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DEPOSITION AND CHARACTERIZATION OF ULTRA THIN DIAMOND LIKE CARBON FILMS

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Abstract. Amorphous hydrogenated and/or nitrogenated carbon films, a-C:H/a-C:N, in overall thickness up to 2 nm are materials of choice as a mechanical and corrosion protection layer of the magnetic media in modern hard disk drive disks. In order to obtain high density and void-free films the sputtering technology has been replaced by different plasma and ion beam deposition techniques. Hydrocarbon gas precursors, like C_2H_2 or CH_4 with H_2 and N_2 as reactive gases are commonly used in Kaufman DC ion and RF plasma beam sources. Optimum incident energy of carbon ions, C^+, is up to 100 eV while the typical ion current densities during the film formation are in the mA/cm^2 range. Other carbon deposition techniques, like filtered cathodic arc, still suffer from co-deposition of fine nano-sized carbon clusters (nano dust) and their improvements are moving toward arc excitation in the kHz and MHz frequency range.

Non-destructive film analysis like μ-Raman optical spectroscopy, spectroscopic ellipsometry, FTIR and optical surface analysis are mainly used in the carbon film characterization. Due to extreme low film thicknesses the surface enhanced Raman spectroscopy (SERS) with pre-deposited layer of Au can reduce the signal collection time and minimize photon-induced damage during the spectra acquisition. Standard approach in the μ-Raman film evaluation is the measurement of the position (shift) and area of D and G-peaks under the deconvoluted overall carbon spectrum. Also, a slope of the carbon spectrum in the 1000-2000 cm^{-1} wavenumber range is used as a measure of the hydrogen intake within a film. Diamond like carbon (DLC) film should possess elasticity and self-healing properties during the occasional crash of the read-write head flying only couple of nanometers above the spinning film. Film corrosion protection capabilities are mostly evaluated by electrochemical tests, potentio-dynamic and linear polarization method and by business environmental method. Corrosion mechanism, seen as a build-up of cobalt compounds on the top of DLC film, can be minimized with higher carbon film density (above 2.2g/cm^3), void-free film formation and lower film surface nano-roughness. Also, the carbide forming flash layer of Cr or Ti, with typical thicknesses of 0.5 nm may precede the DLC film deposition. Plasma beam sources should be cleaned periodically in oxygen or hydrogen gas flow to prevent incorporation of carbon sooth particles and nano-dust into the film. DLC film susceptibility to cobalt migration from the magnetic layer can be estimated using different techniques: by counting the number of corrosion spots per disk surface area, measuring the amount of cobalt on the surface with inductively coupled plasma or Rutherford backscattering spectroscopy.