Research

Mechanics Seminar

In search of a multiscale comprehension of magnetic hyperthermia

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Abstract.

When magnetic nanoparticles immersed in a liquid are subjected to an oscillating magnetic field, they end up dissipating the field's energy in the form of heat. In multi domain magnetic particles this mechanism occurs due to an hysteric power loss, related to permanent modifications in the internal strucutre of ferromagnetic matter, which from a thermodynamical point of view is a classical kind of irreversibility. For single domain particles, which have an intrinsic magnetic relaxation time-scale, this process occurs when the frequency of the applied field is faster than the particles relaxation time. This lag leads to an in and out of phase magnetic response to the oscillating field, which can be treated in terms of a complex magnetic susceptibility. The imaginary part $\chi^{''}$ of the complex susceptibility is related to energy dissipation while the real part $\chi^{'}$ is associated with energy storage. In order to understad the mechanisms behind this phenomenon we may reccur to multi-body Langevin Dynamics simulations of polarized systems. This allows us to link the microstructural dynamical behavior of magnetic fluids with the heat dissipation phenomenon through magnetic hyperthermia. This approach is specially effective in accounting for magnetic production terms in the differential form of the first law of thermodynamics (energy equation). But in a real tissue additional mechanisms such as heat conduction, blood perfusion, metabolic heat generation and mass diffusion must be included to provide a realistic modeling of temperature fields in cancer tissues. This prediction is crucial for the success of this technique. In this talk we seek to provide a multiscale presentation and understanding of the problem and present some new exciting ideas that have been carried out by our group in the past few years.