ANALYSIS OF BORON DOPED DIAMOND FILMS BY ANGLE RESOLVED X-RAY PHOTOELECTRON SPECTROSCOPY

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1. Introduction

The boron doped diamond (BDD) has been extensively reported as an excellent material to be applied as electrode in electrochemical study due to its outstanding features such as: the wide potential window in aqueous solutions and the weak adsorption for most types of molecules [1, 2]. Diamond films with different CH_4 concentrations (1, 3,5 e 7%) were grown on silicon substrates in a hot filament chemical vapor deposition reactor. Morphological, structural and surface studies were conducted to aim the understanding about the film properties. The morphological and structural characterizations of these materials were made by Scanning Electron Microscopy and by Raman Scattering Spectroscopy techniques. The surface chemical state information was conducted by XPS measurements. Angle-resolved XPS (ARXPS), was used to detect electrons from different depths. ARXPS is a technique that varies the emission angle at which the electrons are collected, thereby enabling electron detection from different depths, besides the intensity of each chemical state component was recorded as a function of the polar (azimuth) angle for several azimuth (polar) angles. The sample (polar or azimuth) rotations were performed using step-by-step motors.

2. Experimental

The films were grown by hot filament-assisted chemical vapor deposition (HFCVD) technique with the following growth parameters: 780^{o}C, using 6 filaments of 123 µm diameter, 50 Torr, 14 h and gas mixture 100% of CH_4/H_2 with different CH_4 concentrations [3]**.** The reactor has a substrate rotation mechanism that improved the film uniformity. The films were deposited on the silicon substrate after seeding pre-treatment. Boron source was obtained by an additional hydrogen line passing through a bubbler containing B_2O_3 dissolved in methanol. The doping level corresponds to the acceptor densities of around 10^{21} atoms cm^{-3} estimated from Raman's measurements.). Prior to XPS analysis successive attacks with Argon ion beams were carried out on the sample surface.

3. Results and Discussions

Images obtained by scanning electron microscopy showed continuous microcrystalline and homogeneous films with grain oriented randomly; by increasing the CH4 concentration the grains start to form agglomerates, reducing the formation of well faceted crystals, this feature has become more apparent in films with a greater concentration of boron. Raman scattering spectroscopy confirmed growth of diamond with the characteristic peak located at 1332 cm^{-1} and the doping of film with the appearance of bands at 1220 and 500 cm^{-1}, as well the presence of graphite due to G-band located at 1580 cm^{-1} [1,2]. High resolution x-Ray diffraction was used in grazing mode at three different angles (1, 5 and 30°) to investigate the diamond phases according to the depth of the film examined, it was found one predominant phase (111) of the diamond, and a reduction of substrate phase for higher concentration of CH4. The samples were also analyzed by X-ray photoelectron spectroscopy (XPS). The results show that as the etching time increases, the peak of the boron becomes more intense, being these more evident in the samples with a higher concentration of CH4. ARXPS in combination with azimuth angle showed a strong indication that the boron is located in the deepest diamond phases. Further analysis will be done to confirm these observations and to investigate its relationship with the conductivity of the films.

4. References

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