Enhanced magnetic properties of bit patterned magnetic recording media by improved magnetic island geometry

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The continued industrial success of the hard disk drive (HDD) technology is mainly due to the continuing increase of recording capacity while keeping the price per bit low. For further enhanced recording density of 1 TB/in^2 or higher, the bit patterned media (BPM) approach is desirable. Some of the main technical issues in the BPM include the nano-geometrical resolution, reliability/reproducibility of periodically patterned magnetic bit characteristics, associated media surface roughness, and processing cost. The protruding magnetic nanostructure features in the BPM as well as the magnetic deposition on the sidewall of the patterned pillars are not desirable for magnetic properties of the magnet islands, for lithographic patterning and tribology issues related to the operation of recording read/write heads.

In this paper, we demonstrate significantly improved magnetic properties of bit patterned media with much higher coercivity and squareness values by a simple, convenient, and reliable trench-filled nanostructure to ensure the thin film sputtered magnetic material deposits only on the pre-patterned media islands, avoiding the deposition on pillar sidewalls. A two-step planarization process was utilized. First, the poly-methylmethacrylate (PMMA) filler was spin-coat applied to block the recessed trenches in the nano-imprint-lithographically patterned Si during magnetic layer deposition. Second, hydrogen silsesquioxane (HSQ) filler was applied to the valley regions of the patterned magnetic media to finally planarize and obtain nano-topographically flat recording media. The surface roughness of the nano-structured BPM before vs. after trench filling was monitored by atomic force microscopy (AFM) and scanning electron microscopy (SEM). The magnetic properties of the BPM media material, evaluated by magnetic force microscopy and superconducting quantum interference device (SQUID) magnetometer, indicate that so processed media without the undesirable deposition of magnetic material on pillar sidewalls and corners exhibited significant improvements.

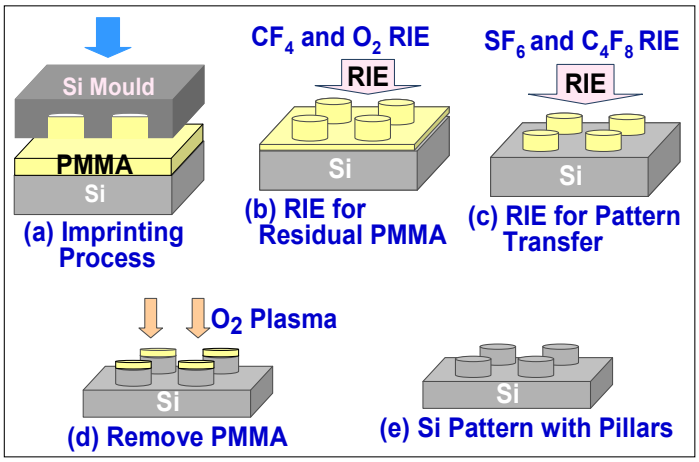

Figure 1. Nano-imprint processes for bit patterned media.

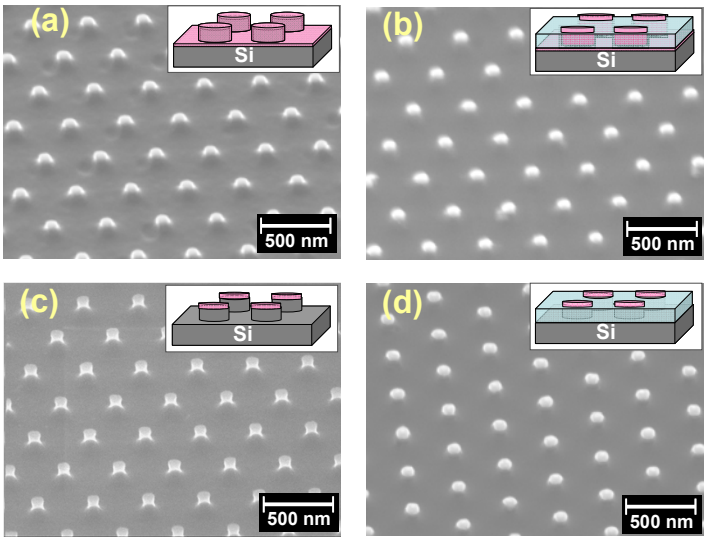

Figure 2. Topographical features of BPM. (a) Magnetic media deposited without trench blocking, (b) Additional geometry planarization, (c) Better defined magnetic islands deposited with trench blocking, (d) Additional geometry planarization. The insets illustrate the BPM nanostructures.