4. NANOTECHNOLOGY

4.1. Materials and Structures

2.4.1.1. The Inelastic/Elastic and Tribological Properties of PTFE-Based Nanocomposites Filled with Co Cluster-Doped CNTs. /E. Kutelia, G. Darsavelidze, T. Dzigrashvili, D. Gventsadze, O. Tsurtsumia, L. Gventsadze, T. Kukava, L. Rukhadze, L. Nadaraia, I. Kurashvili, S. Bakhtiyarov/. Bulletin of the Georgian National Academy of Sciences. – 2020. – vol. 14. – #1. – pp. 57-63. – eng.; abs.: eng., geo.

The elastic/inelastic behavior and tribological properties of new PTFE-based nanocomposite materials filled with 5wt% and 10wt% Co atomic cluster-doped carbon nanotubes (CNTs) were investigated using low-frequency amplitude-independent (AIIF) and amplitude-dependent (ADIF) internal friction measurements, compressive deformation and tribological test methods. It is shown that the Co atom cluster-doped CNTs filler provides a considerable positive effect on the physicomechanical characteristics of the respective PTFE-based nanocomposite materials used for tribological applications. The obvious effectiveness of the externally applied gradient magnetic field in the process of mixture preparation has been established for sintering of the PTFE-based nanocomposite materials modified by carbon nanotubes doped with the ferromagnetic atom (Co) clusters, finally resulting in the improvement of wear- and creep resistance of the obtained nanocomposites. Fig. 2, Tab. 2, Ref. 13.

Keywords: PTFE, co cluster-doped CNTs, nanocomposite, internal friction, wear

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2.4.1.2. The Influence of Cycling Deformation and Annealing on the Elastic/Inelastic Properties of PTFE-Based Nanocomposite Filled with 7.5wt% Fe Cluster-Doped CNTs. /E. Kutelia, G. Darsavelidze, T. Dzigrashvili, L. Rukhadze, D. Gventsadze, I. Kurashvili, L. Nadaraia, O. Tsurtsumia, L. Gventsadze, I. Losaberidze, S. Bakhtiyarov/. Bulletin of the Georgian National Academy of Sciences. – 2020. – vol. 14. – #2. – pp. 36-41. – eng.; abs.: eng., geo.

For the development of PTFE-based nanocomposites with the regulated technological mechanical and parameters, it is necessary to reveal a correlation between their structural and dynamicalmechanical properties. The researches in this direction were performed using a low-frequency internal friction technique. The behavior of the elastic/inelastic properties of PTFE-based nanocomposite material filled with the optimal (7.5 wt%) concentration of Fe atom cluster-doped carbon nanotubes (CNTs), depending on high amplitude cycling deformation and post-deformation annealing was investigated using amplitude-independent (AIIF) and amplitude-dependent (ADIF) internal friction measurements. The characteristics of dynamical-mechanical strengthening of the Fe cluster doped PTFE-based polymeric materials were determined for the first time, and the possible mechanisms of strengthening have been analyzed. It was shown that high-amplitude cyclic deformation leads to a considerable reduction in activation energy (H, kcal/mole) of β(crystalline) and α(amorphous) relaxation processes, the magnitude of critical amplitudes (ε_c) of microplastic deformation beginning and shear modulus ($G \sim f^2$) in comparison to those for the initial sample before cyclic deformation. It was also found that the post-deformation annealing of the cyclically deformed sample at 150˚C/30 min ensures a complete restoration of the above parameters to the values exceeding those for the initial sample. Fig. 2, Tab. 1, Ref. 16.

Keywords: PTFE, nanocomposite, Fe cluster-doped CNT, internal friction, shear modulus

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2.4.1.3. Study of the physico-chemical properties of silver nanoparticles stabilized with oleic acid using theoretical calculation. /P. Toidze, M. Gabrichidze/. Ceramics and Advanced Technologies. – 2019. – vol. 21. – #1(41). – pp. 14-20. – geo.; abs.: geo., eng.

Inorganic-organic core–shell nanoparticles are considered to be common building blocks for synthesis of multifunctional hybrid nanocomposites, which are promising materials for biomedical and catalytic application. Knowledge of the metal nanoparticle-ligand interaction mechanism is crucial for design strategy of such materials. In the present study silver-oleic acid capped nanoparticles are used as a model for mono- and bilayer ligand chemisorption. HyperChem software generates molecules (the builder), perform structural optimizations, and analyze molecular orbitals and its relation to functionality. Molecular modeling involves the development of mathematical models of molecules that can be used to predict and interpret their properties. A quantum mechanical model of the electronic structure of a molecule, which involves solving the Schrödinger equation. Quantum mechanics can be used to predict electronic properties of molecules, such as dipole moments and spectroscopy. Quantum chemical simulation leads farther insight into the mode of bonding and structure of adsorbed layer. OA interaction with Ag atoms results in charge density increase at metal surface and creation of negative electrostatic potential at carboxyl group owing to covalent bonding. Formation of secondary layer accompanied by redistribution of charge density: slight decrease in metal surface charge density, double decrease of charge density at C=C bond and strong increase in negative charge of carboxyl group of secondary layer. The absence of a double bond in the molecule of stearic acid affects the quality of stabilization of the surface of silver nanoparticles. Controlled release of biologically active silver from nanosilver can be regulated by the surface ligands. The capabilities of nanosilver in inhibiting bacteria were ascribed to the surface ligand-mediated silver ion release from both extracellular process and intracellular manner.The studies AgNPs showed that internalized AgNPs caused cell damage through binding with chain-related proteins and interrupting the electron transfer process. The HyperChem program allows quantum-chemical calculations to explain the role of oleic acid in the formation of mono- and bilayers, the catalytic effect of nano-silver in the oxidation of oleic acid with permanganate and conformational changes in the peptide fragment. Quantum-mechanical calculations allow one to establish the bond lengths in the molecule, the values of the effective charges, and the distribution of the electrostatic potential. Fig. 6, Ref. 17.

Keywords: effeqtive charges, eleqtrostatic potential, oleic acid, stearic acid, lipid-II, nanocomposite

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4.2. Obtaining Technologies

2.4.2.1. Obtaining of bionanoceramic super paramagnetic materials for the creation of local controlled hyperthermia for malignant cancer therapy. /Z. Kovziridze, N. Nijaradze, N. Darakhvelidze/. Ceramics and Advanced Technologies. – 2019. – Vol. 21. – #1(41). – pp. 21-37. – geo.; abs.: geo., eng.

The article seals with such matters as a comparative study of anticancer properties of hyperthermia induced by hematite nanoparticles and the mechanisms of their impact; creation of principally new drug of high anticancer effect; preparation-concentration of a drug containing hematite nano-particles, control of activity; a comparative study of anticancer activity of the drug; the determination-development of optimal regime and schemes; an analysis of powder of the obtained hematite nanoparticles showed homogeneous spreading of particles according to their dimensions and correspondingly – good stability. By further treatment of ferric ions obtained in Zeta potential device above Curie (769oC) temperature (800oC) the hematite nanoparticles of 80 nm size were obtained in oxidizing medium at the regime 4-5C/min. Tab. 1, Fig. 12, Ref. 24.

Keywords: nanoparticle, hematite, hyperthermia, stability

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2.4.2.2. Electrosynthesis and application of nanomagnetite for purification of water previously contaminated by phenol. /M. Donadze, N. Makhaldiani/. Ceramics and Advanced Technologies. – 2020. - vol. 22. – #1(43). – pp. 15-22. – geo.; abs.: geo., eng.

The aim of the study is the electrosynthesis of Fe_3O_4 nanomagnetite and the purification of precontaminated water from phenol using a filter containing nanomagnetite. The main component of the filter is magnetite nanoparticles stabilized with oleic acid, obtained by electrosynthesis in a two-layer bath. An aluminum arc was used as a rotating cathode and optimal electrolysis parameters were determined. A porous filter was obtained after impregnation of bohemite with magnetic nanoparticles and its subsequent burning at 450°C. In a two-layer bath, a monodispersed sol of magnetite in hexane was obtained. The optimal parameters of electrolysis are determined. The resulting nanomagnetite was characterized by X-ray analysis (XRD), infrared spectroscopy (FT-IR), elementary analysis and scanning microscopy (SEM-EDS). Particle size determined by dynamic light scattering (DLS Malvern). A filter based on nanomagnetite shows a significant effect in the process of purifying drinking water from phenol. Monodisperse organosole of nanomagnetite was obtained by electrolysis in a two-layer bath. A porous filter containing nanomagnetite can be used to purify water contaminated with phenol at the place of consumption. Fig. 8, Ref. 17.

Keywords: nanomagnetite, electrosynthesis, boehmite, Fenton mechanism, phenol

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2.4.2.3. Synthesis and application of the hybrid nanocomposite - Ag@MnOx for purification with bacteria (e.coli) and heavy metals contaminated water. /N. Makhaldiani, M. Donadze/. Ceramics and Advanced Technologies. – 2020. - vol. 22. - #1(43). – pp. 23-36. – geo.; abs.: geo., eng.

The aim of the study was the synthesis of the Ag@MnOx nanocomposite and the purification of water from bacteria and heavy metal ions using filter containing a hybrid nanocomposite. The main filter component is silver nanoparticles stabilized with oleic acid, obtained by electrosynthesis in a two-layer bath. An aluminum arc was used as a rotating cathode and optimal electrolysis parameters were determined. Hybrid nanocomposite obtained by oxidation of oleic acid with potassium permanganate. A porous filter was obtained by coating of honeycomb structure cordierite with a primary layer-washcoat (γ-Al_2O_3) and its subsequent impregnation with a hybrid nanocomposite. The use of an arc instead of a disk-shaped cathode in a two-layer bath reduces the size of silver particles and increases the degree of monodispersity. A filter based on a hybrid nanocomposite shows a good antibacterial effect in the process of purification of drinking water from E.coli bacteria; good sorption effect for copper ions and sorption and oxidative effect for manganese ions. A porous honeycomb structure filter containing a nanohybrid composite Ag @MnO_x can be used to purify water contaminated with bacteria and heavy metals at the place of consumption (well water, exotic tourism zone, etc.). Tab. 1, Fig. 14, Ref. 16.

Auth.

Keywords: nanosilver, hybrid nanocomposite, cordierite, heavy metals, coli index

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2.4.2.4. Obtaining metal-containing nanoparticles in polyethylene matrix by mechano-chemical method and study of their properties. /S.K. Ragimova/. Azerbaijan Chemical Journal. – 2020. – #2. – pp. 20-25. – eng.; abs.: eng., az., rus.

Metal-containing nanoparticles in the matrix of high-pressure polyethylene are obtained by the mechanochemical method without the use of organic solvents by high-speed thermal decomposition of salts of organic acids under conditions of high shear deformations. The phase composition and structure of the obtained nanocomposites were studied by X-ray phase, scanning electron microscope, and thermogravimetric analyzes. It is shown that the formation of nanoparticles of metal oxides in the polymer matrix, contribute to the stabilization of the composite, raising the temperature of the onset of its thermaloxidative degradation. Micrographs of the obtained nanocomposites indicate the formation of layered structures that possess high fracture toughness. Fig. 8, Tab. 1, Ref. 12.

Keywords: metal-containing nanoparticles, high pressure polyethylene, mechano-chemical method, Xray phase, scanning electron microscope and thermogravimetric analyzes

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2.4.2.5. Synthesis, conversion and antimicrobial activity of derivatives of 2-hydroxy-1-haloidphenoxy-ethers of nonanol-2. /S.A. Mammadov, A.A. Mahmudova, G.G. Mammadova, V.S. Hasanov, N.P. Ladokhina, L.F. Zeynalova/. Azerbaijan Chemical Journal. – 2020. – #1. – pp. 59-65. – eng.; abs.: eng., az., rus.

Reactivity of hydroxyl group 1-haloid-phenoxy-2-hydroxynonanes to nucleophilic substitution with acetoxymethylchloride was studied. It was found that regardless of the nature of haloids and their position in aryloxy radical, the yields of acetoxymethyl ethers make nearly 70% that proves high reactivity of hydroxyl group. Indeed, during the reaction with isocyanates phenoxynonanol-2 forms urethanes with yield 69–70%. Initial synthon was prepared by the reaction of 1-bromine-nonanol-2 with substituted phenols. Study of synthesized polyethers and urethanes as antimicrobial additives to lubricating oils gave positive results. It was determined that urethanes exhibit stronger antimicrobial effect than polyethers. Fig. 2, Table. 3, Ref. 12.

Keywords: phenoxyethers, urethanes, polyethers, acetoxymethyl, antimicrobial additives

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2.4.2.6. Deposition of nanodrop phase from emitter tip on nearby mobile surface. /I.S. Gasanov , S.A. Aliyev, I.I. Gurbanov, E.M. Akberov, F.E. Mamedov, A.H. Kerimova/. Azerbaijan Journal of Physics. – 2020. – vol. 26. – #1. – pp. 40-43. – eng.; abs.: eng.

The formation processes of low-sized structures by means of a fine-dispersed phase of liquid metal ion source (LMIS) are considered. The emitting tip is located in close distance from moved surface with the aim of deposition of narrow stripes. At distance tip – surface near 80 μm on the axis of thin and wide traces of (İn+ , Sn+) ions the massive continuous paths by width of several microns are obtained. The structure of deposited stripes by the length more than 10 mm is the grain structure. At further approach of tip to surface, the path melts because of high density of ion current and heterogeneous profile of its cross-section become smooth. For deposition of narrower structures, the effective cooling of conducting mobile substrate is necessary. Fig. 5, Ref. 8.

Keywords: liquid metal ion source, field emission, nanoparticle

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4.3. Processing Technologies

2.4.3.1. Nanotechnologies or technological advances of the future. /I. Phutkaradze/. Chemistry News. – 2019. – vol. 3. – #1. – pp. 16-19. – geo.; abs.: geo.

Nanotechnologies are the technology of the future. It is a multidisciplinary field, which includes chemistry, biology, physics, computer science, medicine and engineering. Its main task is to manage processes at the molecular level for which purpose it uses the smallest nanoparticles sized from 1 to 100 nanometers. In the field of technologies nanomaterial chips, processors and other means of communication are noteworthy, which according to scientists, will make a nanorevolution in the world. Fig. 3, Ref. 5.

Keywords: nanotechnology, nanoparticle, nanosystem, nanomolecule, nanomedicine, nanorevolution

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2.4.3.2. Results of laboratory and industrial tests of IKHLAS-1 nanodemulsifier on the Akkulka Oil Field and the new mechanism of destruction of oil emulsions. /T.K. Dashdiyeva/. Azerbaijan Chemical Journal. – 2020. – #3. – pp. 34-45. – eng.; abs.: eng., az., rus.

The article presents the results of laboratory and industrial tests of the IKHLAS-1 nanodemulsifier for the Akkulka Oil Field of the LLC Tetisaralgaz of the Republic of Kazakhstan. According to the test results, it was found that the IKHLAS-1 nanodemulsifier under all technological conditions of primary oil preparation shows significant advantages compared to the basic DMO-86520 demulsifier. Therefore, IKHLAS-1 was recommended for widespread introduction of the Akkulka Oil Field at the Group Installation of primary preparation of oil. Implementation results (since October 2017) also confirms the high efficiency of the IKHLAS-1 nanodemulsifier. The article sets out also a new mechanism for the destruction of oil emulsions. Tab. 9, Ref. 15.

Keywords: nanodemulsifier IKHLAS-1, oil field nanotechnology, oil production, nanotechnology in oil and water preparation, new mechanism, destruction of oil emulsions

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