Synthesis of Nickel-Platinum Composite Nanoparticles and Silica-Coating of Them

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Abstract : Nickel (Ni) and Ni-containing nanoparticles are promising materials due to their unique magnetic properties. In a preliminary experiment, aggregates of such nanoparticles formed after they were synthesized. Since the nanoparticle aggregation may deteriorate their unique properties, a method to suppress the nanoparticle aggregation has been required. In the present work, compositing with nickel (Ni) and platinum (Pt) and silica-coating of them were examined for suppression. Ni-Pt nanoparticles were synthesized in water exposed to air, in which nickel (II) acetate tetrahydrate, hexachloroplatinate (IV) hexahydrate, and sodium borohydride were used as a Ni source, a Pt source, and a reducing reagent, respectively. Polyvinylpyrrolidone, poly (sodium 4-styrene sulfonate), and citric acid were used as the stabilizers. Silica-coating of Ni-Pt nanoparticles was performed by adding tetraethylorthosilicate(TEOS)/ethanol solution to the Ni-Pt nanoparticle colloidal solution (Ni-Pt/SiO_2). The morphology of Ni-Pt nanoparticles was dependent on the reaction time and the species of stabilizer. The Ni-Pt/SiO_2 nanoparticles were composed of Ni-Pt nanoparticles as core and SiO_2 as shell, and their morphology depended on the TEOS concentrations. Furthermore, the Ni-Pt/SiO_2 nanoparticles were more dispersed compared to uncoated Ni-Pt nanoparticles. This suggested that the silica-coating had an effect on controlling the aggregation. The liquid-phase synthesis process involving the sol-gel method used in this study is advantageous for achieving monodispersion of particles and high-purity of materials. If the challenges of optimizing reaction conditions to achieve them during scale-up can be addressed, the proposed method holds great potential for large-scale production of particles in applications such as magnetic storage devices and biomedical imaging.

Keywords : metal, composite, nickel, platinum, nanoparticle, silica-coating
Conference Title : ICCN 2025 : International Conference on Composites and Nanoengineering
Conference Location : Madrid, Spain
Conference Dates : March 17-18, 2025