doi:10.1017/S143192761600043X

CoO@MnFe2O4 Octahedron-Shaped Nanocages

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Magnetic nanoparticles have promising applications in magnetic separation, sensing and biodetection [1]. Hollow and pierced magnetic nanoparticles, called magnetic nanocages, have large surface area, low density and peculiar magnetic properties. This makes Fe_3O_4 nanocages promising candidates for further applications in catalysis, hyperthermia or drug-delivery.

In this work we focus on the transmission electron microscopy (TEM) characterization of CoO@$MnFe_2O_4$ octahedron-shaped nanocages obtained after a multi-step process. A 200 kV transmission electron microscope (JEOL JEM 2010F TEM) was used to carry out different electron microscopy characterization techniques like high resolution transmission electron microscopy (HRTEM), scanning transmission electron microscopy (STEM), electron energy loss spectroscopy (EELS) and energy dispersive spectroscopy (EDS). Besides, with the obtained images we performed Fourier analysis to demonstrate the epitaxial growth and the setup of the $MnFe_2O_4$ layer.

CoO@$MnFe_2O_4$ nanocages were obtained using pre-obtained octahedron-shaped CoO nanoparticles as templates to first deposit a magnetite (Fe_3O_4) layer [2-3]. After that, a solid-state reaction transforms the Fe_3O_4 into $MnFe_2O_4$, and the former solid nanoparticles into CoO@$MnFe_2O_4$ nanocages. Interesting, TEM results show the octahedron shape is maintained along the process, despite the formation of large holes piercing the facets and the volume of the nanoparticle (Figure 1). The deposited shell is 3 nm thick and the Fourier transform analysis showed an almost perfect epitaxial growth of the $MnFe_2O_4$ over the remains of the CoO core, as it was demonstrated before in the case of the solid CoO@Fe_3O_4 octahedron-shaped nanoparticles [3]. EDS confirmed the composition of the particles, and EELS showed the presence of Mn and Fe predominantly in the shell while some CoO still is located in the core.

References:

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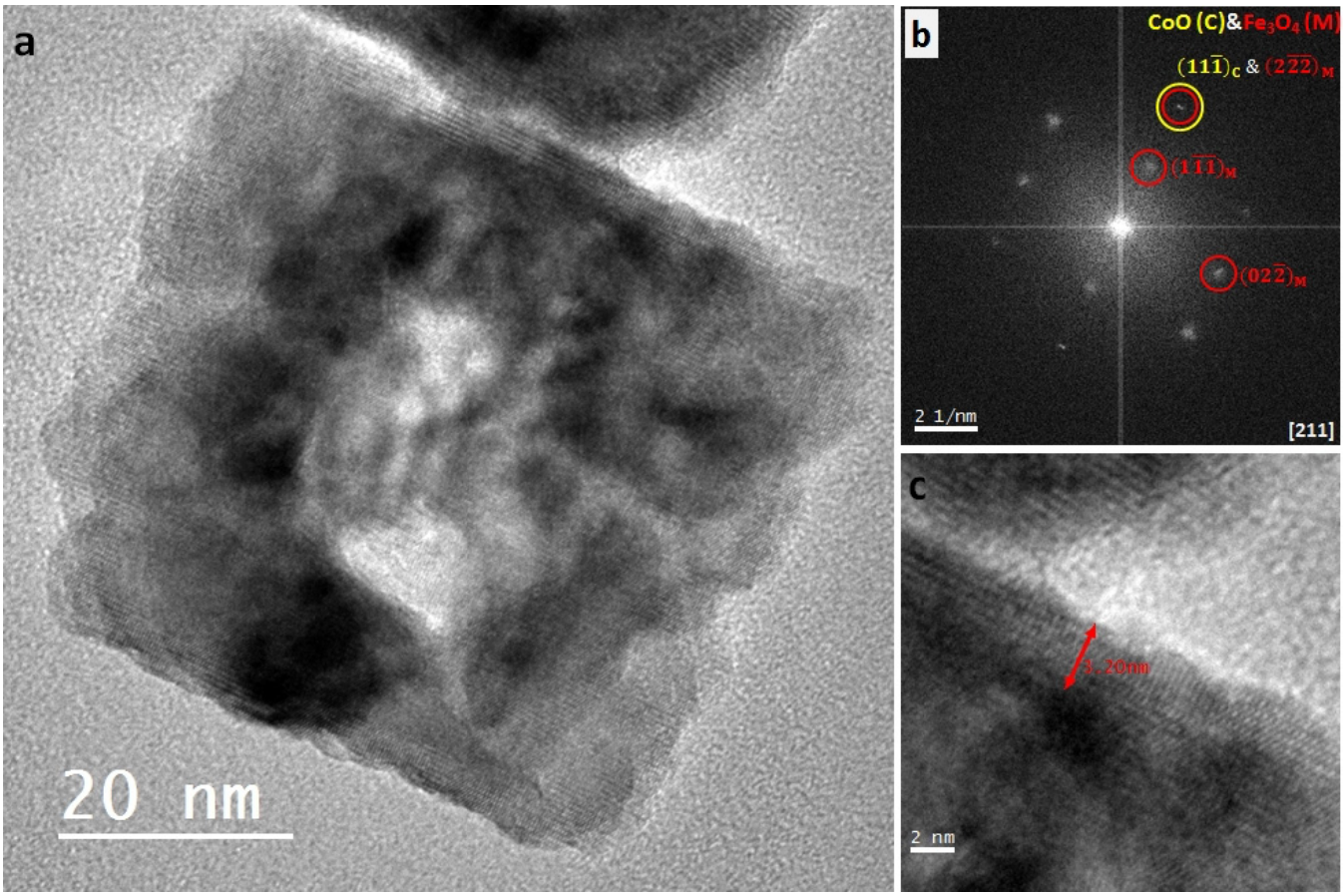

Figure 1. (a) TEM image of a CoO@$MnFe_2O_4$ nanocage in the [211] zone axis. (b) Fourier transform of the nanocage showed in (a) displaying spots corresponding to CoO and Fe_3O_4 aligned. (c) Image showing the thickness of the $MnFe_2O_4$.

https://doi.org/10.1017/S143192761600043X Published online by Cambridge University Press