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Nanopatterning of $Co_{73}Pt_{27}$-TiO_2 magnetic thin film by focused ion beam irradiation

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Nano-scale fabrication becomes an essential process in various application fields of magnetic thin films such as MRAM, patterned media and spintronic device. The topographic patterning process, for example, IBE(ion beam etching) and RIE(reactive ion etching), fabricates the nano-structure by removing the unnecessary materials and inherently has drawbacks like etching damage, redeposition and planarity issue. Recently, there has been an attempt to avoid these setbacks by applying non-topographic patterning process for magnetic thin films. This pure magnetic patterning technology utilizes the irradiation or implantation of ions like He^+, Ga^+,Ni^+ into the magnetic thin films in order to modify the magnetic properties. When Ga^+ ions are irradiated with FIB(focused ion beam) system, it is possible to fabricate the magnetic thin films directly in nano-scale with the combination of the irradiation induced magnetic patterning and the direct nano-fabrication ability of FIB. In this presentation, we will show their radiation effects of Ga^+ ion on the magnetic properties of perpendicular magnetic recording media for DTR (discrete track recording) and patterned media applications. The perpendicular media was prepared on a glass substrate and its detailed structure was Glass/Ta 5 nm/CoFeZrNb 40 nm/Ta 3 nm/Ru 15 nm/Ru-O_2 8 nm/$Co_{73}Pt_{27}$-TiO_2 16 nm. The sample was then exposed to the 10 pA 30 keV Ga^+ focused ion beam with different dose from 1×10^{15} ions/cm^2 to 30×10^{15} ions/cm^2. The exposed area was 3×3 μm^2 and the change of magnetic properties were observed with the MFM(magnetic force microscopy). As Ga^+ ion dose increased from 1×10^{15} ions/cm^2 to 30×10^{15} ions/cm^2, the perpendicular magnetic anisotropy was degraded and no longer observed above 20×10^{15} ions/cm^2 dose. The deterioration of the perpendicular magnetic anisotropy and ferromagnetic properties can be attributed to the concentration profile change due to Ga^+ion implantation.

Keywords: FIB, magnetic, nanopattern

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TiO_2 Nanocarving Process: Selective and Anisotropic Nanosized-Etching of Bulk TiO_2 into Nanofibers

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The widespread utilization of nano-structured materials is often complicated by the conflicting demands for precise control of fine features (down to the nanometer scale) and for large-scale mass production. Recently, a simple, inexpensive gas phase reaction termed as “nanocarving process” has been developed for TiO_2 single crystal nanofibers. The nanocarving process converts TiO_2 grains into arrays of single crystal nanofibers by selective and anisotropic etching. Unlike other nano-structure forming techniques, nano-carving doesn’t require any sophisticated equipment. All one needs to produce the structure is a controlled atmosphere furnace for a subsequent heat treatment (5% H_2/N_2 at 700 °C). This process yields high surface area structures that are well attached to a substrate making them easy to adapt for industrial and commercial applications. This presentation reviews the condition for the nanocarving process and discusses the mechanism of the selective etching

Keywords: TiO2, Nanofiber, Nanowire, Synthesis, Etching