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Thickness dependent metal insulator transition in diamond-like-carbon films of different thickness SOMA MUKHERJEE, B.K. CHAUDHURI, Department of Solid State Physics, Indian Association for the Cultivation of Science, India, C.C. CHOU, H.D. YANG, Department of Physics, Center for Nanoscience and Nanotechnology, National Sun Yat-Sen University, Taiwan, H. SAKATA, M. WAKAKI, Department of Optical and Imaging Science & Technology, Tokai University, Japan — Transport properties of amorphous diamond-like-carbon (DLC) films of different thickness (90 and 600nm) prepared by plasma-beam ion-injection deposition (PBIID) method have been studied. The 90nm thick film (DLC1) shows metallic behavior above 200K and a metal- insulator transition occurs below this temperature. The metallic resistivity can be fitted with the relation $\rho = \rho'_0(\mathrm{sp}^2)\mathrm{T}^\beta$ (with $\beta \sim 1$). The much thicker film DLC2 (600nm thick) is, however, a semiconductor over the temperature range 80-300K showing large increase of resistivity below 150K. The scanning electron and micrographs and Raman spectroscopic studies show the presence of nanometer size diamond-like crystals embedded in the amorphous matrix. Comparatively larger number of such nanodiamonds and larger $\mathrm{sp}^3/\mathrm{sp}^2$ ratio observed from XPS study can be attributed to the higher resistivity ($\sim 10^{10}$ ohm cm) of DLC2 than that of DLC1($\sim 10^4$ ohm cm). Low temperature semiconducting behavior of the thinner film is explained by Mott variable range hopping (VRH) model while the resistivity of the thicker film is found to follows Mott small polaron hopping (SPH) model in the high temperature range. Thickness dependence of DLC film conductivity has also been discussed.

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