EFFECT OF SNO_2 OVERLAYER THICKNESS ON SURFACE MORPHOLOGY OF PRE-SCRATCHED DIAMOND THIN FILMS

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Abstract:

Artificial diamond achieved great interest from last few decades. This work describes the influence of SnO_2 overlayer thickness on nucleation and growth of diamond films on pre-scratched silicon substrates. The SnO_2 overlayer was deposited by spray pyrolysis technique and diamond was deposited by Hot Filament Chemical Vapour Deposition (HFCVD) technique. The samples were characterised by Scanning Electron Microscopy (SEM) and Raman spectroscopy.

Keywords*: CVD, SnO_2 overlayer, Raman, SEM*

Introduction:

Diamond could not be converted into other form of carbon easily therefore it is trend to say "Diamond is forever". Now a day's diamond is available naturally as well as a synthetic material that has opened non presidential applications of it and attracted by everyone. Natural diamond is rare and the brilliance of cut and polished gems have made it one of the most esteemed components of jewellery. Diamond possesses extreme properties over the other materials[1,2]. Now we can explore the use of diamond in different application due to enormous development in chemical vapour deposition (CVD) diamond [1,2].

The diamond crystal structure is a metastable phase, whereas the graphite crystal structure has a lower total energy. In diamond crystal structure, two interpenetrating face-centered-cubic (FCC) sublattices, in which each atom is bonded in a tetrahedral configuration to four nearest neighbour atoms of the opposite FCC sublattice. Due to development of CVD techniques diamond can be used in development of semiconducting materials with appropriate doping.

In CVD diamond deposition, nucleation and growth of the diamond is very important. To start the nucleation on silicon substrate the pre-treatment of scratching with diamond paste , intermediate layer formation etc are used. In present study the study of nucleation and growth of diamond thin films with different thickness of the SnO_2 over layer was studied. The samples were characterised by Scanning electron microscopy and Raman spectroscopy.

Experimental

The silicon was scratched by diamond paste. The pre-scratched silicon was coated with the SnO_2 overlayer with different thickness. The SnO_2 layer was deposited by using indigenously developed spray pyrolysis system[5]. Diamond was deposited by Hot Filament Chemical Vapour Deposition (HFCVD) technique[3,4]. Methane and hydrogen was used as source gas in HFCVD diamond deposition. The mixture of these gases were passed over the preheated filament at 2000^0C. Due to diffusion the carbon species were adsorb, chemisorb, desorb at the substrate and the diamond was deposited as an end product on the substrate.

The deposited films were characterised by scanning electron micrograph (SEM) and Raman spectroscopy.

Results and Discussion:

The effect of the SnO_2 overlayer thickness on the nucleation and growth of the diamond thin films were studied by using the substrate of pre-scratched silicon coated with SnO_2 layer having 0.16, 0.30 and 0.79 µm. Fig shows the SEM and Raman spectra of diamond thin films deposited on pre-scratched silicon substrate

with SnO_2 overlayer of thickness 0.16 and 0.79 µm. The figures of 0.30 µm were discussed some where [3]. SEM micrographs shows that continuous film was form for all thicknesses. The crystallinity of diamond is discernible in all the samples, moreover high quality film was deposited with 0.30 µm thick overlayer of SnO_2. Diamond thin film with 0.79 µm thick overlayer has not well faceted crystallites and crystal facets are looked like the collection of nano-crystallites, the detailed study is required. The surface morphology up to 0.30 µm shows that, the average size (~0.5-0.7 µm) of diamond crystallites was observed. Further increase of the thickness of the overlayer to 0.79 µm the average size increases and found to be 1.5 µm.

The Raman spectra shows the characteristic peak of diamond at ~1332 cm^{-1}. This peak was observed in all the cases. For all films a hump at ~1550 cm^{-1} is evident of coexistence of nondiamond carbon with diamond in the films.

Conclusion:

A combined pre-treatment of scratching with diamond paste and SnO_2 overlayer forms uniform and smooth high quality diamond film as analysed by SEM and Raman spectra. Hence overlayer of SnO_2 offers a possible way to enhance the nucleation density and quality of diamond thin films.

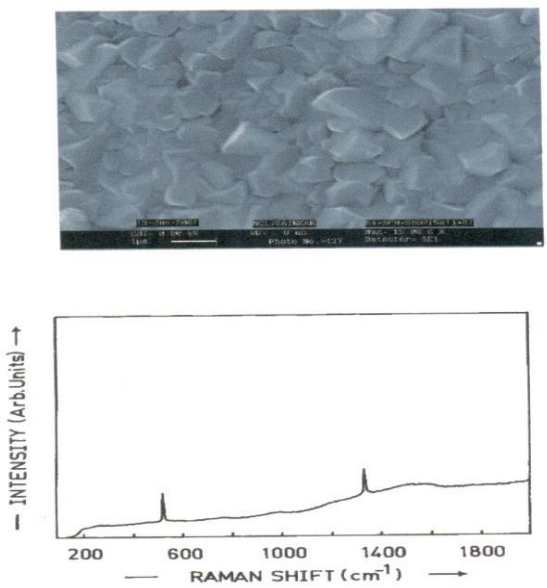

Fig. 1 SEM and Raman Spectra of diamond thin films deposited on pre-scratched Si substrate with SnO_2 overlayer of thickness 0.16 µm

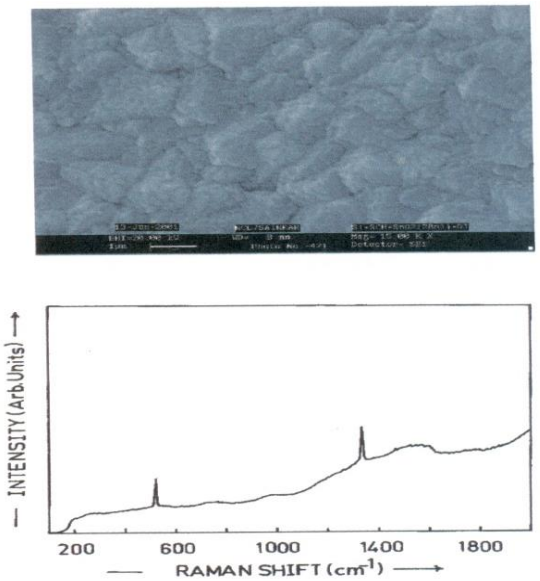

Fig. 2 SEM and Raman Spectra of diamond thin films deposited on pre-scratched Si substrate with SnO_2 overlayer of

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