Domain-Wall Resistance in Metal Nanocontacts

J. Velev and W. H. Butler

MINT Center - The University of Alabama

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Abstract

We present a study of ballistic conductance through Ni, Co and Fe nanocontacts within a semi-empirical tight-binding model. In our model, both spin channels are treated simultaneously which allows us to simulate a domain wall pinned in the nanocontact. We observe that the interplay of the contact and the domain wall resistance can produce very large giant magnetoresistance ratios but only for nanocontacts that are very narrow and have very small aspect ratios.

Conclusion

We extended our model of ballistic transport to include transport through non-collinear moments.

• large GMR (>300%) for atomic size nanocontacts made of Ni and Co
• GMR of Fe an order of magnitude smaller at atomic sizes, comparable at larger sizes
• the domain wall effect is maximized if the constriction is made of a non-magnetic material

For more information and reprints contact:
J. Velev, MINT Center. E-mail: jvelev@mint.ua.edu

Domain wall geometry and magnetoresistance. N denotes lateral size of constriction. w denotes thickness of domain wall (length of constriction).

For a bulk domain wall, MR decreases as a power of the wall thickness d-x (x=1-3).

Short constriction (w=2ml). Large MR for atomic size Ni and Co. Converges to the bulk value as N goes to infinity.

For long constriction (w=7ml). MR of non-magnetic constrictions. MR increases with size in contrast to all magnetic nanocontacts.