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Bistability and controllable magnetic switching of 100-nm asymmetric ferromagnetic nanorings F.Q. ZHU, GIA-WEI CHERN, OLEG TCHERNYSHYOV, C.L. CHIEN, Johns Hopkins University — Nanorings can acquire the vortex state with flux closure and zero stray field. We have developed a method for fabricating a large number of nanorings over a macroscopic area. However, for 100-nm nanorings, the nanorings can acquire both the rotating onion state and the vortex state during magnetic reversal with comparable probability. In this work, we report the fabrication and properties of asymmetric nanorings, whose thickness and width vary along the circumference. In contrast to symmetric nanorings, the percentage of vortex formation in asymmetric nanorings can be controlled by the direction of the magnetic field. When the field is along the asymmetry axis, nearly every nanoring can acquire the vortex state. The introduction of asymmetry in the nanorings allows full vortex formation without losing the virtue of small dimension, high stability and high areal density. We have also developed a theoretical model to calculate the dependence of domain wall energy on the local width and thickness of the nanorings to account for the enhancement of vortex state in asymmetric nanorings.

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