Deposition of diamond-like carbon film using high power impulse magnetron sputtering

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Hydrogen-free diamond-like carbon film was deposited by using high power impulse magnetron sputtering in order to reduce the friction coefficient. The pressure dependence on the film structure was evaluated by using Raman spectroscopy.

1. Introduction

Diamond-Like Carbon (DLC) film has excellent material properties such as chemical stability, high hardness, low friction, and so on. In the tribology field, the DLC films are expected to be applied to sliding parts of cars due to its excellent features. The hydrogen-free DLC film can also realize the reduction of the friction coefficient [1]. A high power impulse magnetron sputtering (HiPIMS), which is applying a high voltage in a short time to the target due to promote an ionization of the target particles, realizes a smooth surface, good adhesion and a very dense film.[2] In this study, hydrogen-free DLC films was deposited using HiPIMS.

2. Experimental

The pulsed voltage of from 600 to 670V was applied to the target with the pulse duration of 50 μs and frequency of 500 Hz. Pure carbon target was used. The distance between the target and substrates were 50 mm. The gas flow rate of Ar was 100sccm and the pressure was change to be from 0.3 Pa to 3 Pa. Negative bias voltage of 100 V was applied to the substrate holder. Deposition time was 1 hour.

3. Results

Fig.1 shows Raman spectra of DLC film with various pressures. Raman spectra of DLC film was composed of two peaks of D(disorder) band at 1350 cm^{-1} and G(graphite) band at 1590 cm^{-1}. G band represents the graphite structure and D band represents the defect lattice. Raman spectra show the typical DLC film in the range of 0.3 to 1 Pa. However, graphite film was observed at 3 Pa. Fig.2 shows the intensity ratio of the D and G band (I_D/I_G) of Raman spectra as a function of pressure. I_D/I_G was estimated from the deconvolution of Raman spectra and represents relative sp2/sp3 composition ratio. I_D/I_G decreased with decreasing pressure up to 0.5Pa and then increased below 0.5 Pa. This result indicates that the sp3 structure in films increased with decreasing pressure due to ion bombardment. At below 0.5 Pa, however, the film was damaged by the large ion energy.

References

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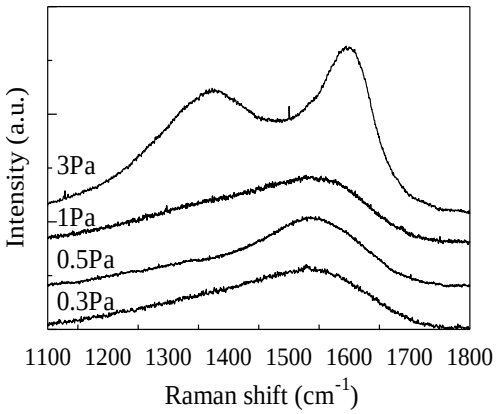

Fig. 1. Raman spectra with various pressures.

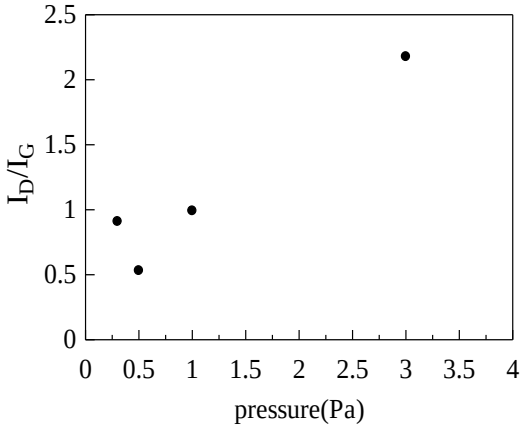

Fig. 2. I_D/I_G as a function of pressure .