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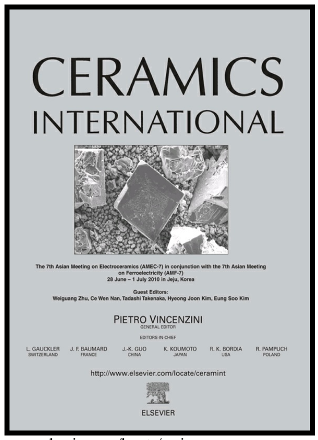

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Anisotropic growth of α-Fe_2O_3 nanostructures

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In this work, we report on the anisotropic growth of α-Fe_2O_3 nanoslabs which are produced by co-precipitation method with the addition of sucrose. In our previous work, we have argued that such behavior can be related with the chelating agent. Experiments of X-ray diffraction (XRD), high-resolution transmission electronic microscopy (HRTEM) and magnetic measurements as a function of temperature and applied magnetic field are used to characterize the samples. The HRTEM image of the sample prepared with 10 mmol/l of sucrose consists of faceted-like nanoslabs while that prepared without sucrose exhibits particles with a non-uniform shape. Besides, both the HRTEM image and the analysis of the XRD pattern show clearly a preferential growth of the [110] crystallographic direction. To strengthen our supposition, besides T- and field-dependence of magnetization are consistent with a superparamagnetic behavior the fits of the ZFC-FC curves for sample grown with 10 mmol/l of sucrose present a strong increase of the effective anisotropy constant, K_{eff}, which can be related with the increasing of the shape magnetic anisotropy.

PACS numbers:
Keywords: Preferential growth, Anisotropic growth, Magnetic properties, Hematite, Fe_2O_3

I. INTRODUCTION

Recently, the intensive use of nanostructured materials (i.e., systems with dimensions of the order of nanometers) in technological applications such as sensors, medical diagnosis applications: magnetic liquids for drug delivery, and in magnetic recording technology [1–4] have drive systematic studies to tailoring the structural and morphological properties of them in order to induce some specific physical and/or chemical properties. For this purpose, it is well-known that chemical methods with chelating agents are the most used to structural and morphological controlling. In the particular case of magnetic nanomaterials, besides the control of the above mentioned properties one must be worried with the size distribution, agglomeration and magnetic anisotropy. Additionally, it always is important to pay attention in the changing of physical and chemical properties when compared with their bulk form counterpart. Among the magnetic materials, iron oxide nanoparticles have attracted remarkable interest due to both the theoretical aspects and their wide range of potential applications, e.g., in cancer therapies and medical diagnosis.

In particular, the hematite (α-Fe_2O_3) exhibits n-type semiconductor properties at room temperature and it has shown to be a very promising candidate for applications, such as catalysts, pigments, magnetic materials, gas sensors and in the development lithium-ion batteries.[5–8] In its bulk form, α-Fe_2O_3 crystallizes in the trigonal system with space group $R-3c$. Its magnetic structure, determined by neutron diffraction, showed an antiferromagnetic ordering (Neel temperature, $T_N = 960$ K).[9] On the other hand, from a point of view of growth methods, many particular shape (e.g. nanospindles [10], nanorings [11], nanosheets [12], nanorods [7], nanowires [13], nanorices [14], nanotubes [15], nanospheres [16] and nanoplates [17, 18]) have been obtained depending on the chemical routine. If one keep in mind that these nanostructures have been obtained for using different preparation method and chemical additives, it is evident that such parameters can be used to tune the particles morphologies. In this work, we present a systematic study carried out for the α-Fe_2O_3 nanoslabs obtained by the co-precipitation method with addition of sucrose, which exhibit an anisotropic growth. XRD, HRTEM and magnetic measurements as a function of temperature show clearly that the faceted-like nanoslabs present a preferential growth of the [110] crystallographic direction. In this case, as we have commented in our previous work [19], the sucrose chelating agent must be responsible by the preferential growth.