

Characterisation of ultrafine Ni/NiO and Co/CoO core-shell particles by transmission electron microscopy

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Nanoparticles consisting of a ferromagnetic (FM) metal core and an antiferromagnetic (AFM) metal oxide shell have great potential for use in future data storage technology and application within novel medical treatments against cancer. This makes such core-shell particles to an attractive field of interdisciplinary research and owing to their extremely small dimensions TEM to the method of choice for their chemical and structural characterisation.

One of the major concerns for application of nanoparticles in magnetic storage devices is the breakdown of their ferromagnetic property if the particles become too small (FM to superparamagnetic transition). However, by covering the FM core with an AFM oxide shell magnetisation of such ultrafine particles can be kept stable even up to RT through the exchange anisotropy which pins the ferromagnetic spins at the magnetic interface. Thus crucial parameters for synthesis of these functional core-shell particles are size, shape, crystal structure and degree of crystallinity of the FM core and its AFM shell.

The present work deals with first results about new Ni/NiO core-shell particles and their comparison to the more common Co/CoO ones. Both species were synthesised by laser ablation and (almost) adiabatic expansion within the nanoparticle beam apparatus LUCAS [*Eur. Phys. J. D* 9(1999)127]. Three types of samples have been produced by oxidising the particles in situ in an ambient oxygen atmosphere of about 10 mbar at RT, 473 K and 673 K, respectively. Analysis of the particles was carried out by conventional TEM methods (STEM-EDX, HRTEM, SAED) and by energy-filtering TEM (EFTEM). In this course electron spectroscopic imaging (ESI) proved most suitable for chemical imaging the core-shell structure of the particles and directly allows quantification of the AFM metal oxide shell thickness.

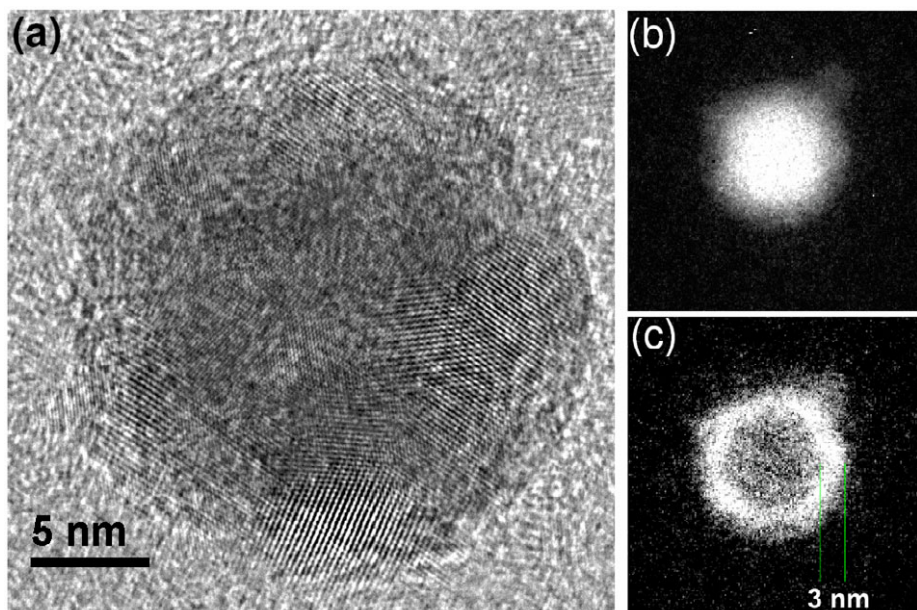


FIG. 1. (a) HRTEM image of a typical Co/CoO core-shell particle which proves the crystalline state of the CoO shell. (b) Corresponding ESI element map for cobalt (Co-L_{3,2} edge) and (c) for oxygen (O-K edge).