MAR06-2005-001204

Abstract for an Invited Paper
for the MAR06 Meeting of
the American Physical Society

Magnetic nanorings and manipulation of nanowires

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The properties of nanoscale entities, such as nanorings and nanowires, and the response of such entities to external fields are dictated by their geometrical shapes and sizes, which can be manipulated by fabrication. We have developed a method for fabricating a large number of nanorings (10^{10}) of different sizes in the range of 100 nm and ring cross sections. During magnetic reversal, both the vortex state and the rotating onion state appear with different proportions, which depend on the ring diameter, ring cross section, and the profile of the ring cross section. In the case of nanowires in suspension, the large aspect ratio of the nanowires can be exploited for manipulation despite extremely small Reynolds numbers of 10^{-5}. Using AC electric field applied to microelectrodes, both magnetic and non-magnetic nanowires can be efficiently assembled into desired patterns. We also demonstrate rotation of nanowires with precisely controlled rotation speed and chirality, as well as an electrically driven nanowire micromotor a few μm in size. In collaboration with F. Q. Zhu, D. L. Fan, O. Tchernyshyov, R. C. Cammarata (Johns Hopkins University) and X. C. Zhu and J. G. Zhu (Carnegie-Mellon University).