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In-situ optical characterization of plasma deposited a-C:H films during deposition by CH4 plasmas and erosion by N2-H2 plasmas

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Abstract – Hard amorphous hydrogenated carbon (a-C:H) films have been intensively attracted attention since the beginning of the past decade due to their several technological applications in tool coatings, bearing surfaces, electronic and optical devices, tribological coatings and corrosion protection [1]. In this work we report the characterization of plasma-deposited a-C:H films, in-situ, by the near-normal incident single-wavelength laser reflectometry (He-Ne laser, 633 nm wavelength), during deposition by PECVD in methane atmospheres, and during film erosion by N_2-H_2 plasmas .

The a-C:H films were deposited onto Si single crystalline substrates, placed on the cooled cathode of a RF-PECVD system, with 50 mTorr deposition pressure and within a large self-bias range (100-1000 V), being submitted to N_2-H_2 plasma erosion immediately after deposition. The optical constants and film growth or erosion rate were obtained by least-square fitting the reflectance vs. time curves to the ambient-film-substrate model (Fig. 1); using the virtual interface method [2]. The refractive index n, the extinction coefficient k obtained during deposition were compared to that obtained during erosion, with very good agreement (Figs.2 and 3). It was found also that the standard error in the optical constants is much smaller than the process run-to-run variation using fixed deposition parameters. The last one is typically 1.4 % for the refractive index, 5% for the extinction coefficient and 9% for the growth rate. In addition we observed that the erosion rate in N_2-H_2 plasmas of the carbon films against deposition self-bias, follows a pattern very similar to the refractive index.

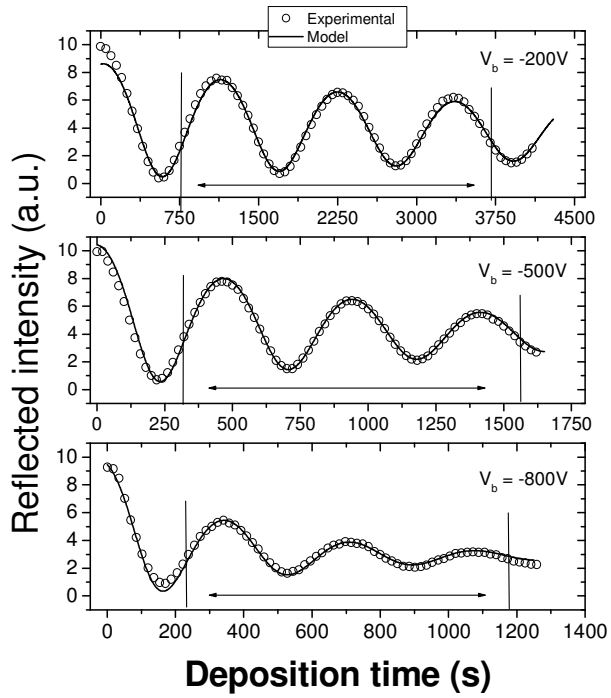

Figure 1: The evolution of the reflectance as a function of deposition time for some deposition parameters, together with the fitted model reflectance.

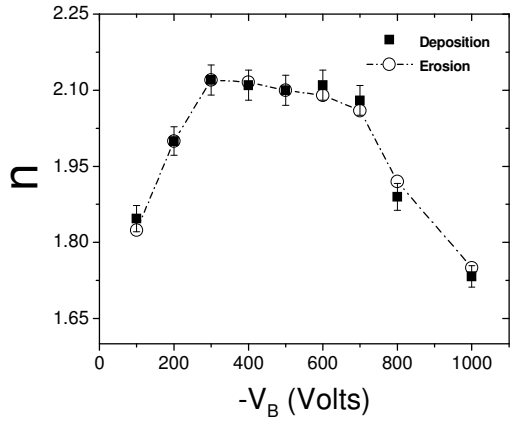

Figure 2: Variation of n as function of V_b comparing the deposition and erosion.

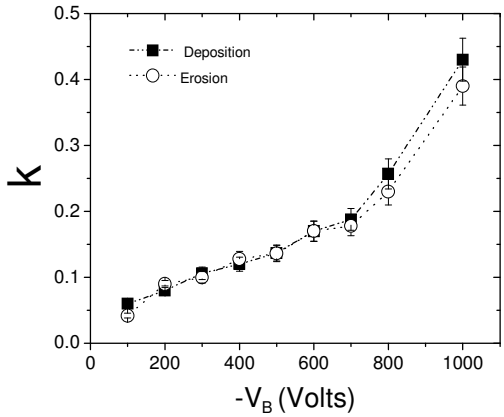

Figure 3: Variation of k as function of V_b comparing the deposition and erosion.

References:
[1] Robertson J,. Mater. Sci. Eng., R Rep. 37 (2002); 129
[2] Breiland W.G.,Killeen K.P., J. Appl. Phys. 78 (1995) ; 6726.