# COMMENTS

*Comments are short papers which criticize or correct papers of other authors previously published in the* **Physical Review**. *Each Comment should state clearly to which paper it refers and must be accompanied by a brief abstract. The same publication schedule as for regular articles is followed, and page proofs are sent to authors.*

## Comment on "Large magnetoresistance in an amorphous $Co_{68.1}Fe_{4.4}Si_{12.5}B_{15}$ ferromagnetic wire"

M. Vázquez
*Instituto de Magnetismo Aplicado, RENFE-UCM, P. O. Box 155, 28230 Las Rozas (Madrid), Spain and Instituto de Ciencia de Materiales de Madrid, Consejo Superior de Investigactiones Cientificas, Serrano 144, 28006 Madrid, Spain*

J. Velázquez and D.-X. Chen
*Instituto de Magnetismo Aplicado, RENFE-UCM, P. O. Box 155, 28230 Las Rozas (Madrid), Spain*
(Received 18 March 1994)

In a recent paper [Phys. Rev. B **47**, 14 233 (1993)], Mandal and Ghatak claimed that a relative change in ac resistance up to 12% by changing the applied field was found in a Co-rich amorphous wire. This large change was ascribed to the giant magnetoresistance effect. We have made both dc and ac four-probe measurements on wires of the same composition under applied fields and no such large change has been observed. We believe that the results commented on reflect the strongly field-dependent self-inductance. Although the reactance at low frequencies is very small compared with the resistance, its effect could be enhanced under some circuit conditions.

The search for materials exhibiting giant magnetoresistance (GMR) is certainly of current major interest due to their enormous possibilities in the field of technological applications. GMR has been observed in multilayer systems,[1] or more recently in magnetic granular films and melt-spun ribbons.[2–4] All of them comprise two immiscible metallic components, one magnetic and the other nonmagnetic. The change in resistance with the applied magnetic field reaches values up to around 50%. The physical mechanism responsible for GMR has been attributed to the differential scattering of conducting electrons whose spins make particular angles with the local magnetization of different scattering centers. Surprisingly, a similar GMR effect has recently been reported in a single-phase ferromagnetic material. Mandal and Ghatak[5] claimed that a large negative magnetoresistance was observed in a Co-rich amorphous wire with accompanying magnetic hysteresis. The maximum reported change in resistance measured at 82 Hz was around 12% at room temperature under a tensile stress of 240 MPa. The results were discussed in terms of the scattering of carriers by magnetic domain walls. We have made measurements on wires with the same composition using various techniques, and no such large changes were detected. Therefore, the interpretation of their results may need to be revised.

Amorphous wires with nominal composition $Co_{68.1}Fe_{4.4}Si_{12.5}B_{15}$ were kindly supplied by UNITIKA Ltd. having 124 $\mu$m in diameter and 30 cm in length. Further details about the magnetization process, magnetoelastic properties, and the influence of heat treatments have been previously reported.[6] The resistance has been measured by means of the four-probe technique at room temperature as a function of the longitudinal applied field. The distance between the voltage contacts was 17.5 cm, within the uniform field range.

The field dependence of the resistance has been evaluated with both dc and ac currents. In the dc case, 1 mA current flowed along the wire and the voltage was detected by a multimeter. The relative change in resistance is given in Fig 1 as a function of the applied field. We see that the maximum relative change in resistance

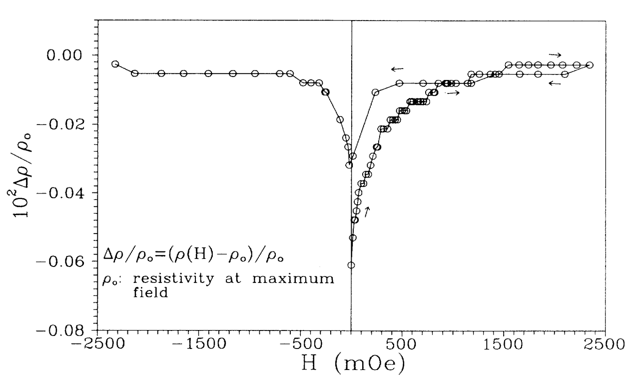


FIG. 1. Relative change in magnetoresistance in a $Co_{68.1}Fe_{4.4}Si_{12.5}B_{15}$ amorphous wire measured with 1 mA dc current.

 

is 0.06%, two orders of magnitude smaller than those reported in Ref. 5. For the ac measurements, the currents were chosen between 0.5 and 10 mA (rms) at 82 Hz. Since a lock-in technique was used in Ref. 5, besides using a multimeter, we also used a lock-in amplifier to measure the voltage. However, no changes in resistance were detected above the resolution of the voltage detector (≈ 0.1%). Therefore, our ac results are consistent with the dc ones. These results are also in agreement with some published data on ferromagnetic amorphous ribbons and wires.[7,8]

In order to reproduce the results in Ref. 5, we connected the wire to one arm of a Wheatstone bridge and nulled it at dc condition so that the contribution of its dc resistance at zero field was removed. We then connected the bridge to an ac supply. In this case, the voltage detector gave signals strongly depending on the applied field, and the changes in "resistance" could be as large as a factor of 30 (high-field value is about 3% of its value in zero field). This change was found to depend on the amplitude and frequency of the current and on applied stresses. A similar phenomenon was called by Mohri the magnetoinductive effect.[9] Such changes are actually due to the self-inductance of the wire. Since the wire is soft magnetic with the circular susceptibility being highly dependent on the longitudinal applied field, its self-inductance, defined as the ratio of circular flux to the longitudinal current, can be rather high and also highly field dependent. Thus, when measuring magnetoresistance in this kind of sample through an ac technique, particular attention must be paid to the circuit connection to avoid undesired "enhancement" from changes of self-inductance, which can lead to misinterpretation of results.

In conclusion, according to our measurements in Co-rich amorphous wires, magnetoresistance remains within 0.1%. However, ac measurements can give a large change in "resistance" if errors are introduced in the circuit. This resistance is actually a part of impedance, whose large change is due to the field-sensitive self-inductance of the soft magnetic wire.


[1] M. N. Babich, J. M. Broto, A. Fert, F. Nguyen Van Dau, F. Petroff, P. Etienne, G. Creuzet, A. Frederick, and J. Chazelas, Phys. Rev. Lett. **61**, 2472 (1988).

[2] A. E. Berkowitz, J. R. Mitchell, M. J. Carey, A. P. Young, S. Zhang, F. E. Spada, F. T. Parker, A. Hutten, and G. Thomas, Phys. Rev. Lett. **68**, 3745 (1992).

[3] J. Q. Xiao, J. S. Jiang, and C. L. Chien, Phys. Rev. Lett. **68**, 3749 (1992).

[4] B. Dieny, A. Chamberod, J. B. Genin, B. Rodmacq, S. R. Teixeira, S. Auffret, P. Gerard, O. Redon, J. Pierre, R. Ferrer, and B. Barbara, J. Magn. Magn. Mater. **126**, 433 (1993).

[5] K. Mandal and S. K. Ghatak, Phys. Rev. B **47**, 14 233 (1993).

[6] C. Gómez-Polo and M. Vázquez, J. Magn. Magn. Mater. **118**, 86 (1993).

[7] R. Kern and U. Gonser, Physica **B 119**, 198 (1983).

[8] Y. Makino, J. L. Costa, V. Madurga, and K. V. Rao, IEEE Trans. Magn. **25**, 3620 (1989).

[9] K. Mohri, IEEE Trans. Magn. **28**, 3150 (1992).