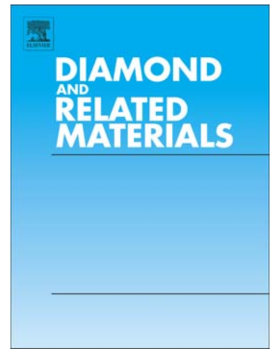

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The Influence of Recess Depth and Crystallographic Orientation of Seed Sides on Homoepitaxial Growth of CVD Single Crystal Diamonds

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Abstract Microwave plasma chemical vapor deposition (MPCVD) has gained increasing attention as a feasible and effective way to produce large, high-quality, single-crystal diamonds. However, the growth of polycrystalline diamond on the periphery of the seed crystal and the cracking generated by the internal stress during the growing process lead to significant decline of the quality and integrity of the CVD diamond, thus increasing the difficulty of synthesizing large diamond layers. Although optimized growth parameters and refined substrate holders have been employed by some researchers to improve the periphery quality of CVD diamond layers, more research needs to be done in this area. In this study, we used a specially designed substrate holder with a circular recess, in which the seed crystal was placed. By designing substrate holders with different recess depths and a seed crystal with different side-surface crystallographic orientations, we aimed to determine the influence of the recess depths and the crystallographic orientation of seed sides on the growth quality according to polarizing microscope, laser Raman spectroscopy, UV fluorescence imaging, and photoluminescence (PL) mapping measurements. The results demonstrate that as the recess depth increases, the amount of polycrystalline diamonds and the internal stress on the periphery are controlled effectively. The crystalline quality is improved, and the growth rate is decreased. In addition, compared to the periphery with {100} seed sides, the periphery with {110} seed sides displays better crystalline quality, lower internal stress, and fewer polycrystalline diamonds after growth, which is probably due to the intrinsic nature of the growth steps propagating on the {100} diamond surface and the effect of nitrogen atoms on the growing process in the diamond lattice.

Keywords: Microwave plasma CVD; Single crystal diamond; Substrate holder; Crystallographic orientation; Growth quality

1. Introduction

Single crystal diamond is a promising material for future industrial products because of its outstanding properties such as an unrivaled thermal conductivity (>2000 W $cm^{-2}K^{-1}$), a high carrier mobility, a high breakdown voltage, and a large bandgap (5.5eV), together with exceptional hardness and resistance to harsh environments. Also, it is quite popular as an attractive gem stone because of its excellent optical properties such as the eye-catching sparkle and fancy coloration

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