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Magnetic field gradient driven self-assembly of superparamagnetic nanoparticles using programmable magnetically-recorded templates

L. YE, University of South Carolina, B. QI, T.G. LAWTON, O.T. MEFFORD, Clemson University, C. RINALDI, University of Florida, S. GARZON, HGST, a Western Digital company, T.M. CRAWFORD, University of South Carolina — Using the enormous magnetic field gradients (100 MT/m @ z=20 nm) present near the surface of magnetic recording media, we demonstrate the fabrication of diffraction gratings with lines consisting entirely of magnetic nanoparticles assembled from a colloidal fluid onto a disk drive medium, followed by transfer to a flexible and transparent polymer thin film. These nanomanufactured gratings have line spacings programmed with commercial magnetic recording and are inherently concave with radii of curvature controlled by varying the polymer film thickness. The diffracted intensity increases non-monotonically with the length of time the colloidal fluid remains on the disk surface. In addition to comparing longitudinal and perpendicular magnetic recording, a combination of spectral diffraction efficiency measurements, magnetometry, scanning electron microscopy and inductively coupled plasma atomic emmission spectroscopy of these gratings are employed to understand colloidal nanoparticle dynamics in this extreme gradient limit. Such experiments are necessary to optimize nanoparticle assembly and obtain uniform patterned features. This low-cost and sustainable approach to nanomanufacturing could enable low-cost, high-quality diffraction gratings as well as more complex polymer nanocomposite materials assembled with single-nanometer precision.

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