Nanolaminated advanced carbon overcoat study by Rutherford backscattering spectroscopy and Monte Carlo ion beam simulation of film growth

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Carbon overcoat serves as a mechanical and corrosion protection layer of the hard disk magnetic structure. Its overall thickness should be below 2nm and is usually composed of two layers, a-C:N and a-C:H(N) film. To improve the disk corrosion protective properties, after the magnetic layer deposition a flash layer of carbide forming elements, like Cr or Ti, can be pre-deposited. Now, reactive ion (plasma) beam technologies are mainly used for the carbon overcoat deposition, while DC sputtering is a technique of choice for the under laying structures. To achieve a low nano-scale carbon surface roughness, is necessary to use ions with incident energy up to100 eV/ion, favorably under the grazing incidence angles. Ion beam polishing effect and enhanced surface mobility of ad-atoms during the film growth play an important role for the ultra smooth surface coverage. For the flash layer deposition in thickness below 0.5 nm the filtered cathodic arc technique with metal ion beams has been proposed to replace sputtering.

The hard disk nano-scale film thicknesses require special arrangements during film growth as well as extremely sensitive surface analysis tools in the evaluation of corrosion protection capabilities. For the overall film composition study we used Rutherford backscattering spectroscopy (RBS). For the evaluation of possible interlayer mixing a Monte Carlo simulation was conducted calculating the stopping range of 100 eV incident Cr and C ions in the CoCrPtB magnetic layer.

Magnetic layer ($Co_{80}Cr_{10}Pt_7B_3$, 30 nm) has been sputter deposited over polished Si wafer. A flash layer of Cr (0.5 nm, by FCA method) and a-C:H(N) carbon overcoat were deposited on top of it. Four such samples, 1,2,3,4, have been exposed to corrosion environment (exposure to the vapor of 0.5M HCl solution) for the duration of 21 h, 46.5h, 52h and 284h, respectively. RBS sample composition after the corrosion test has been studied in the *top* arrangement, Fig.1. Taking into account energy positions of the Co, Pt and Cr peaks one may conclude that from the change in the Si edge position, samples 2 and 3 have similar thicknesses of the magnetic layer. The same is applicable for samples 1 and 4. Sample No.3 has some kind of artifact indicating possible segregation due to corrosion induced Co migration to the top. There is no systematic change observable here indicating that corrosion profile is a random event. The change in peak position may be related to the increase of the over layer thickness (everything on top of the magnetic layer) and a cobalt hydroxide/chloride built up.

In order to obtain dense and pinhole-free films there is a need for energetic ion beam bombardment during film growth. With FCA source the flash layer of Cr was deposited at ion energy of 100 eV. The calculated penetration depth of Cr ions into CoCrPtB was always below 0.5 nm. Monte Carlo simulation of the stopping range of ions in material, normally referred to the crystalline solid structures, can be applied for the amorphous solids with short range crystallinity

and at low ion beam incident energies. The calculated Cr (100 eV) ion range into the CoCrPtB magnetic layer was 6Å, 4Å and 3Å for the ion incident angles at 0, 45 and 85 degrees, respectively. Low penetration depth of Cr ions ensures minimization of the thickness of the õdeath magnetic layerö. The calculated range of C ions into Chromium and into CoCrPtB layer was up to 5Å, Fig.2. Propagation of energetic carbon atoms takes place through cascade processes: displacement collisions, vacancy production, replacement collisions and interstitial atoms.
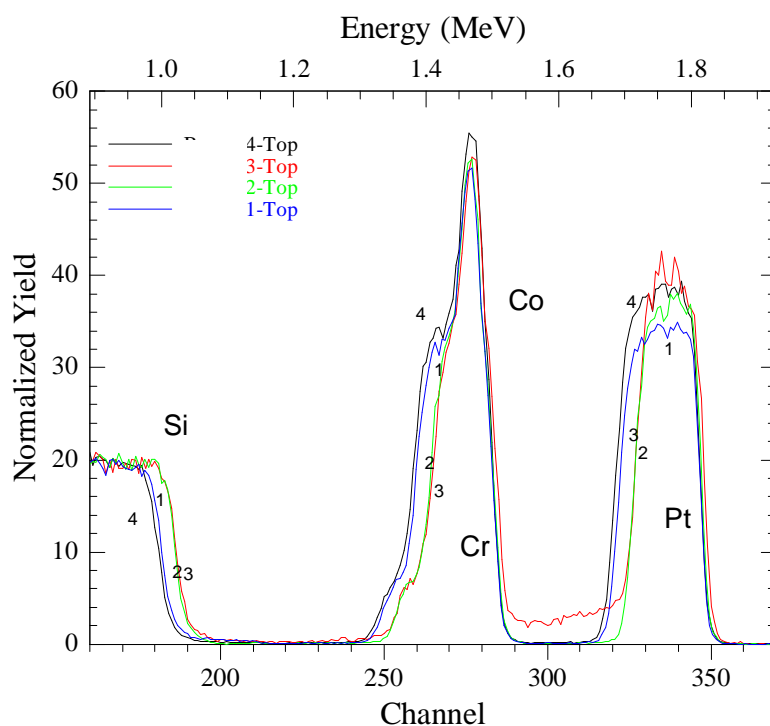

Fig.1. RBS spectra for the corrosion exposed Si/CoCrPtB/Cr/a-C:H samples. Exposure times for samples 1, 2, 3 and 4 were 21h, 46.5h, 52h and 284h, respectively.
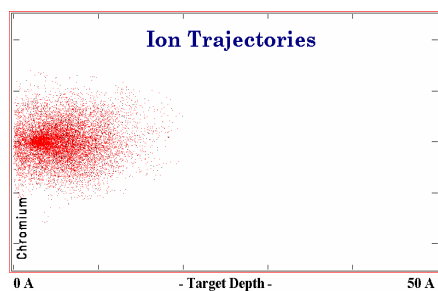

Fig.2. Carbon ion (100 eV) trajectories into Cr.

Reference

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