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The Synthesis of Maghemite and Hematite (γ-Fe_2O_3, α-Fe_2O_3) Nanospheres

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Abstract. Maghemite and hematite nanospheres were synthesized by using the Sol-gel technique. The structural properties of these nanosphere powders were characterized by X-ray diffraction (XRD), transmission electron microscopy (TEM), field emission scanning electron microscopy (FESEM),and pore size distribution.Hematite phase shows crystalline structures.The mean particle size that resulted from BET and XRD analyses were 4.9 nm and 2 nm. The field emission scanning electron microscopy shows iron-oxide powder is composed of nanosized particles, but in nanosized aggregates (agglomeration of particles). It can be seen from transmission electron microscopy that the size of the particles are very small which is in good agreement with the FESEM and the X-ray diffraction. TEM and FESEM confirmed that the iron-oxide powder is composed of sizes from 8 nm to 10 nm. The BET and pore size method were employed for specific surface area determination.

Introduction

Nanostructures –structures that are defined as having at least one dimension between 1 and 100 nm-have received steadily growing interests as a result of their peculiar and fascinating properties, and applications superior to their bulk counterparts. This gives rise, in organic materials, to interesting physicochemical and optoelectronic properties, due to electron confinement and high surface –area effects. The major aim of the nanoparticles research is to synthesize the controlled particles in large quantities and understand their properties before using them for any application. Metal oxides in nanometer-sized particles have attracted great attention in recent years due to the significantly unique properties which these materials exhibit compared with their bulk counterparts [1-3].

It is observed that below a critical size, which is characteristic of that material, various physico-chemical properties start changing dramatically [4]. Nanoparticles of magnetic metals and oxides have attracted great interest in recent years because of their unique physical and chemical properties, especially maghemite nanoparticles due to their technological and fundamental importance, such as information storage. For example, there are many active efforts to develop magnetic and optical storage components with critical dimensions as small as tens of nanometers, magnetic resonance imaging contrast agents, superparamagnetism, bioprocessing, gas sensitive materials, macroscopic quantum tunneling associated with size quantization, electronic quantum confinement effects and the transformation of γ–Fe_2O_3 phase into more stable α–Fe_2O_3 phase in the range of 773-873 K [4-10]. Different methods have been reported in the literature for the preparation of nanosized iron-oxide nanoparticles, vai chemical routs[8] with enhanced surface to volume to ratio and novel properties better than micro-sized/bulk[9]. So the studies on the nanoparticles of granular γ-Fe_2O_3 attract much attention .The most common iron oxides and hydroxides are hematite (α-Fe_2O_3), maghemite (γ-Fe_2O_3), magnetite (Fe_3O_4) and goethite (α-FeOOH). The sol-gel technique is largely used for the production of metal oxide thin films, allowing the accurate control of the film morphology and purity [10].

In this study we have scrutinized the effect of urea concentration on particle size,by decreasing urea concentration we can reduce the partcile size of iron-oxide nanopartiles.