

## Resonant Raman scattering studies of boron doped diamond

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### ABSTRACT

The light scattering properties of boron doped diamond film have been investigated by Raman spectroscopy using ultraviolet (325 and 244 nm) and visible (514 nm) excitations. The relative intensity of electronic Raman scattering to Phonon scattering decreases with the increase of the excitation energies, while the Fano-type interference between discrete phonon scattering and continuum electronic scattering becomes weak and phonon scattering peak shifts to higher Raman shift. The result indicates that boron induced phonon “softening” in diamond is smaller than that estimated based on the visible Raman spectra.

### INTRODUCTION

Boron is an effective p-type dopant in diamond. The properties of boron doped diamond have been studied for a long time. In heavily doped diamond films, a Fano-type quantum mechanical interference between the zone-center Raman-active optical phonon and a continuum of electronic Raman scattering was observed. Examining the sample using different excitation energies is a very powerful method for studying this type of phenomenon. It is interesting to study this phenomenon of heavily boron doped diamond by ultraviolet excitation. We report the results of Raman scattering on heavily boron doped diamond using ultraviolet (325 and 244 nm) and visible (514 nm) excitations.

### RESULTS

Figure 1 shows the Raman spectra acquired from (111) oriented heavily boron doped homoepitaxial diamond layers. Figures 1(a), 1(b) and 1(c) were excited by 514, 325 and 244 nm lasers, respectively. The two broad bands located at about 500 and 1200  $\text{cm}^{-1}$  on the visible Raman spectrum cannot be detected when it is excited by the UV lasers. The relative intensity of electronic Raman scattering to Phonon scattering decreases with the increase of the excitation energies, while the Fano-type interference between discrete phonon scattering and continuum electronic scattering becomes weak and phonon scattering peak shifts to higher Raman shift. According to the work of Ushizawa et al. [1], for the sample with the phonon scattering peak maximum  $\omega_m$  located at 1318  $\text{cm}^{-1}$  excited by 514 nm photons, the boron concentration is  $2.1 \times 10^{20} \text{ cm}^{-3}$  and the phonon frequency of boron doped diamond  $\omega$  is 1324  $\text{cm}^{-1}$ ; for our samples, the  $\omega_m$  is located at 1315  $\text{cm}^{-1}$  (excited by 514 nm photon), the estimated boron density of our sample should be higher than  $2.1 \times 10^{20} \text{ cm}^{-3}$ , however the value of  $\omega$  estimated here based on the UV Raman spectra is higher than the value of  $\omega$  estimated here based on the UV Raman spectra is higher than the value deduced from the spectra excited by the visible laser. This result means that the boron induced phonon “softening” is not so large as estimated before. The two often-observed

low frequency bands disappear when excited by UV lasers, this off-resonance behavior indicates that the bands are originated from carbon phases other than diamond and defects are introduced at high boron concentration.

### CONCLUSION

This work shows that UV Raman scattering is a powerful tool to determine the uniformity and concentration of boron doped diamond films.

### REFERENCE

[1] K. Ushizawa, M. Nishitani-Gamo, K. Watanabe, I. Sakaguchi, Y. Sato, and T. Ando, *J. Raman Spectrosc.* 30, 957 (1999).

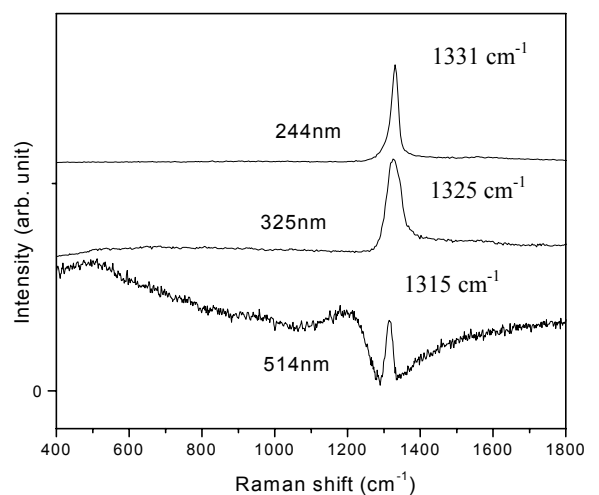


Figure 1: Raman spectra of the heavily boron doped diamond films excited by three different wavelengths.