

Neutral pH Ferrofluid Fabrication for Biomedical Applications

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Ferrofluids are composed of nanoscale magnetic nanoparticles (iron, cobalt, nickel, or their oxides) and strongly polarized in the presence of magnetic field. After coating the surface of these nanoscale particles (~ 10 nm) by surfactant molecules (e.g., oleic acid, tetramethylammonium hydroxide, citric acid, etc.), they become fully stable and do not aggregate or segregate under the strong magnetic field. Ferrofluids are used for various applications, including medical (cancer detection / curing, pharmaceutical, MRI), ferrofluidic seal around the spinning drive shafts, liquid coolant (megaphones and loudspeakers), friction reducer / shock absorber, earthquake, as well as defense, aerospace, grain size

measurement and heat transfer. Ferrofluids are produced at extreme high or low pH values in order to prevent agglomeration of the nanoparticles caused by van der Waals and magnetic forces. This limits the application of ferrofluid for various fields because of the oxidation, corrosion as well as harmful effect to body. In this study, magnetite (Fe_3O_4) nanoparticles (~ 10 nm) were produced by coprecipitation of iron (II) and iron (III) chloride salts in the presence of ammonium hydroxide, and stabilized using first citric acid at 100°C and a fatty acid at room temperature. Measured pH value of the ferrofluid was 7.0. As is known, magnetite nanoparticles that have excellent magnetic saturation (~ 78 emu/g) are desirable for those applications due to the strong ferromagnetic behavior, less sensitivity to oxidation and relatively low toxicity compared to many other magnetic materials (e.g., iron, nickel and cobalt).