Nanomagnets for biomedical applications: from spherical shapes to planar geometries

R. Morales[1,2],
B.Mora[3],
A. Perez-Valle[4],
C. Redondo[3],
M.D. Boyano[5].

[1]Department of Physical-Chemistry & BCMaterials, University of the Basque Country UPV/EHU, 48940 Leioa, Spain
[2]IKERBASQUE, Basque Foundation for Science, 48011 Bilbao, Spain
[3]Department of Physical-Chemistry, University of the Basque Country UPV/EHU, 48940 Leioa, Spain
[4]Department of Cell Biology and Histology, University of the Basque Country UPV/EHU, 48940 Leioa, Spain
[5]Department of Cell Biology and Histology UPV/EHU, and Biocruces Health Research Institute 48903 Barakaldo, Spain

rafael.morales@ehu.eus

Magnetic nanomaterials have risen the expectation to develop novel biomedical applications. Their unique properties and physical effects under external fields have attracted their interest in several areas; among them, cell manipulation through the remote action, diagnosis through high sensitive magnetic sensors or contrast enhancement in magnetic resonance imaging, and therapy through the heating effect under high-frequency fields.[1, 2] Magnetic nanoparticles (MNP) are chemically synthesized in compact forms like nanocubes, nanowires, and more conventionally spherical shapes.[3, 4] These nanomagnets are in a superparamagnetic state to be suitable for medical applications. Therefore, their size must be smaller than few tens of nanometers.

On the contrary, magnetic nanostructures (MNS) are fabricated using lithography techniques.[5] This approach produces planar geometries like disks or ellipses (Figure 1). This planar shape confers them new properties for magnetic actuation. However, MNS do not present superparamagnetic behavior due to their dimensions around hundreds of nanometers. Consequently, they must be designed with special magnetic configurations to achieve the zero remanence required in biomedical applications.[6]

We will discuss these special configurations and cost-effective routes to fabricate suitable planar nanomagnets. Magnetic properties and toxicity studies *in-vitro* models of tumor cells will be presented. We will also state the expected advantages of MNS in novel diagnostics and therapeutic applications.

This work was supported by AEI-MINECO FIS2016-76058, UE FEDER "Una manera de hacer Europa", the European Union´s Horizon 2020 research and innovation programme under the Marie Sklodowsks-Curie grant agreement No 734801, and the Basque government grant IT970-16, IT1162-19, and PIBA 2018-11.

References

[1] A.G. Roca *et al*. J. Phys. D: Appl. Phys. 42 (2009) 224002.
[2] J. Beik *et al*. J. Control. Release 235 (2016) 205.
[3] M.E.F. Brollo *et al*. Sci. Rep. 4 (2014) 6839.
[4] S-H. Noh *et al*. Nano Today 13 (2017) 61.
[5] B. Mora *et al.* ACS Appl. Mater. Interfaces 10 (2018) 8165.
[6] L. Peixoto *et al*. Appl. Phys. Rev. *in press.*

Figures

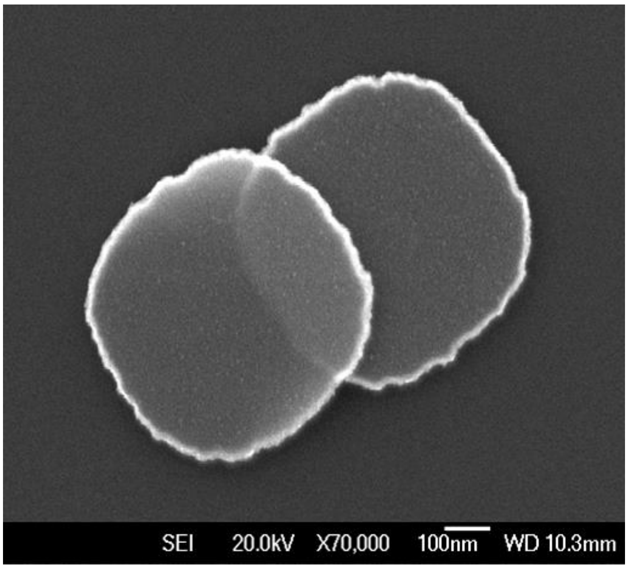

Figure 1. Magnetic nanostructures of NiFe fabricated by interference lithography