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Estimation of Optical Emission Spectroscopy on synthesizing B-doped Diamond using Mode Conversion Type Microwave Plasma CVD

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Abstract

In this paper, we investigate the influence of plasma state on volume resistivity of B-doped diamond (BDD). It is difficult to prepare BDD of required volume resistivity. Various researches have been studied on the control of the resistance value of BDD. Thus, systematic research on the relationship between volume resistivity and B in plasma is necessary. Therefore, plasma during growth is measured by Optical Emission Spectroscopy (OES) and make clear relationship between emission species and resistance value. OES, peaks of B (249.7 nm), BH (433.1 nm), BO(436.3 nm), H_α, H_β, CH and C_2 were observed for each condition. Electrical resistivity measurements by the four-point probe method, minimum volume resistivity of 0.17 Ω·cm was obtained. With increasing B containing emission species such as B and BH peaks in OES spectra, volume resistivity is decreased. It suggested that B system emission species in OES spectra influences volume resistivity of BDD.

Keywords: CVD, B-doped diamond, OES, volume resistivity, microwave

1. Introduction

B-doped diamond (BDD) is diamond imparted with conductivity in addition to having excellent properties of diamond. There are few examples of practical applications compared to general diamond. This is due to the fact that there are many points that are not clarified concerning the control of parameters of BDD. In particular, various researches have been done on the control of the resistance value of BDD, and both have tried to control the resistance value, but there are large variations [1]. For BDD synthesis, synthesis is carried out using a gas B source that is highly toxic and flammable, such as B_2H_6 [2,3] and $B(CH_3)_3$ [4,5], but the gas B source needs security systems.

On the other hand, liquid B sources, in which B_2O_3 [6] and H_3BO_3 are dissolved in pure water and alcohol solution as B sources [7], are relatively safe and no need security systems. At the time of synthesis, it is possible to synthesize BDD by using bubbling tank as a carrier gas. In this study, we measured of plasma using OES (Optical Emission Spectroscopy) during synthesis and investigated on the relationship with volume resistivity.

2. Experimental method

Boron-doped diamond films were synthesized using the mode-conversion type microwave plasma Chemical Vapor Deposition (CVD) apparatus [8]. Si (P-type, 8-12 Ω·cm) substrate was scratched by diamond powder and then cleaned ultrasonically in acetone solution. During synthesis, plasma states were estimated using optical emission spectroscopy (OES) (US2000+UV-VIS/Ocean Optics). The surface of the deposits was observed by Scaning Electron Microscope (SEM) (TOPCON/SM-300). Qualities of the deposits were estimated by