# Large magnetoimpedance effects in nanostructured Fe-rich composite materials for GMI sensor applications

Nguyen Q.H., Le A.-T., Yu S.C., Nguyen C., Lee H.

BK21 Physics Program, Department of Physics, Chungbuk National University, Cheongju 361-763; Center for Materials Science, College of Science, Vietnam National University, Hanoi, Viet Nam; Department of Physics Education, Kongju National University, Kongju 314-701

Abstract: In this letter, a systematic study of the giant magnetoimpedance (GMI) effect in nanostructured Fe-rich composite materials reported. The nanostructure of Fe-rich composite materials consisting of ultra-fine nanoscale Fe(Si) grains embedded in a residual amorphous matrix was attained by annealing their amorphous precursors at a proper temperature (550 °C). The impedance measurements were conducted in the frequency range of 1-10 MHz for a dc magnetic field varying within ±300 Oe. We demonstrated that the nanocrystallization of the alloys led to an improved magnetic softness of the material and, hence, to the GMI effect. It was obvious that, at low frequencies ($f \leq 4$ MHz), the maximum value of GMI was observed at near zero field ($H_{dc} 0$) and the GMI profiles exhibited a typical single-peak feature. At high frequencies ($f \geq 5$ MHz), however, a two-peak feature was observed. More interestingly, the GMI ratio and its field sensitivity reached the highest values of 170% and 64%/Oe at a frequency of 2 MHz, respectively. This result is very beneficial for developing highly sensitive GMI sensor applications. The observed GMI features in nanostructured Fe-rich composite materials can be interpreted by adapting the skin-effect model in conjunction with the magnetic-field dependence of the longitudinal permeability.

Author Keywords: Giant magnetoimpedance effect; GMI sensor; Nanocomposite; Skin effect

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Correspondence Address: Yu, S. C.; BK21 Physics Program, Department of Physics, Chungbuk National University, Cheongju 361-763; email: scyu@chungbuk.ac.kr

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Authors with affiliations:

- Nguyen, Q.H., BK21 Physics Program, Department of Physics, Chungbuk National University, Cheongju 361-763
- Le, A.-T., BK21 Physics Program, Department of Physics, Chungbuk National University, Cheongju 361-763

- Yu, S.C., BK21 Physics Program, Department of Physics, Chungbuk National University, Cheongju 361-763
- Nguyen, C., Center for Materials Science, College of Science, Vietnam National University, Hanoi, Viet Nam
- Lee, H., Department of Physics Education, Kongju National University, Kongju 314-701


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