MAR13-2012-020042

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

GMAG PhD Dissertation Research Award Talk: Dynamic Magnetic Traps for Particle Self-Assembly and Lab-on-Chip Applications

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Micro-patterned Permalloy thin films serve as an excellent means to architect the spatial profile of magnetic fields with the tunable, high gradients required to manipulate objects with weak induced magnetic moments. In this presentation, I will highlight two projects carried out during my PhD studies. These findings demonstrate the functionalities achieved through carefully designed patterns of different sizes and shapes (e.g. circular, triangular, octagonal profiles): (i) By tuning a precessing magnetic field in conjunction with such Permalloy patterns, microsphere (i.e. dipole) cluster structures ranging from closely packed to frustrated and to plum-pudding-like planar lattices are stabilized. Such self-assembly of components at the micro to nanometer range not only support a rich variety of physical phenomena, but also have applications, for example, as filters or force probes and field-tunable photonic crystals. (ii) Mobile magnetic trap arrays consisting of Permalloy disks have enabled rapid transport of magnetic beads or immunomagnetically labeled cells across surfaces. Integration of these arrays with microfluidic droplet technology allows separation of labeled cells and their subsequent encapsulation into picoliter-sized droplets. The droplets serve as isolated containers for individual cells to be probed without cross-contamination. The separation-encapsulation function could become a critical component in point-of-care single-cell analysis platforms.