Effect of particle size on magnetic properties of chromium oxide nanoparticles dispersed in mesoporous silica

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Magnetic nanoparticle systems have received considerable interest in recent years owing to their unique magnetic properties as well as their technological applications [1,2]. In this work, an investigation of the effect of particle size distribution is carried out on chromium oxide nanoparticles (NP) dispersed into porous Vycor glass (PVG). Nanoparticles of Cr_2O_3 are widely applied in fields as catalysts, advanced colorants, hydrogen sorption materials, and wear resistance materials. Bulk chromium oxide Cr_2O_3 is an antiferromagnetic material. However, after nanostructuring into ultra-thin layers or discrete particles, it exhibits a weak ferromagnetism that increases with decreasing its particle size [3,4]. The monoliths impregnated with chromium basic acetate single-source precursor, $[Cr_3O(CH_3CO_2)_6(H_2O)_3](CH_3CO_2)$, were thermally treated at 700 ºC for 4 h. This procedure is denominated as one impregnation-decomposition cycle (IDC). Afterwards, similar cycles were repeated and we have prepared samples with 3, 5, and 7 IDC. All the monoliths independent of the number of IDC were submitted to 7 thermal treatments each. After several IDC, the linear mass increase is the result of a mean diameter size increase of the sphere-like shaped nanoparticles via layer-by-layer assembly. The IDC methodology has been shown to be a versatile bottom-up nanofabrication technique. This statement is confirmed by the XRD, Raman, TEM and are found to be consistent with nanoparticles of Cr_2O_3. Magnetic characterization was performed from 2.5 to 350 K using a SQUID magnetometer and a PPMS mounted with a vibrating sample magnetometer head. Both the zero-field cooling – field-cooling curves, as well as hysteresis curves up to 10 T, were recorded. For all number of cycles, the magnetic behavior remains typical of antiferromagnetic, not showing any superparamagnetic blocked transition Moreover, the magnetic moment increases with the number of cycles, revealing the increasing of the particle size.

Keywords: chromium oxide, nanoparticle, magnetism, porous materials, size effect.

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