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Stability of Magnetic Domains with Notches in Permalloy Nanowires

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Understanding properties of domains and domain walls (DW) in ferromagnetic nanowire is required for applications. [1]-[2] Especially, domain stability is an important issue to control DW and to design notches for manufacturing high density logic devices. Here we present a numerical prediction on the stability of domains in Permalloy nanowires with oommf [3]. From micromagnetic evaluation, the stability is found to be sensitive to the domain wall configuration, either transverse or vortex walls aligned parallel or antiparallel to the nearest neighbors. The smallest domains are attained with the transverse walls aligned parallel to each other, which demonstrate the importance of the wall polarization control in the practical application. As seen in Fig. 1 (c), the minimum stable length with any domain wall configuration is found to be about 2.4 times the wire width.

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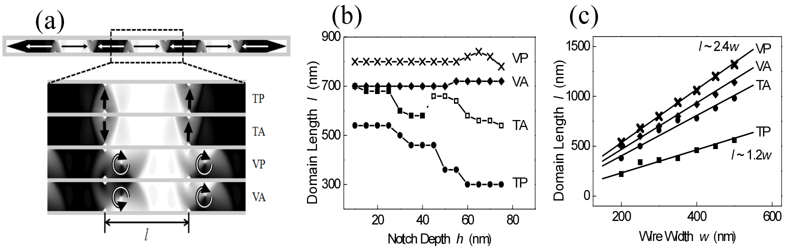

Fig. 1. (a) The geometry of nanowire and domain arrangement respect to domain configuration. i is domain length. (b) Minimum stable domain length with respect to the notch depth for several domain configurations. (c) Minimum stable domain length with respect to the wire width for several domain configurations.

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Magnetization Reversal Behaviors and Domain Wall Magnetoresistance Effect in Nanobridges

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The domain wall magnetoresistance (DWMR) in nano-structured films was extensively studied in the past decade due to rich research topics and great potential application in spin-electronics. However, up to now, DWMR is still under intensive discussions because of conflicts in experimental results. Both positive [1-3] and negitive [4] domain wall magnetoresistance effects have been found. And theoretically it has difficulties in explaining the effect satisfactorily. In this presentation, the extended structure, named as nanobridge (NB), combined by a nanowire of well-defined shape and nanocontact was used and the variation of the magnetoresistance under different external magnetic fields with the sizes (width and length) of nanobridge structures was intensively studied. Electron-beam lithography and lift-off process were used to prepare Permalloy patterned thin films on Si (100) substrates coated with 100-nm SiO2 buffer layers. The Permalloy thin films were deposited by DC magnetron sputtering. The room-temperature magnetoresistance (MR) measurements were made by a four-point technique. A field of 4 k Oe was used to saturate the magnetization and the detailed investigations were carried out from - 500 Oe to + 500 Oe. The MR results have been compared with the spin configurations obtained by using the micromagnetic simulation software (the Object Oriented Micro Magnetic Framework, OOMMF). Two sets of NB with bridge lengths 60 nm and 400 nm were used in the study. The width of nanobridge segment of two sets was varied from 40 nm to 100 nm. The switching field shows an inverse dependence on nanobridge width and switching field distribution is affected by the bridge length. Besides, the magnetoresistance contributed from domain wall has been determined to be positive that was interpreted to arise mainly from spin-dependent impurity scattering of mistracking model.

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