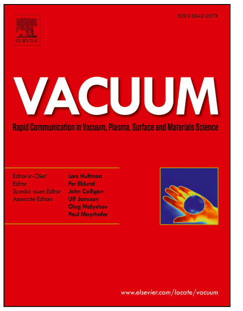
Accepted Manuscript



Homo-epitaxial growth of single crystal diamond in the purified environment by active O atoms

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PII: S0042-207X(18)30049-6

DOI: 10.1016/j.vacuum.2018.06.016

Reference: VAC 8036

To appear in: *Vacuum*

Received Date: 9 January 2018

Revised Date: 30 April 2018

Accepted Date: 5 June 2018

Please cite this article as: Liu J, Lin L, Zhao Y, Zheng Y, An K, Wei J, Chen L, Hei L, Wang J, Feng Z, Li C, Homo-epitaxial growth of single crystal diamond in the purified environment by active O atoms, *Vacuum* (2018), doi: 10.1016/j.vacuum.2018.06.016.

Homo-epitaxial growth of single crystal diamond in the purified environment by active O atoms

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Abstract:
The pure oxygen was introduced into the growth environment of the single crystal diamond with different contents, and the growth characteristics of single crystal diamond and the reaction dynamics in the plasma were studied in detail. As the ratio of O_2 to H_2 is up to 1.5%, the unique shaped etching pits with eight symmetric crystallographic planes appear. Optical emission spectra present typical characteristic radicals in the O_2 incorporated growth environment. With amount of O_2 increases, the growth rate decreases gradually due to the low active carbon source concentration and electron temperature. In the carbon contained hydrogen plasma, O_2 will react with CH radicals preferentially at low concentration and the dynamic equilibrium of CH and C_2 radicals was achieved at the O_2 concentration of 0.5% and 1%. Accompanying with the O_2 addition, the nitrogen and silicon related impurities have been reduced during the epitaxial growth process. Meanwhile, all of the FWHM of characteristic peaks in Raman decrease obviously after the epitaxial growth without and with O_2 addition, and FWHM of most samples are about 2.6cm^{-1}, which are comparable with the natural type IIa SCD without stress.

Key word: Diamond; Single crystal growth; OES; Purification; Epitaxial growth.
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1. Introduction

Diamond has been widely researched due to its excellent mechanical, optical, thermal and electrical properties such as the highest hardness, highest thermal conductivity, almost all-band transmission, the highest carrier mobility and so on[1-3]. Based on the the properties, high quality diamond has been widely applied in the cutting tools[4], heat sinks[5], high-power windows[6]and electronic devices[7-8], especially the jewelries[9].

In recent years, the single crystal diamond (SCD) preparation technique based on chemical vapor deposition (CVD) has achieved dramatical progress. First of all, the size of single crystal diamond was enlarged by homo-epitaxial and hetero-epitaxial growth. One promising technology to obtain large size wafer is the mosaic fabrication method based on homo epitaxy[10–11]. The maximum size present is 4 ×6 cm^2, reported by AIST[11]. However, there is an obvious boundary between the mosaic plates of SCD. Meanwhile, researchers also seek out the hetero-epitaxial growth based on the metal oxide and Ir. Until now larger than 10mm×10mm SCD has been obtained by using $SrTiO_3$[12] or YSZ [13]as the buffer layer to reduce the interface stress. A drawback of hetero-epitaxial growth is the high dislocation density. Secondly, the dislocation density of the epitaxial diamond has been improved by using a low dislocation density crystal as the seed. After growth, the dislocation density of the epitaxial layer was 400 cm^{-2}[14]. Thirdly, the high growth rate was achieved by adjusting the growth parameters and adding a small amount of N_2. The growth rate of up to 165um/h was obtained for the single crystal diamond up to 18 mm in thickness at high power density[15].

Until now, to achieve high pure single crystal diamond deposition with limited impurities is another topic. Generally the background concentration of nitrogen and silicon is hard to be