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Structure, physical and mechanical properties of the polycarbonate-barium ferrite nanocomposite

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Magnetic nanocomposites have broad application potential in medicine, electronics, information technology and other branches of national economy. Among other magnetic materials, ferrites have gained special interest. Although in comparison to metals and metal alloys, magnetic properties of ferrites are lower, they are cheaper and more resistant in oxidative environments. In addition, ferrites possess higher electrical resistivities and thus are especially useful at high frequency applications. It is well recognized that optimum level of the magnetic properties of the ferrites is attainable when the dimensions of their particles are well below domain sizes and when the dimensions of their particles decrease to an extent where the ratio of the number of surface atoms to the total number of atoms in the particle approaches 0.5. At such particle dimensions ferrites possess several specific properties such as supermagnetism and macroscopic quantum tunnelling not characteristic for larger diameter particles. Introduction of subdomain ferrite nanoparticles in the matrixes of other materials such as metals, ceramics and polymers can yield perspective advanced materials for modern technologies. Consequently this investigation is devoted to the modification of the polycarbonate (PC) nanocomposites with subdomain ferrite nanoparticles. Barium ferrite (BaF) was obtained by citrate-nitrate self-combustion route. Obtained nanopowders were introduced in the PC matrix by melt mixing. Weight content of the ferrite in the PC nanocomposites was varied from 2 to 10 wt. %. Thermogravimetric, calorimetric, electrical, magnetic and structural properties of the PC matrix nanocomposites were investigated. It was confirmed that after auto-combustion and calcination pure $BaFe_{12}O_{19}$ with subdomain crystallite sizes was formed. AFM measurements confirmed that individual particle dimensions of the synthetized nanoferrites were at about 30 nm. SEM micrographs also revealed rather good distribution of the nanostructured ferrite particles in the thermoplastic PC matrix, however, some agglomerates were also observed. By calorimetric measurements it was demonstrated that at certain BaF content in the polymer matrix glass transition temperature of the PC nanocomposites rose by some degrees. Magnetic properties of the investigated nanocomposites were found to increase with the addition of certain amount of the ferrite nanofiller. Electrical properties of the PC based nanocomposites, however, were not significantly changed with addition of the BaF. In the same time addition of the ferrite nanofiller to the PC matrix caused substantial increase in the elastic modulus, yield strength and ultimate strength of the investigated nanocomposites, while corresponding relative deformations were influenced insignificantly.

Poster Location: MS11

The Effect of MWCNTs on Molecular Weight on In Situ -Polymerization of Styrene and Methyl Methacrylate

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Nanoscale particles in polymers offer the promise of multifunctional polymer composite with enhanced mechanical, electrical, optical, thermal, or magnetic properties. Good dispersion of nanomaterials into the polymer matrix is presumed to be easier by in situ polymerization. In general, the challenge in achieving the ability to control and predict nanocomposite properties is to understand the interfacial phenomenon between the particles and polymers. There are plenty of studies how to functionalize CNTs, but significantly less studies how CNTs affect the polymerization of different monomers. Two different in situ polymerization techniques were studied, emulsion polymerization (initiator potassium peroxodisulfate) and combined emulsion/suspension polymerization (initiator azobisisobutyronitrile) with styrene and methyl methacrylate. The amount of MWCNTs affected to molecular weight. The molecular weights increased as the amount of MWCNTs increased. The MWCNTs stabilized the emulsions and polydispersities decreased with higher amount of MWCNTs. In emulsion polymerization, MWCNTs acted as catalysts and thinner nanotubes provide better catalytic effect than thicker nanotubes that have less surface area. In combined emulsion/suspension polymerization, molecular weights were lower than in emulsion polymerizations. In combined polymerization, MWCNTs reacted with the initiator and there is less initiator to polymerize the monomer. There is probably a critical surface area of MWCNTs, when more initiator is consumed in reaction with MWCNTs than in polymerization of monomer. The collapse of molecular weight can be prevented by covering the surface of MWCNTs.

Poster Location: MS01

The synthesis of blue or violet anisotropic silver nanoparticles using polyamidoamine dendrimers as novel catalysts

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Nanoparticles are objects having at least one dimension of order of nanometers. According to the shape, nanoparticles can be divided into spherical and anisotropic. In recent years, noble metals triangular (called nanoprisms) and hexaangular nanoplates, nanodiscs, nanorods, nanospheres and further shapes were synthetized and characterized. To date, several methods of silver nanoprisms preparation are known [1,2]. In principle, they can be divided into photochemical and solvothermal. The photochemical method consists in photoconversion of small citrate capped silver nanospheres to larger nanoprisms by white light. Purely chemical methods omitting light action were also developed. Silver nanoprisms, truncated nanoprisms, hexagonal nanoplates and nanodisks were prepared by silver salt reduction by a variety of reducing agents in the presence of capping agents like citrate, polyvinylpyrrolidone and detergents [1]. Here we present a preparation of silver nanoprisms, hexagonal nanoplates and nanodiscs based on simultaneus action of sodium borohydride and hydrogen peroxide in the presence of PAMAM etylenediamine core dendrimers. When we mixed solution of Ag nanoparticles encapsulated in dendrimer with hydrogen peroxide in excess of sodium borohydride, we observed blue (violet) products formation. Atomic force microscopy analysis clearly showed that violet and blue colour could be ascribed to silver nanoprisms, hexagonal nanoplates and nanodisks. The first two shapes embody about 100 300 nm edge lenght and 10 15 nm thickness. UV-VIS spectra revealed two peaks: the first at 350 nm, which is usually ascribed to anisotropic silver nanoparticles, and the second in about 550 850 nm range with the correct value depending on reaction parameters, which is responsible for blue (violet) colour. Infrared spectroscopy revealed that organic dendrimer moiety is probably not associated with nanoparticles. We performed a number of optimization attempts with the aim to produce a maximum amount of blue (violet) products. The key factor is the concentration ratio of dendrimer to silver ion. At high ratio, blue (violet) products are formed unlike at low one leading to brown products formation. In the dependence on hydrogen peroxide amount added, there exist an optimum amount leading to maximum blue colour production, while colour extinction and aggregation leading to visible precipitate formation is observed at higher one. The reaction is strictly pH controlled. We studied the influence of various buffers having adjusted pH values. No buffer addition as well as too high buffer capacity don't lead to blue (violet) products formation. 0,03 M morpholinoethanesulfonic acid buffer pH 6,5 was found to provide suitable environment. According to our knowledge, we demonstrate for the first time a possibility to employ dendrimers as novel catalysts for anisotropic silver nanoparticles formation using procedure based on simultaneous action of hydrogen peroxide and sodium borohydride, which has been already published in literature. [1] V. Torres, M. Popa, D. Crespo, J. M. C. Moreno, Microelectronic Engineering 84 (2007) 1665-1668. [2] R. C. Jin, Y. W. Cao, C. A. Mirkin, K.L. Kelly, G. C. Schatz, J.G. Zheng, Science 294 (2001) 1901.

Poster Location: MS07