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Patterned Magnetic Media: Recording Properties and Fabrication Issues

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As the onset of thermal instability with decreasing grain size makes the extension of conventional sputtered granular media to higher data recording densities increasingly difficult, the use of nanopatterning techniques to create well-ordered arrays of isolated, highly uniform magnetic islands may enable a new generation of recording media extendible to densities of 1 terabit per square inch and beyond. A workable patterned media recording system requires a highly uniform magnetic island array, both in terms of dimensional parameters (island size, shape, and placement tolerance within the array) and materials properties (magnetic moment and switching field). Selectively writing individual tracks of islands without affecting neighboring islands requires a write transducer with sufficiently high field gradient and peak field. The island size range of interest (15-25 nm diameter islands on 20-40 nm array periodicity) makes fabrication of patterned media particularly challenging. One strategy for media fabrication is to create a high resolution master pattern via e-beam lithography and/or self-assembly, and to replicate this pattern over thousands of media samples using UV-cure nanoimprint lithography. The imprinted pattern can serve as an etch mask for patterning either the media substrate or magnetic layer. Trenches between islands may be filled to create a smooth surface suitable for flying a read/write head over the media surface at a spacing of a few nm. Although a variety of magnetic materials may be used, multilayer Co-Pt or Co-Pd are preferred based on their perpendicular anisotropy, moment, switching field, and strong coupling between grains (necessary to ensure that islands switch as a single unit). Depending on the fabrication method used, magnetic material in the trenches between islands can generate unwanted magnetic flux which generates noise in the readback signal. Island nonuniformity (both dimensional and magnetic) also contributes to increased errors in writing and increased noise in readback. Write errors may be generated via imperfect synchronization of the switching of the write field as the write transducer passes over the media. Tight tolerance control is required both for write synchronization and positional tracking of the head over the island array.