MAGNETORESISTANCE AND DOMAIN WALL DISPLACEMENT IN SUBMICROMETER PERMALLOY RING STRUCTURES

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Manipulation of magnetic domain walls in nanostructures by the use of magnetic fields and electric current has recently the focus of intense research due to its great potential for application to spintronics and also because of the basic physics involved in the phenomenon. [1–4] Magnetic nanorings are particularly apt geometry to investigate such an effect and this, together with their outstanding magnetic properties, makes them good candidates as building blocks for high density magnetic random access memories and magnetosensors. In the present investigation we measured and modelled the magnetoresistance in submicrometer Permalloy circular, square, and triangular ring structures. The conventional anisotropic magnetoresistance effect due to the presence of head-to-head type domain walls is the main source of magnetoresistance. Using an external field head-to-head domain walls can be placed at selected locations in the ring and their position sensed by magnetoresistance. The effects of nonplanarity of the magnetic structures as well as of shape defects and roughness on the domain walls structure and on the magnetoresistive behaviour are investigated. It is shown that a domain wall can be reversibly and controllably displaced between adjacent corners of the structure by current pulses of different polarity. These observations can be explained by a directional spin-torque effect. Finally we tested possible applications of devices based on this kind of structures to biomolecular recognition.

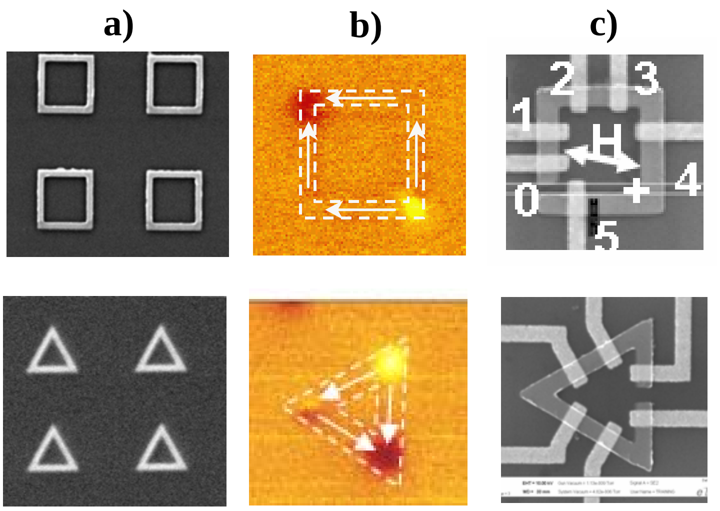

Fig. 1. Panel (a): scanning electron micrographs of square and triangular ring structures (image size 10 x 10 μm^2). Panel (b): magnetic force microscopy images showing domain walls pinned at corners of the structures. Panel (c): scanning electron images of the final devices used for magnetoresistance characterization (image size 1.5 x 1.5 μm^2).

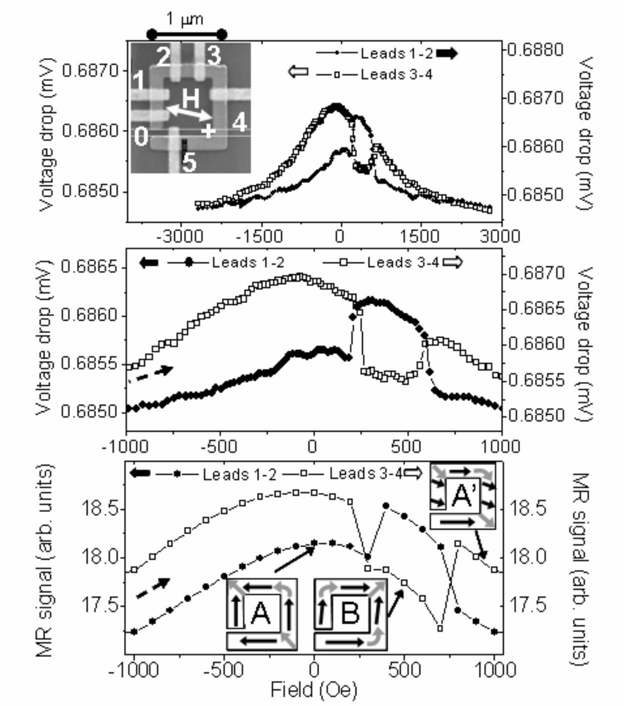

Fig. 2. Measured (topmost and middle panels) and calculated (bottom panel) magnetoresistance response of the square ring device.

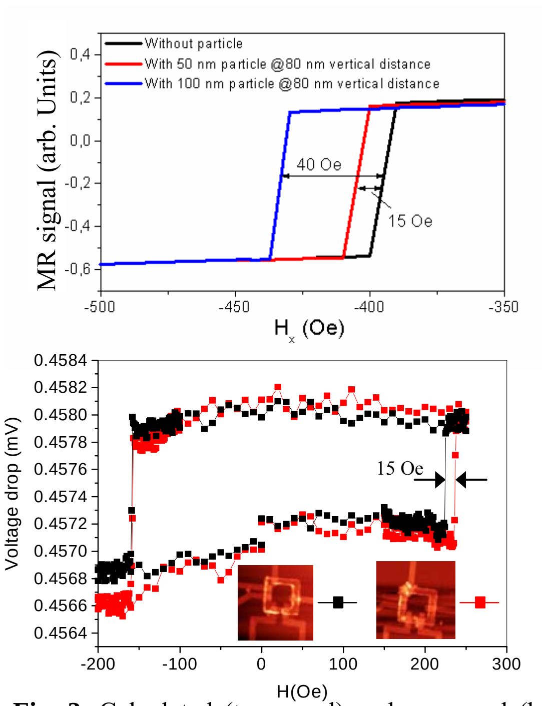

Fig. 3. Calculated (top panel) and measured (bottom panel) domain wall depinning field from one corner with (blue and red lines in top panel and red symbols in bottom panel) and without (black line and symbols in both panels) magnetic beads placed on top of one corner of the square ring device.

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