Deposition of Diamond-like Carbon Thin Films on Silicon and Silicon Nitride

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Diamond-like carbon (DLC) is a form of amorphous carbon (C) with excellent mechanical and tribological properties. It has superior mechanical properties similar to diamond due to the large percentage of sp^3 hybridized C.[1,2] However, silicon nitride (Si_3N_4) is a refractory material that has been extensively studied in both tribological and high-temperature applications because of its high hardness, high-temperature strength, and chemical inertness attributed to its dense and highly oriented covalent bonds.[3]

In this study, a process for depositing DLC films as an overcoat was developed using a custom-designed low-energy ion source system (Figure 1). In addition, a radio frequency (RF)-powered magnetron sputtering system was used to deposit SiN films.

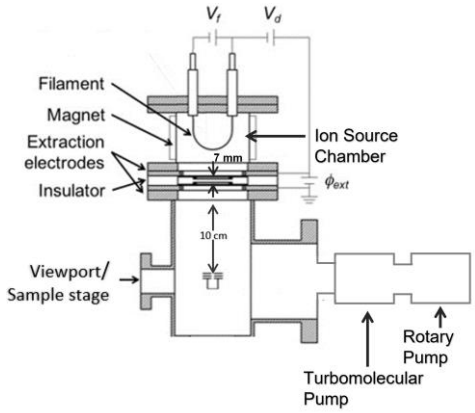

Figure 1. Schematic representation of the low-energy ion source system.

The films were deposited on silicon (Si) substrates and the effect of the deposition parameters such as the gas precursor ratio of argon (Ar): acetylene (C_2H_2) (50:50 and 70:30), and the deposition time (5, 10, and 15 min) for DLC was investigated.

Raman spectral analysis revealed the successful deposition of DLC thin films (Figure 2). It was also observed that increasing the working gas content from 50:50 to 70:30 Ar:C_2H_2 gas ratio increased the I_D/I_G ratio. Thus, between the two gas ratios, 70:30 Ar:C_2H_2 would be the better admixture for a better DLC thin film. XRD measurements confirmed the chemical identity and crystal phase of the PVD-grown Si_3N_4 (401) thin films which were deposited using a RF magnetron sputtering system.

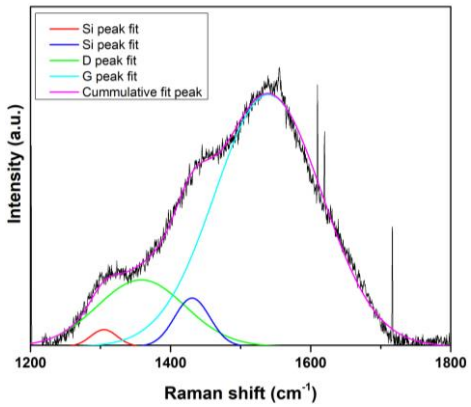

Figure 2. Raman spectrum deconvolution of DLC using visible light illumination (532 nm).

Atomic force microscopy characterizations of the DLC-on-Si_3N_4 bilayer showed very smooth surfaces with the root-mean-square roughness equal to 0.46 nm.

A low-energy ion beam deposited DLC with a 70:30 Ar:N_2 gas ratio on top of RF magnetron sputtered Si_3N_4 as a bilayer thin film offers the best balance of mechanical and tribological properties. Using the calculated deposition rates, we can control the overall thickness to produce the desired dimensions. Thus, DLC-Si_3N_4 bilayer thin film is a feasible overcoat for hard disk drive media.

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