Magnetic Configuration and Switching Behaviors in E-beam Patterned Pac-man Submicron Magnets for Magnetoresistive Random Access Memory (MRAM)

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Abstract:
Understanding of the switching behaviors of nanomagnet is a key issue to successful development of spintronic devices. The magnetic switching repeatability is dependent on both shape and aspect ratio of currently used submicron magnets. The shapes to discuss include conventional shape (rectangle), modified shape (hexagon, ellipse), symmetric (disk, ring) and asymmetric shapes (cut-disk, notched disk). A new shape, namely "Pac-man," (US Patent pending; published in *Applied Physics Letters*, **83,** 329, 2003) proposed by University of Idaho is introduced to compare its switching behavior to other shapes. Arrays of submicron magnets having various shapes were fabricated by e- beam lithographic, sputter deposition, and ion milling techniques. Simultaneous Atomic Force Microscope (AFM) and Magnetic Force Microscope (MFM) techniques were used to characterize the magnetic configuration, switching field, switching field distribution of arrays of submicron magnets and domain wall structures of ring element. An array of submicron magnets with the Pac-man shape shows the narrowest switching field distribution and a well-defined, single-domain configuration. Micromagnetic simulation was also performed on ring and Pac-man submicron magnets to understand domain wall structure and magnetization process, respectivley. Micromagnetic spin dynamics movie will be on to visualize magnetization process taking place in Pac-man submicron elements through either vortex nulceation or free- vortex.