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Application of polymeric materials as a matrix for stabilization and control of the structure of metal nanoparticles

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The high reactivity and aggregation tendencies of metallic nanoparticles stimulate a search for effective stabilization and passivation techniques. In particular, much attention has been paid to organic compounds, including polymers, as candidate matrices for the stabilization of disperse metallic systems. The principle of penetration of particles into a layer of a polymer matrix is based on the method of stabilization and passivation of metal nanoparticles developed in the present work. In the process of contact of metal particles with the surface of the polymer matrix, the kinetic energy of the particles ensures their penetration into a certain thickness, as well as the reorganization of carbon cycles and re-polymerization. This leads to encapsulation of each nanosized particle and thereby prevents the process of their coagulation. The polypropylene and benzene were used as a stabilizing matrix. The vacuum system used to prepare nanoparticles of Aluminum (Al). The spherical reactor was cooled with liquid nitrogen and was equipped with lead-ins for the evaporator and hydrogen atomizer. The evaporator temperature was measured with a pyrometer through an optical window. The rate of Al evaporation was determined using an electronic balance vacuum-connected with the reactor. The balance was calibrated by measuring the pressure change caused by wafer evaporation from a special pan suspended from one of the balance arms. This method ensured absolute calibration. When Al atoms encounter the matrix, they penetrate some depth into the layer, rapidly losing their kinetic energy. This gives rise to local heating, favoring Al diffusion deeper into the layer. To examine the effects of the evaporation rate, benzene-to-aluminum and polypropylene to-aluminum ratio on the size of deposited clusters, aluminum (0.03 g) was deposited onto layers produced by freezing 5; 20 and 60 g of benzene and 120; 235 and 260 g of polypropylene. The deposits were examined on a JEM-1100CX electron microscope. It was interesting to investigate the physicochemical processes accompanying the incorporation of Al particles into the organic matrix. According to IR-spectroscopy data, Al deposition in vacuum produced no bonds involving Al. After benzene was distilled off, the reactor contained only Al powder. After Al deposition in a hydrogen atmosphere, the IR spectrum showed, along with absorptions at 2750-3100, 1520-1620 and 600-700 cm⁻¹ (=C-H stretches, C=C stretches and out-of-plane C-H bending vibrations, respectively), a band at 725 cm⁻¹, attributable to the Al-C bond.

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