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Magnetoliposomes based on $Ni_xCu_{1-x}Fe_2O_4$ or $NiFe_{2-y}Al_yO_4$ nanocrystals for applications in magnetic separation and classification

Daniela F. Gomes,[a] Ana Rita O. Rodrigues,[a] Elisabete M. S. Castanheira,[a] Paulo J. G. Coutinho[a,b]

[a] *Centre of Physics (CFUM), University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal*
[b] *QuantaLab, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal*

The potential of magnetic nanoparticles (MNPs) for biomedical applications has been recognized, due to their unique size and physicochemical properties. Nanoparticles with superparamagnetic behaviour are preferred, as they exhibit a strong magnetization only when an external magnetic field is applied. Relevant applications of MNPs have been developed, such as on magnetic resonance imaging (MRI), cell sorting, wastewater treatment and immunoassays.

The magnetic response of the nanoparticles can be controlled by their composition. Ferrites are a broad class of compounds with general formula MFe_2O_4, where M stands for a divalent metallic cation. Among these, copper ferrite ($CuFe_2O_4$) presents a moderate saturation magnetization, while nickel ferrite ($NiFe_2O_4$) holds a large one [1]. Mixed ferrites with composition $Ni_xCu_{1-x}Fe_2O_4$ were then prepared by coprecipitation method [2], in order to control the saturation magnetization with the fraction of Ni (parameter *x*).

Another possibility is the partial substitution of iron atoms with aluminium, as $NiAl_2O_4$ nanocrystals show very low saturation magnetization [3]. Thus, ferrites of $NiFe_{2-y}Al_yO_4$ composition were also obtained. XRD spectra of the obtained nanoparticles (Fig. 1) show the spinel-type crystalline phase and, by inspection with a small magnet, the magnetic properties are, as expected, dependent on *x* and *y* composition parameters.

Magnetoliposomes consist of magnetic nanoparticles that are either covered by a lipid bilayer (solid magnetoliposomes) or entrapped in the aqueous interior of spherical liposomes (aqueous magnetoliposomes). Solid magnetoliposomes of the prepared mixed ferrites were obtained, and their bilayer structure was proven by the use lipophilic fluorescence probes and methods developed in previous work [2,4]. These magnetoliposomes will then have a controllable magnetic response and can exhibit strong fluorescent signals, so that they will be exploited in magnetic separation and classification in microfluidic systems.

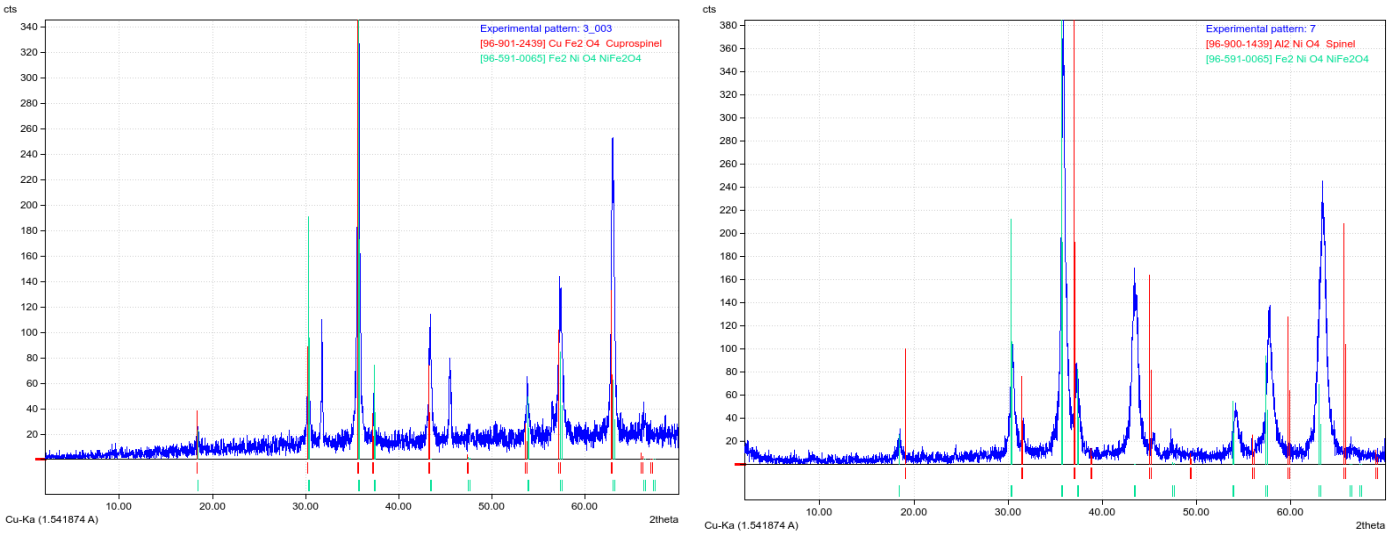

Fig. 1: XRD spectra of mixed ferrites prepared by coprecipitation method. Left: $Ni_{0.5}Cu_{0.5}Fe_2O_4$; Right: $NiFeAlO_4$.

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2) A. R. O. Rodrigues *et al.*, *Phys. Chem. Chem. Phys*., **2015**, *17*, 18011.
3) A. T. Raghavender *et al.*, *J. Magn. Magn. Mat.*, **2007**, *316*, 1.
4) A. R. O. Rodrigues *et al.*, *RSC Advances*, **2016**, *6*, 17302.

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