Magnetic hyperthermia at the nanoscale

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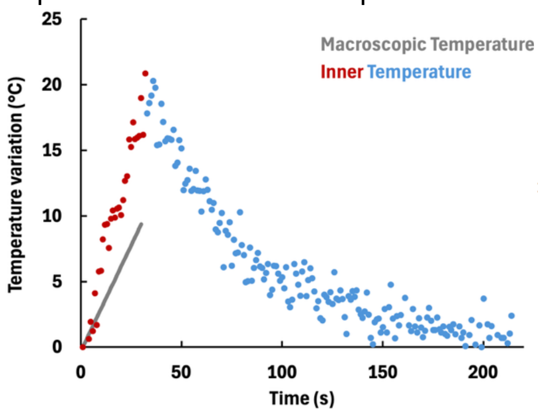
Magnetic hyperthermia is one of the key application of magnetic nanoparticles (MNPs) for catalysis or for biomedical applications [1]. Evidence for local effects of thermal activation, even at very low nanoparticle concentrations, and at their only vicinity was recently presented [2]. Still, the local heat exchange around those nanoprobes remains controversial with too few evidences on its origin and even on its existence. We recently used quick EXAFS to investigate heat generation inside aqueous suspensions of iron oxide nanoparticles. In line with what was published recently in the case of gold colloids[3], we analysed the evolution of the Debye-Waller factor when the particles are subjected to an oscillating magnetic field, which allowed determining the local temperature. In contrast with some recent publications[4,5], we found the temperature inside particles to be higher than the macroscopic one. In parallel, we analysed by fluorescence decay spectroscopy the heat exchange on photosensitive ligands permanently and covalently bound to the surface of maghemite nanoparticles. The measurement of rhodamine B lifetime allowed evaluating the thermal increase, in very dilute nanoparticle dispersions, at 4 given distances ranging from 5 to 7 nanometres from the surface. We globally obtained coherent results compared to already published works achieved with thermo-labile ligands [5,6,7], but without chemically cleavable groups at the surface of nanoparticles in solution.



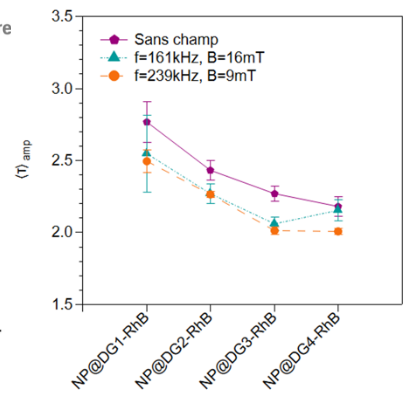


Figure 1: Temperature inside MNPs (T_on=30s (red); T_off=180s (blue)) and macroscopic temperature (grey) during hyperthermia determined by EXFAS analysis. The lifetime of Rhodamine B grafted on MNPs under magnetic hyperthermia.

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