Parekh, Vishal, “Process Development for Fabrication Of Bit-Patterned Medium For Magnetic Storage Devices”

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The dissertation describes lithographic structuring of large-area patterned medium samples with ~40nm features using ion beam proximity lithography (IBPL). The quality of the patterns formed in IBPL system is primarily limited by the quality of the stencil masks. Hence, the emphasis of this work has been to develop a reliable mask fabrication process that can achieve a size uniformity that is suitable for patterned media. A silicon nitride stencil mask fabrication process that incorporates palladium as a hard mask for transferring the lithography pattern into the nitride membranes has been developed for this purpose. A conformal gold coating allows for further reduction of the mask features without a significant increase in the feature size variation. An average standard deviation of 3nm and 5nm was measured during various steps of the stencil mask fabrication and after printing using IBPL in PMMA resist respectively. Patterned medium prototypes with diameters ranging from 40nm to 300nm have been fabricated. Magnetic measurements demonstrate a 6-15 fold increase in the coercivity of the patterned samples compared to continuous samples making them suitable for next generation recording.

Scattered particle exposure experiments on fabricated stencil masks to quantify the near-surface background dose for fabricating dense arrays of features in the 45-100nm range were carried out. Ion irradiation of patterned multilayer samples was also studied as a means to control magnetic anisotropy as well as to evaluate possible ion irradiation damage involved in ion-beam proximity lithography patterning.

For the first time, a novel self-limiting low energy argon ion-milling based process that enables square and hexagonal device pattern formation using precursor arrays of uniform circular openings printed in poly methylmethacrylate by electron beam lithography is described. This technique can be implemented for bit-patterned medium fabrication as well as template fabrication for nanoimprint lithography.

Thus, availability of a robust high resolution stencil mask process, low scattered particle exposure, and aperture array lithography capability make IBPL a promising candidate for bit-patterned medium fabrication. I believe that this work represents significant advancement in stencil mask fabrication for IBPL and is a step forward in the fabrication of bit-patterned medium for magnetic storage devices.