A Sensitive AC Magnetometer using A Resonant Excitation Coil for Characterization of Magnetic Fluid in Nonlinear Magnetization Region

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In order to tailor magnetic nanoparticles (MNPs) for intended applications, it is important to unravel their dynamics with respect to excitation magnetic field. In this work, we report on the development of a sensitive AC magnetometer using a resonant excitation coil for this purpose. The excitation coil fabricated from a Litz wire is connected to a capacitor network to effectively reduce the impedance of the circuit. The high efficiency showed by the excitation coil enables investigation of MNP's dynamics in the nonlinear magnetization region. We demonstrate the sensitivity of the developed system by measuring the harmonics of a multicore iron oxide nanoparticle solution down to 300 ng/ml of iron concentration. We experimentally show that the first harmonic component is not completely 'transparent' to the diamagnetic background of the carrier liquid compared to the higher harmonics. We also demonstrate the complex magnetization measurement of the iron oxide nanoparticles in solution and dry states from 3 Hz to 18 kHz. A highly sensitive exploration of MNPs' dynamics can be expected using the developed AC magnetometer.

***Index Terms*—Magnetometer, AC susceptibility, harmonics, magnetic nanoparticles.**