conductivity, threshold voltage

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2.1.2.7. EPR investigations of γ-irradiated polytetrafluoroethylene/CdS nanocomposites. /E.G. Hajieva/. Azerbaijan Journal of Physics. – 2019. – vol. 25. – #4. – pp. 22-25. – eng.; abs.: eng.

It is shown that g-factor values for PTFE/CdS nanocomposites at the dose 5kQr correspond to free electrons. The nonlinear dependence of signal intensity on craze number is observed with an increase of craze cycle in EPR spectra. Fig. 4, Tab. 1, Ref. 23.

Keywords: γ-irradiation, nanocomposites, polytetrafluoroethylene, magnetic field, EPR-spectra, dielectric properties, dielectric loss, dielectric constant, crazing, g-factor

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