Abstract

Title: Synthesis of Nanostructured Carbon and Silicon Carbon Heterostructured Thin Films by Plasma Enhanced Chemical Vapour Deposition techniques for Energy based Applications.

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The primary aim of this study is to develop and optimize diamond-like carbon (DLC) films and doped DLC films enriched with nanodiamond components on cost-effective glass substrates without involving the conventional pre-treatment with diamond powders. The films are synthesized using CH_4 precursors diluted with Ar and H_2 in a high-density plasma environment at low pressure (~ 30-40 mTorr) and low power (250 W) and at a relatively low temperature (450 ℃). This unique approach of fabrication of DLC films is possible only by employing two types of plasma enhance chemical vapour deposition systems (PECVD): inductively coupled plasma CVD (ICP CVD) and capacitively coupled plasma CVD (CCP CVD). Operating at radio frequencies (13.56 MHz), both types of PECVDs enable the ignition and sustenance of high-density plasma at low pressures and low powers respectively by their own specialized techniques. Initially, an optimization of the flow rates of CH_4 was carried out with other parameters fixed at 900 W of RF power, 30 mTorr pressure and 450 ℃ substrate temperatures in order to obtain DLC films with good nanocrystalline phases and high optical band gap. Later, the effect of applying negative bias voltages to the substrate and its variation on the crystalline qualities was studied. The next work deals with the investigation on the consequences of boron dopant incorporation in intrinsic DLC thin film through an increased flow rate ratio of B_2H_6/CH_4 in ICP-CVD. The optimized B doped DLC films were found to possess sufficient electrical conductivity as compared to its intrinsic counterpart, while maintaining considerable nano-crystallinity. Later, an effort was made to improve the boron doping effect and subsequent electrical conductivity at room temperature without the addition of further dopant input, only by increasing the bias voltage application to the substrate. This technique was fruitful in not only improving the electrical conductivity, but also helped in enhancing the crystallinity sufficiently. The next work is based on the optimization of transparent and crystalline DLC films in CCP CVD at a low RF power of 250 W by the variation of pressure and flow rates of CH_4 and H_2. Further, its application as an antireflective coating on glass-based Si solar cells to enhance its efficiency has been demonstrated.

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