Killing cancer cells using nanoparticles submitted to high- and low-frequency magnetic fields

J. Carrey,
B. Mehdaoui, R.P. Tan, N. Hallali, A. Meffre, L.-M. Lacroix, B. Chaudret, M. Respaud

Laboratoire de Physique et Chimie des nano-objets (LPCNO), CNRS, INSA, UPS, Université de Toulouse, 135, av. de Rangueil, 31077, Toulouse, FRANCE

julian.carrey@insa-toulouse.fr

Destroying cancer cells using magnetic nanoparticles and magnetic field can be done using two approaches : i) using the heat released by magnetic nanoparticles submitted to a high-frequency alternating magnetic field, a method known as magnetic hyperthermia, or ii) using the mechanical action generated by MNPs submitted to a low-frequency alternating or rotating magnetic field. In this presentation, we will first present an overview of these two approaches, including results from biology, chemistry and physics.
We will then present theoretical results obtained in our group on the conditions to maximize these effects: heating in magnetic hyperthermia and torque amplitude for the other approach. It will be shown that, in both case, a precise control of the size and magnetic properties of the nanoparticles is required. Experimental results obtained in our group permits to validate some of these experimental results, and will also be presented.

References

[1] R. P. Tan, J. Carrey and M. Respaud, Phys. Rev. B. 90, 214412 (2014), https://doi.org/10.1103/PhysRevB.90.214421
[2] J. Carrey and N. Hallali, Phys. Rev. B 94, 184420 (2016), https://doi.org/10.1103/PhysRevB.94.184420

Figures

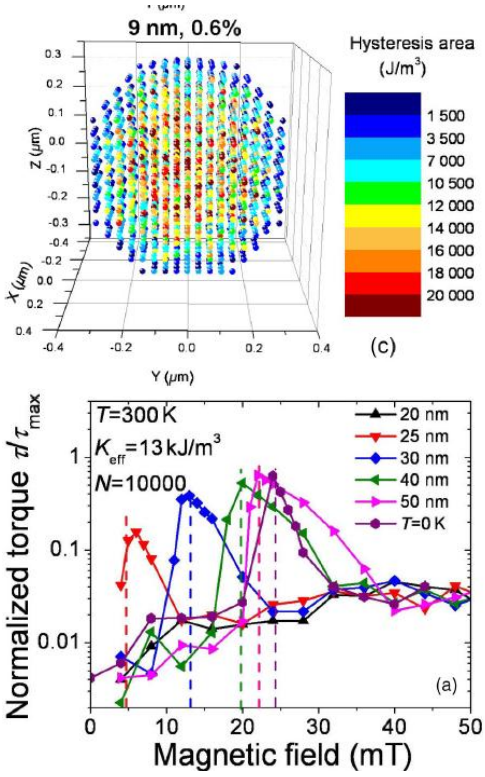

Figure 1. (up) : Heating power of an assembly of 9 nm MNPs, with a volume concentration of 0.6%, submitted to a high-frequency magnetic field. Each dot represents a MNP. The color scales is related to the heating power of the MNP. It is evidenced that the heating is much stronger in the middle of the assembly than on its periphery. (down) Torque undergone by non-interacting MNPs submitted to a low-frequency rotating magnetic field at room temperature as a function of the MNP diameter. In a given range of magnetic field, the torque is strongly enhanced