World Academy of Science, Engineering and Technology
International Journal of Materials and Metallurgical Engineering
Vol:12, No:06, 2018

Altering Surface Properties of Magnetic Nanoparticles with Single-Step Surface Modification with Various Surface Active Agents

Authors : Krupali Mehta, Sandip Bhatt, Umesh Trivedi, Bhavesh Bharatiya, Mukesh Ranjan, Atindra D. Shukla

Abstract : Owing to the dominating surface forces and large-scale surface interactions, the nano-scale particles face difficulties in getting suspended in various media. Magnetic nanoparticles of iron oxide offer a great deal of promise due to their ease of preparation, reasonable magnetic properties, low cost and environmental compatibility. We intend to modify the surface of magnetic Fe_2O_3 nanoparticles with selected surface modifying agents using simple and effective single-step chemical reactions in order to enhance dispersibility of magnetic nanoparticles in non-polar media. Magnetic particles were prepared by hydrolysis of Fe^{2+}/Fe^{3+} chlorides and their subsequent oxidation in aqueous medium. The dried particles were then treated with Octadecyl quaternary ammonium silane (Terrasil™), stearic acid and gallic acid ester of stearyl alcohol in ethanol separately to yield S-2 to S-4 respectively. The untreated Fe_2O_3 was designated as S-1. The surface modified nanoparticles were then analysed with Dynamic Light Scattering (DLS), Fourier Transform Infrared spectroscopy (FTIR), X-Ray Diffraction (XRD), Thermogravimetric Gravimetric Analysis (TGA) and Scanning Electron Microscopy and Energy dispersive X-Ray analysis (SEM-EDAX). Characterization reveals the particle size averaging 20-50 nm with and without modification. However, the crystallite size in all cases remained ~7.0 nm with the diffractogram matching to Fe_2O_3 crystal structure. FT-IR suggested the presence of surfactants on nanoparticles' surface, also confirmed by SEM-EDAX where mapping of elements proved their presence. TGA indicated the weight losses in S-2 to S-4 at 300°C onwards suggesting the presence of organic moiety. Hydrophobic character of modified surfaces was confirmed with contact angle analysis, all modified nanoparticles showed super hydrophobic behaviour with average contact angles ~129° for S-2, ~139.5° for S-3 and ~151° for S-4. This indicated that surface modified particles are super hydrophobic and they are easily dispersible in non-polar media. These modified particles could be ideal candidates to be suspended in oil-based fluids, polymer matrices, etc. We are pursuing elaborate suspension/sedimentation studies of these particles in various oils to establish this conjecture.

Keywords : iron nanoparticles, modification, hydrophobic, dispersion
Conference Title : ICNN 2018 : International Conference on Nanoscience and Nanotechnology
Conference Location : Toronto, Canada
Conference Dates : June 21-22, 2018