Tunable mesoscale magnetic structures by nanoimprint lithography

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Magnetism in condensed matter systems, defined by the exchange correlation length and the domain wall width, give rise to size-dependent magnetic behavior, including superparamagnetism, at the nanometer length scale. Further exchange, proximity and interface effects play an important role. We have developed a versatile, defect-free, nanoimprint lithography process for the large-area patterning of magnetic structures of metals, oxides and multilayers on the mesoscale. The process combines, where necessary, a tetrafluoroethylene (ETFE) "working stamp", a bi-layer resist lift-off, a Mo mask transfer process for high temperature deposition, including epitaxial growth on lattice-matched substrates and a process for the direct release of the elements in solution without the need for a sacrificial layer. Recent examples of our work to be discussed will include: (a) Competing anisotropies and temperature dependence of exchange bias in mesoscale, epitaxial, bilayer metallic wires arrays. (b) Sombrero-shaped synthetic antiferromagnet $(Fe_3O_4/Ti)_n$ nanoelements with tunable out-of-plane and in-plane magnetization components and their direct release in solution, and (c) Large-area NIL patterning of sub-100 nm epitaxial $L1_0$ FePt dots array for bit-patterned media