3NANO-22
Nano Science/Technology/Biotechnology
6th Edition, Roma (Italy)

Surface and interface effects in magnetic Fe3O4@MgO@CoFe2O4 onion-like nanoparticles

Jorge M. Nuñez [1,2,3], Simon Hettler[3,4], Enio Lima Jr[1]., Gerardo. F. Goya,[3,5], Raul Arenal[3,4,6], Roberto D. Zysler[1,2], Myriam H. Aguirre[3,4], Elin L. Winkler[1,2]
1 Resonancias Magnéticas-Centro Atómico Bariloche (CNEA, CONICET) S. C. Bariloche 8400, Río Negro, Argentina and Instituto de Nanociencia y Nanotecnología, CNEA, CONICET, S. C. Bariloche 8400, Río Negro, Argentina.
2 Instituto Balseiro (UNCuyo, CNEA), Av. Bustillo 9500, S.C. de Bariloche 8400, Río Negro, Argentina.
3 Instituto de Nanociencias y Materiales de Aragón-CSIC-Universidad de Zaragoza, C/ Mariano Esquillor s/n, Zaragoza 50018, Zaragoza, Spain
4 Laboratorio de Microscopías Avanzadas, Universidad de Zaragoza, Mariano Esquillor s/n, Zaragoza 50018, Zaragoza, Spain
5 Dept. Física de la Materia Condensada, Universidad de Zaragoza, C/ Mariano Esquillor s/n, Zaragoza 50018, Zaragoza, Spain
6 ARAID Foundation, Zaragoza, Spain
jorge.nunez@ib.edu.ar – 826727@unizar.es

The Core/shell (CS) architecture make possible to combine in the same nanoparticle (NP) different materials, increasing the degrees of freedom to design and manufacture new systems [1]. Recent studies in CS NPs shown that, by systematically varying the shell composition, is possible to fine-tune the magnetic and electrical transport proprieties of these systems [2-3]. In addition, new properties are observed in CS bimagnetic materials due the exchange interaction at the interface [4], as exchange-bias [5] or exchange-spring [6].
In this frame, the design and fabrication of more complex and higher quality NPs is a key factor to develop new multifunctional nanoparticles for advanced applications [1]. In this work we present that high quality core / shell / shell (CSS) NPs can be grown by adapting the seed-mediated growth method proposed by Sun et al [7].
Fe_3O_4@MgO@$CoFe_2O_4$ CSS monodispersed NPs were synthesized by thermal decomposition in a three-step process. Their structure and morphology were characterized by different techniques of transmission electron microscopy (TEM) and powder X ray diffraction. By analyzing TEM images, we obtain a monodisperse size distribution whit mean size of (29±6) nm. CSS structure can be confirmed by observing high angular annular dark field scanning transmission electron microscopy (HAADF STEM) images, that shown a dark annular contrast due to the presence of MgO in the inner shell, and from the elemental mapping performed by electron energy lost spectroscopy (EELS) the stoichiometry is corroborated. The magnetic properties were studied from magnetization measurements as a function of the applied field (MvsH) and temperature (MvsT), in a range of ±2.5T and 5K-380K. In field cooling MvsH curves the presence of a bias field was observed below 125K. The results are analyzed in term of the magnetic coupling between the soft Fe_3O_4 and hard $CoFe_2O_4$ magnetic phases, and the role of the nonmagnetic MgO separator is discussed.

[1] A. López-Ortega, M. Estrader, G. Salazar-Alvarez, A.G. Roca, J. Nogués, J. Phys. Rep., 553 (2015).
[2] G. Lavorato, E. Lima Jr., M. Vasquez Mansilla, H. Troiani, R. Zysler, E. Winkler, J. Phys.Chem.C, 122 (2018).
[3] F. Fabris, E. Lima, C. Quinteros, L. Neñer, M. Granada, M. Sirena, R. Zysler, H. Troiani, V. Leborán, F. Rivadulla y E. Winkler, Physical Review Applied. 11 (2019).
[4] W.H. Meiklejohn, C.P. Bean, Phys. Rev., 102 (1956).
[5] J. Nogués, J. Sort, V. Langlais, V. Skumryev, S. Suriñach, J. Muñoz, M. Baró, Phys. Rep., 422 (2005).
[6] G. Lavorato, E. Winkler, B. Rivas-Murias, F. Rivadulla. Phys. Rev. B, 94 (2016).
[7] S. Sun y H. Zeng, J. Am. Chem. 124 (2002).