HIGH ENERGY PLASMA BASED CARBON OVERCOAT DEPOSITION ON HEAT-ASSISTED MAGNETIC RECORDING MEDIA

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I. INTRODUCTION

Carbon overcoat (COC), made of amorphous diamond-like-carbon with good sp^3 fraction is needed to protect the magnetic recording media from the chemical and mechanical damages. Reduction of COC thickness whilst maintaining its functionality of a protective layer is a crucial requirement in increasing areal density. The current deposition techniques are unable to meet the requirements for COC thickness below 1.5 nm, which creates a need for an alternative deposition technique. Heat-Assisted Magnetic Recording, where the media will be heated also require thermally stable COC. High-energy carbon deposition techniques such as filtered cathodic vacuum arc (FCVA) which provide thin overcoats with high corrosion and wear protection generates particles, which hinders its use as COC for hard disk media [1]. Here, we introduce the use of a novel dense plasma focus (DPF) technology to the hard disk community [2]. COC deposition using a pulsed high-energy plasma focus device on FePt perpendicular magnetic media are reported.

II. EXPERIMENTAL DETAILS

Deposition of COC on FePt samples was carried out in a 3.3 kJ Mather type DPF device at different distances from the anode top (varying as 12, 16, 20, 24 and 28 cm). Methane gas was used as the main precursor for carbon deposition, while in some conditions the admixture of methane and argon gas was used to lower the amount of the precursor. The energy flux of the depositing ions is higher at 12 cm distance of deposition and reduces with the increase in the deposition distance. Since the deposition of COC was carried out using high energy density plasma along with higher energy ion flux, the magnetic and structural properties of FePt media might be modified. Hence, the magnetic and structural properties of pre- and post-COC deposited FePt media were compared using Magneto-optic Kerr Effect (MOKE) and the X-Ray Diffractometer (XRD). Simulation studies were also carried out to understand the effect of high energy deposition. Chemical properties of the COC were characterized by XPS and Raman spectroscopy.

III. RESULTS

In phase 1, COC deposited at very high energies were studied. Figure 1(a) shows the reduction in the coercivity of FePt after deposition of COC. This reduction in the coercivity value can be explained because of the exposure to the high energy ions during the deposition process which facilitates the partial transition of ordered FePt $L1_0$ phase to disordered A1 FePt phase [3]. It can also be noticed that the coercivity of deposited FePt reduces as the ion flux of depositing ion increases with decreasing the deposition distance.

The changes in the structural properties of FePt before and after COC deposition are shown in figure 1(b). The bare samples exhibit face-centered tetragonal phase with a stronger intensity of super-lattice (001) reflection peak from the $L1_0$ phase, while the (111) diffraction peak is relatively weak. It is evident from the XRD spectra that the I(001)/I(111) peak intensity ratio decreases for carbon coated FePt samples. The (111) peak position of COC deposited samples has shifted slightly to lower 2θ values as compared to the bare sample of FePt. The shift indicates the partial transition of FePt face-centered tetragonal phase to face-centered cubic phase, which confirms that the carbon deposition in DPF is highly energetic. Figure 1(c) shows the trend of G peak position for the deposited COC in methane and admixture of argon-methane at different deposition distances, measured by visible Raman spectroscopy. As reported by

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A.C. Ferrari et.al. [4], the increase in the G peak's position (observed at lower deposition distance for methane and argon-methane admixture deposited carbon) in figure 1(c) indicates the increase in the fraction of sp^3 carbon. XPS results (Table I) indicated 44 to 47 % ratio of sp^3 to sp^2 carbon, which is promising for the use of DPF deposited carbon as hard disk media COC.

In the next phase, COC deposited at suitable energies, which do not deteriorate the magnetic properties are investigated. The magnetic properties, XPS investigations and the lubrication affinity of such a COC will be discussed in the talk.

IV. CONCLUSION

We have reported here the use of a high energy density pulsed plasma technique for the deposition of COC on the FePt perpendicular magnetic media. MOKE results depicted a change in the coercivity of the FePt media after COC deposition, which can be reduced by depositing COC using lower energies than those in phase 1. XRD results exhibited the partial transition of ordered FePt $L1_0$ phase to disordered FePt A1 phase after the deposition of COC at very high deposition energies. Raman spectroscopy suggested a higher fraction of sp^3 carbon can be achieved at lower deposition distance, which was verified by the XPS results. In conclusion, all these results demonstrate the promising potential of DPF device as an effective device for the COC deposition in future.

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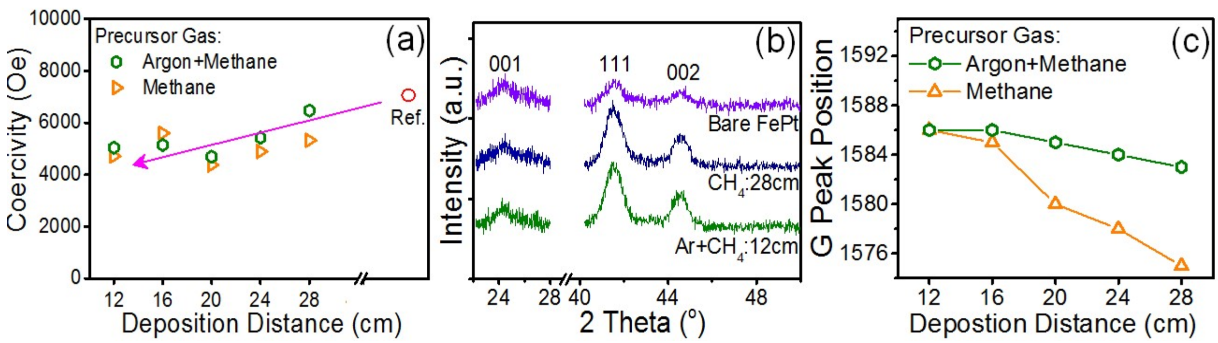

Fig. 1 (a) Coercivity of virgin and COC covered FePt samples prepared at different deposition distance. (b) XRD plot of bare and post COC deposited FePt samples. (c) G peak's position in Raman spectra of COC at different deposition Distance.

Table I XPS results for carbon type ratio in deposited COC

Carbon Type	COC at Ar+CH_4 : 28 cm	COC at Ar+CH_4 : 12 cm
sp^2	49.52	47.60
sp^3	39.72	42.43
sp^3 /sp^2 %	44.50	47.12