A Resonant Type AC Magnetometer for Evaluation of Magnetic Nanoparticles

Nazatul Sharreena Suhaimi[1], Mohd Mawardi Saari[1], Hamzah Ahmad[1], Mohd Rusllim Mohamed[1], Nurul Akmal Che Lah[2]

[1] Faculty of Electrical & Electronic Engineering, Universiti Malaysia Pahang, Pekan Campus, 26600 Pekan, Pahang

[2] Innovative Manufacturing, Mechatronics and Sports Lab (iMAMs), Faculty of Manufacturing Engineering, Universiti Malaysia Pahang, Pekan Campus, 26600 Pekan, Pahang

mmawardi@ump.edu.my

Abstract. Characterization of magnetic nanoparticles is crucial in order to optimize them for different applications requiring specific characteristics. In this article, we report a characterization system using AC susceptibility method. An AC magnetometer system which is composed of the induction coil and resonant capacitors is developed to evaluate the performance of the magnetic nanoparticles. The induction coil consists of excitation and detection coil. The excitation coil is designed with solenoid coils and fabricated with a Litz wire which is composed of 60 strands of copper wire with 0.1 mm diameter to reduce the increase of AC resistance at high frequency. The detection coil is designed to be a first-order differential coil which is used to reduce the environmental noise and cancel the excitation magnetic field. The detection coil is fabricated with a copper wire and it is placed at the center of the excitation coil. The excitation coil is connected to the resonant capacitors to cancel the reactant component and to permit the high magnetic field in the high-frequency region. The resonant capacitors are fabricated with multiple values of capacitors. When the developed system is in the resonant mode, the current flow is constant up to the frequency of 32.5 kHz. The developed system can evaluate the magnetic nanoparticles at different frequency responses. Using the developed system, it is shown that the Neel particles exist inside the solution of magnetic nanoparticles used in this study.

Keywords: AC magnetometer, magnetic nanoparticles, coil.

1 Introduction

Magnetic nanoparticles are mostly applied in the biomedical areas such as *in-vivo* imaging [1], magnetic hyperthermia [2], and magnetic immunoassay. There are different applications of magnetic nanoparticles requiring different characteristics of the magnetic nanoparticles. Therefore, the characterization of the magnetic nanoparticles is important. The characterization of the magnetic nanoparticles can be done by AC susceptibility [3], magnetic relaxation [4], and remanence measurement.