Metal nanoparticles produced in arc plasma and their surface modification with chemical vapors

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First, an arc plasma method for preparing nanoparticles is introduced. The method possesses higher production rate, and is suitable for preparation of nanoparticles of metals with high melting point. The bulk metals are evaporated by the high temperature of the plasma, and the nanoparticles were formed through homogeneous nucleation. In this study, Fe nanoparticles were fabricated, which possessed higher crystallinity compared with conventionally used carbonyl Fe particles.

Second, a chemical vapor surface modification method for stabilizing surface energy of Fe nanoparticles is introduced. After hydroxylation of the surface of the nanoparticles, vapor of a silane coupling agent was directly reacted to the hydroxylated surface. The resultant nanoparticles were well hydrophobic. The hydrophobic surface can enhance oxidation resistance in room temperature as well as dispersibility of nanoparticles into any oils.

Third, a potential application of the surface modified nanoparticles, magneto-rheological (MR) fluid is introduced. MR fluids respond to a magnetic field with a dramatic change in rheological behavior. These fluids can reversibly and instantaneously change from a free-flowing liquid to a semi-solid with controllable yield strength when exposed to a magnetic field. MR can present applications including automotive primary suspensions, truck seat systems, cab suspensions, control-by-wire/tactile-feedback devices, seismic mitigation and human prosthetics. The majority of currently existing MR fluids is composed of micron-sized Fe particles suspended in a nonmagnetic carrier fluid. The particles may lead to unwanted abrasion of the components in contact with the fluid. Also, they are susceptible to settling in the absence of frequent mixing due to predominant gravity forces. Nanoparticle dispersed fluid, nano-MR fluid, is desirable.