Magneto-impedance based detection of superparamagnetic nanoparticles for biomedical applications

Paula Lampen

Functional Materials Laboratory
Department of Physics, University of South Florida
Tampa, FL USA

Magnetic nanoparticles (MNPs) have attracted attention in various biomedical applications, such as molecular detection, targeted drug delivery, hyperthermia, magnetic resonance imaging (MRI), and bioengineering. Surface modification and conjugation with a functional biopolymer can be used to tailor MNPs of special interest for a particular medical application. As research in this area grows, the ability to reliably detect independent or transfected nanoparticles in biological systems is essential for localized therapies and screening for cancerous cells. Although magnetic sensors based on superconducting quantum interference device (SQUID) technology show the highest sensitivity among existing biosensors, the required cryogenic temperatures and heavy shielding to reduce environmental magnetic noise render such systems prohibitively expensive for single laboratory use in many cases. The challenge facing the field of magnetic biosensing is the development of low-cost devices capable of high field sensitivity at room temperature.

Sensors based on the giant magneto-impedance effect (GMI) are a promising candidate technology for cost-effective, room temperature operation. In this talk an overview of recent advances in GMI-based sensing technology is given, with a focus on the detection of superparamagnetic iron-oxide nanoparticles in their as-synthesized form and after functionalization with alginate and curcumin for drug delivery. Detection of the nanoparticles at various concentrations was carried out using a novel magnetoimpedance-based biosensor. High detection sensitivity was achieved at low particle concentration, becoming saturate at an upper limit, as particle concentration exceeds a critical value. The magnetic nanoconjugate of iron oxide nanoparticles encapsulated by biomolecules is a promising nanosystem for applications in drug delivery and biodetection in conjunction with GMI-based sensing element.