Fe/ALN AND Fe/SiO_2 NANOCOMPOSITE THIN FILMS

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The multilayer technology similar to that used in [1], was used for the preparation of nanocomposite thin films consisting of iron nanoparticles embedded in an insulating matrix. The iron layers were prepared in the form of non-continuous films composed of Fe nuclei.
The in-plane mean size of Fe nuclei is several nm; their thickness is 2 nm. The distance between adjacent Fe particles is about 2 nm, which is a distance favorable for tunneling (Fig. 1). The insulating layers (thickness of 2 nm) were sputtered at the parameters, which activate the planarization of the Fe layer surface.

The TEM and HREM structural investigation revealed the amorphous structure of the insulating matrix. The Fe nanocrystallites in SiO_2 matrix have bcc structure, and surprisingly, fcc structure in AlN matrix. In the contribution, we report the transport properties of both types of nanocomposite film. The electric transport mechanism is tunneling. The blockade effect of the transport was observed in both nanocomposite films (Fig. 2). Because of Fe bcc phase in Fe/SiO_2 nanocomposite the layer is magnetic. The magnetic properties were confirmed by longitudinal MOKE (Fig. 3). Consequently we observed the tunneling magnetoresistance effect (Fig. 4).

References:

[1] B. Dieny, S. Sankar, M.R. McCartney, D.J. Smith, P. Bayle-Giullemand and A.E. Berkowitz, J. Magn. Magn. Mater. 185 (1998) 283.

Figures:

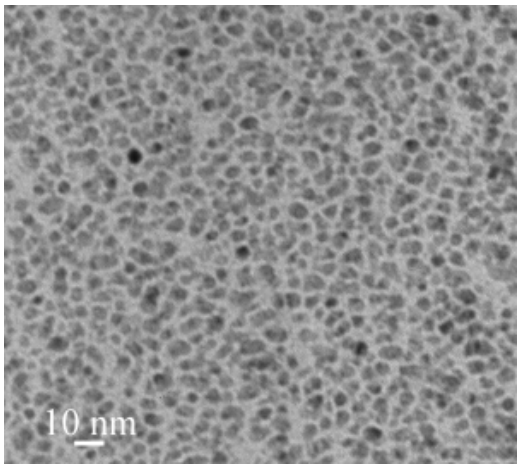

Fig. 1. TEM in-plane micrograph of Fe/AlN nanocomposite layer. The fcc Fe nanocrystallites are separated by 2 nm of AlN

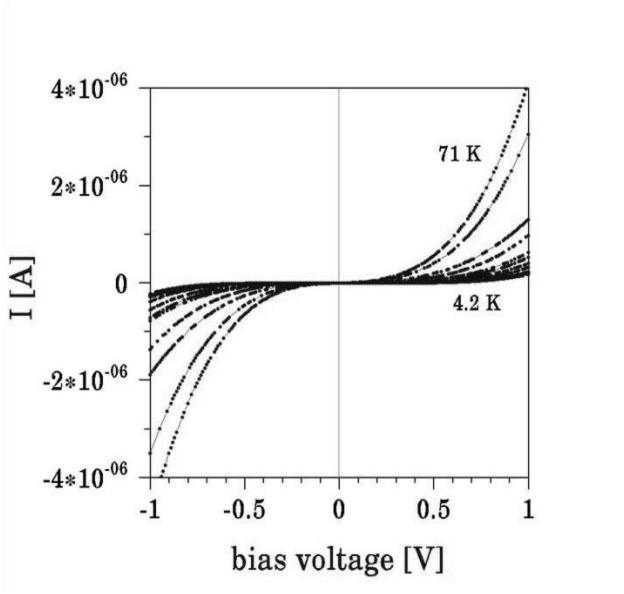

Fig. 2. I(V) characteristics of Fe/AlN nanocomposite layer. The Coulomb blockade is observed at cryogenic temperatures.

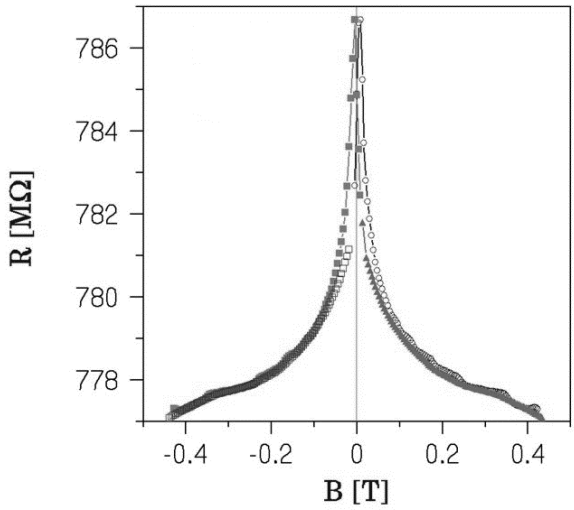

Fig. 4. R(B) dependence of Fe/SiO2 nanocomposite film. Tunneling magnetoresistivity in low magnetic fields (≤ 0.05 T) is about 12 %

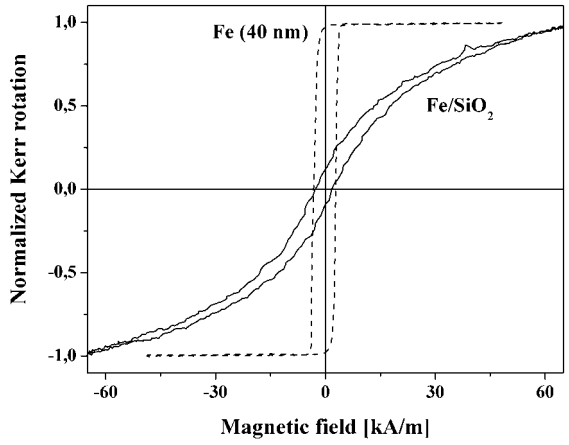

Fig. 3. Comparision of hysteresis loops of continuous Fe (40 nm) film and nanocomposite Fe/SiO_2 thin film. The loops were taken by longitudinal MOKE method.