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Investigation of the effect of structure of surfactants on binding to iron oxide nanoparticles

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The development of nanometer-sized colloidal particles has been intensively studied, due to their considerable technological and fundamental scientific interest. The surface modification of these colloidal nanoparticles and the related surfactants are very important to facilitate their applications to biotechnology, catalysis and nanocomposites. In particular, various metal nanoparticles have been extensively utilized as catalysts for many organic transformations, and stabilizing ligands (surfactants) are known to influence the catalytic activity and selectivity of the nanoparticles. In order to recognize their potential applications in industry and in biotechnology it is critical to understand the surface chemistry of colloidal nanoparticles. Magnetic nanoparticles made from iron oxide, in particular, have attracted extensive interest due to their potential applications in many fields such as in multi-tera bit storage device, catalysis, sensors, and a platform for high-sensitivity biomolecular magnetic resonance imaging (MRI) for medical diagnosis and therapeutics.

In the current study, we first investigated the synthesis of iron oxide nanoparticles using a novel method. We then investigated the coordination ability of so synthesized nanoparticles towards various surfactants to understand how the structures of surfactants relate to its binding abilities with iron oxide nanoparticles using FT-IR spectroscopy. Although large number of surfactants have been used to stabilize iron oxide nanoparticles for various applications these surfactants have not been utilized as stabilizing surfactants for iron oxide nanoparticles. For this investigation we used six surfactants, stearic acid, palmitic acid, sodium dodecyl sulphonic acid (SDS), 4-aminobenzoic acid, anthraquinone-2-sulphonic acid, and sulphanilic acid. FT-IR spectra, obtained for iron oxide nanoparticles coated with above six surfactants, reveal surfactants having long hydrocarbon chain followed by the coordination site such as stearic acid, palmitic acid, sodium dodecyl sulphonic acid (SDS), have been coordinated to iron oxide nanoparticles While, 4-aminobenzoic acid, anthraquinone-2-sulphonic acid, and sulphanilic acid has not been coordinated. Therefore, it is evident that bulky molecules, that have sterically hindered groups close to the coordination site, are prevented from attaching to iron oxide nanoparticles. From above observations it is clear that only those molecules with flexible and less sterically hindered structures can bind to iron oxide nanoparticles.

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