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Rigid-dipole Ferrofluids for 3D viscosity and temperature imaging with MPI

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Here we present the synthesis of stable aqueous ferrofluids made of doped iron oxide (Al-doped ε-Fe_2O_3) nanoparticles with a strong coupling between the magnetic moment and the crystal lattice. We show that, in stable aqueous suspensions, the magnetic moment of these nanoparticles follows a rigid dipole model under AC magnetic fields, due to the high magnetocrystalline anisotropy of the nanoparticles. This means that the non-linear susceptibility of the nanoparticles is highly dependent on the viscosity of their surrounding media, enabling 3D viscosity imaging with $\sim$20 ms time resolution using a traveling wave magnetic particle imaging scanner [1].

As a practical example, we show that this can be successfully applied for 3D viscosity (and temperature) imaging during the unfreezing of the ferrofluid (in the 0 ℃ to 20 ℃ temperature range).

Since these nanoparticles show low cytotoxicity and are stable in cell media, this approach opens new perspectives for visualization and control in cryopreservation and rewarming of liquid biological specimens with kHz imaging rates.

Type:
Oral