Influence of methane concentration on the structure and morphology of CVD Single Crystal Diamond

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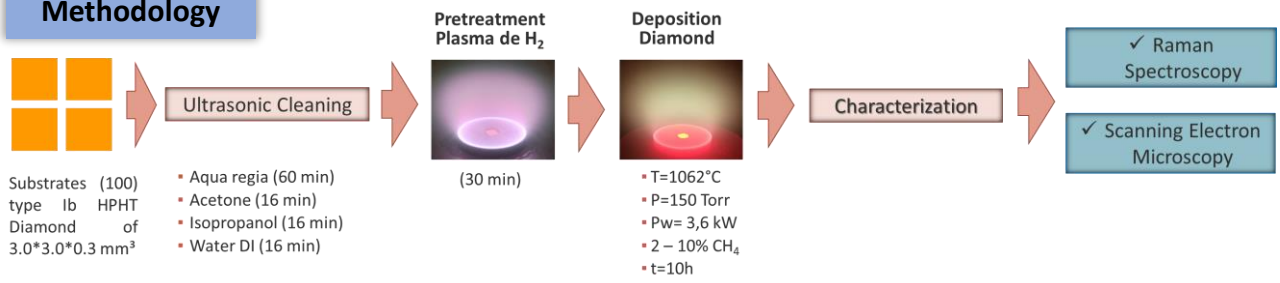
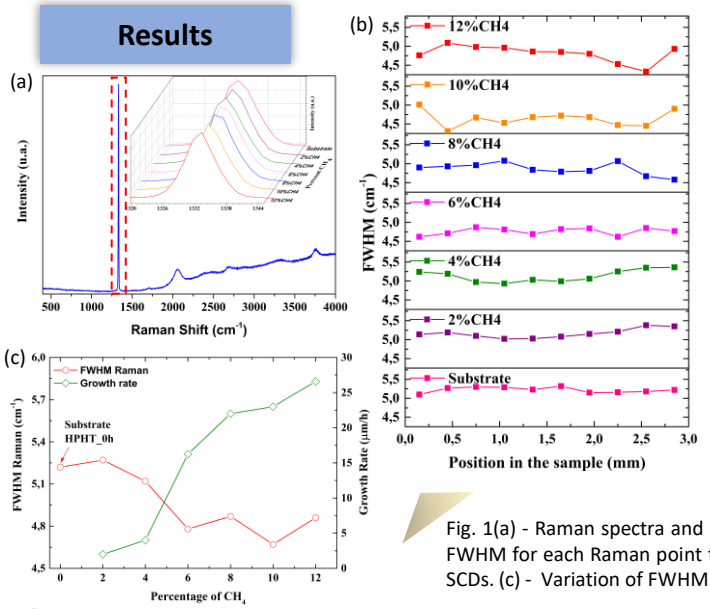
Introduction

In high-demand areas such as microelectronics, broad-spectrum transmission optics and beta-batteries, Single Crystal Diamond (SCD) is the most promising, because it has a wider band compared to other optical materials. Thus, motivating scientists to study optically active defects, three-dimensional defects (such as stacking faults and dislocations) and inherent defects of the cultivation method via CVD, such as: unepitaxial crystals (UCs), hillocks with flat top (FHs) and pyramidal hillocks (PHs). In order to study these defects, new deposition parameters are evaluated via the MWPACVD deposition technique as a function of CH_4 concentration from 2 to 12%, via Raman Spectroscopy and Scanning Electron Microscopy, indicating the presence or absence of Ucs, FHs and PHs as well as movie stress.

Methodology



Results



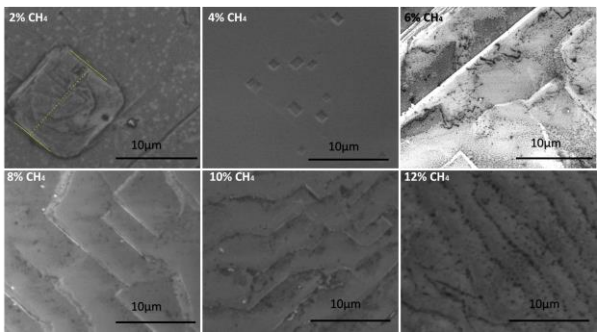


Fig. 2 – SEM micrographs of SCD surface grown at different CH_4 concentrations. As the percentage of CH_4 increased, there was a decrease in the appearance of UC, FHs and PHs

Fig. 1(a) - Raman spectra and 3D image of peak magnification at 1332 cm-1. (b) - Evolution of the FWHM for each Raman point taken from the edge to the other end of the sample for all analyzed SCDs. (c) - Variation of FWHM Raman and growth rate as a function of CH_4 concentration.

Conclusion

The concentration of CH_4 influences the morphology and quality of the film, therefore, the results indicated an excellent purity and morphology for SCD cultivated with 10% CH_4. A predominant central region of low stress, a FWHM in the range of 5.01 to 4.31 cm^{-1}, was achieved without compromising the growth rate.

A window for deeper study at the crystalline and structural level with 3D imaging of monocrystalline diamond films and substrates was opened for a more complete evaluation of defects such as: stacking failuresstacking faults and dislocations Highly influential on the optical properties of diamond, as well as the optical centers caused by the incorporation of nitrogen into the film.

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