

Synthesis and Characterization of Magnetic Nanoparticles with High Magnetization and Good Oxidation Resistibility

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Abstract – Magnetic nanoparticles attract increasing attention because of their current and potential biomedical applications, such as, magnetically targeted and controlled drug delivery, magnetic hyperthermia and magnetic extraction. Increased magnetization can lead to improved performance in targeting and retention in drug delivery and a higher efficiency in biomaterials extraction. We reported an approach to synthesize iron contained magnetic nanoparticles with high magnetization and good oxidation resistibility by pyrolysis of iron pentacarbonyl ($\text{Fe}(\text{CO})_5$) in methane (CH_4). Using the high reactivity of Fe nanoparticles, decomposition of CH_4 on the Fe nanoparticles leads to the formation of nanocrystalline iron carbides at a temperature below 260 °C. Structural investigation indicated that the as-synthesized nanoparticles contained crystalline bcc Fe, iron carbides and spinel iron oxide. The Mössbauer and DSC results testified that the as-synthesized nanoparticle contained three crystalline iron carbide phases, which converted to Fe_3C after a heat treatment. Surface analysis suggested that the as-synthesized and subsequently heated iron-iron carbide particles were coated by iron oxide, which originated from oxidization of surface Fe atoms. The heat-treated nanoparticles exhibited a magnetization of 160 emu/g, which is two times of that of currently used spinel iron oxide nanoparticles. After heating in an acidic solution with a pH value of 5 at 60 °C for 20 h, the nanoparticles retained 90 percentage of the magnetization.