

Functional magnetic nanoparticles for biomedical applications

Hari Srikanth

Department of Physics, University of South Florida, Tampa FL, USA

Magnetic nanoparticles are fundamental building blocks in various applications, including high-density data storage, spintronics, and nanomedicine. The functional performance of these nanoparticles is dictated mainly by their magnetic anisotropies, which arise from surfaces, shapes, and interfacial interactions in hybrid structures. In this talk, I will introduce the key aspects of effective magnetic anisotropy and its characterization using RF transverse susceptibility measurements.

Tuning magnetic anisotropy is crucial for optimizing the performance of magnetic nanoparticles in biomedical applications, particularly in enhancing MRI contrast and improving magnetic hyperthermia for cancer therapy. A critical challenge in this field is the need to improve surface functionalization and increase the specific absorption rate (SAR) or heating efficiency of nanoparticles for effective cancer diagnostics and treatment. To address these challenges, strategies beyond conventional spherical nanoparticles—such as exchange-coupled core-shell structures, nanowires, and nanotubes—offer promising pathways to enhance saturation magnetization, effective anisotropy, and thermal efficiency in magnetic hyperthermia.

This talk will explore the fundamental physics underlying magnetic nanostructures and our latest research advancements in their application to cancer therapy and diagnostics in nanomedicine.

1. “Hybrid magnetic nanoparticles as efficient nanoheaters in biomedical applications” (mini-review) -G.C. Lavorato, R. Das, J. Alonso Masa, M.H. Phan and **H. Srikanth**, **Nanoscale Advances** **3**, 867 (2021)
2. “Competing magnetic interactions and field-induced metamagnetic transition in highly crystalline phase-tunable iron oxide nanorods” -S. Attanayake, A. Chanda, T. Hulse, R. Das, M.H. Phan and **H. Srikanth**, **Nanomaterials** **13**, 1340 (2023)
3. “Tailoring the magnetic and hyperthermic properties of biphasic iron oxide nanocubes through post-annealing” -S. Attanayake, A. Chanda, R. Das, M.H. Phan and **H. Srikanth**, **Crystals** **14**, 519 (2024)