ADVANCES IN MATERIALS ENGINEERING

Volume 2

Edited By:
Md Abdul Maleque
Iskandar Idris Yaacob
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Chapter 030

Synthesis of Magnetic Nanoparticles in Water-in-Oil Microemulsions

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Abstract. Magnetic nanoparticles were synthesized using a novel method called microemulsion processing. In this process, the aqueous cores (typically 5-25 nm in diameter) of water/cetyltrimethylammoniun bromide (CTAB)/n-butanol/octane microemulsions were used as constrained microreactors for the precipitation of magnetic particles directly at room temperature. The typical size of the material was in the range of 3-10 nm. The particle size and size distribution were determined by TEM. The particles were then collected and washed. Phase analysis using X-ray diffraction (XRD) showed broad diffraction peaks corresponding to either magnetite (Fe_3O_4) or maghemite (γ-Fe_2O_3). The crystallite size estimated from the XRD is roughly 3.66 nm and is similar to the physical size of the particles probed by TEM indicating that they were largely monocrystals. Magnetization curve showed an absence of hysterisis indicating that the particles were superparamagnetic.

Introduction

Synthesis of particles with nanometer size dimensions is of increasing scientific and technical interest. Materials with single phase nanoparticles in the size range of 10 to 100 Å exhibit novel electronic, optical, magnetic, and chemical properties due to their extremely small dimension [1]. It is however difficult to obtain ultrafine and monodispersed nanoparticles by classical methods. In this respect, the aqueous cores of water-in-oil microemulsions have been shown to be ideal reaction media for this purpose [2].

A microemulsion is defined as a thermodynamically stable isotropic dispersion of two immiscible liquids consisting of microdomains of one or both liquids stabilized by an interfacial film of surface active molecules [3]. In water-in-oil microemulsions, the aqueous phase is dispersed as nano-size droplets (typically 5 – 25 nm in size) surrounded by a monolayer of surfactant and co-surfactant molecules in the continuous hydrocarbon phase. If a water-soluble metal salt is incorporated in the aqueous phase of the microemulsion, it will reside within the aqueous droplets surrounded by oil (continuous phase). These aqueous droplets continuously collide, coalesce and de-coalesce, resulting in a continuous exchange of solute content [4,5]. Conceptually, if two reactants A and B is controlled by the rate of coalescence of droplets and inter-droplet exchange [5, 6].

Microemulsions have been used as microreactors to produce ultrafine particle since Boutonnet *et al.* [2] first obtained ultrafine monodispersed metal particles of Pt, Pd, Rh and Ir by reducing corresponding salts in the aqueous droplets of water-in-oil microemulsions with