Lock-in thermography: Using heat as an indicator for stability and distribution of magnetic nanoparticles in biological systems

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Magnetic nanoparticles (MNPs) and their ability to convert magnetic energy into heat are currently explored around the globe for various kinds of biomedical applications, with a particular emphasis on hyperthermia treatment. The heating power of these materials is dictated by a myriad of internal (*e.g.* NP size, polydispersity or crystallinity) and external (*e.g.* magnetic field strength or frequency) phenomena. However, experimentally conveying the effective heating power is not always straightforward, reproducible or easily feasible with conventional methods (*e.g.* fiberoptic cables, thermocouples or standard IR imaging). Variations among synthetic batches are not promotive either, as this requires every individual sample to be investigated and validated before administration.

Our group is thus dedicated to developing more reliable and precise experimental methods to evaluate the heating power of the respective MNPs. In this context, we present an abstract approach based on lock-in thermography to rapidly screen the thermal signatures of the MNPs at unprecedented thermal resolutions to subsequently evaluate their therapeutic potential. Superparamagnetic iron oxide nanoparticles exposed to an alternating magnetic field (AMF) were used as model NPs to validate the setup, and their thermal properties were investigated in different states of matter. This included NPs in liquid, semi-solid and aggregated state.

Compared to conventional techniques, this approach is fast, sensitive, non-invasive alternative and capable of probing multiple and dilute specimens simultaneously. In turn, this would contribute in speeding up screening procedures or facilitating comparative studies.

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