Oxidation process of amorphous carbon film due to oxygen plasma, investigated with infrared spectroscopy

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Abstract

An oxidation process of the amorphous carbon film has been investigated with infrared absorption spectroscopy in internal reflection geometry (MIR-IRAS). The film was exposed to oxygen plasma, following to the film deposition. The results suggest that O atoms inserted into C-H bonds in the film when the film was exposed to oxygen plasma.

Introduction

An amorphous carbon film has a lot of useful properties: chemical inertness, mechanical hardness, smooth surface, and bio-compatibility. The film can be deposited at low temperatures using plasma enhanced chemical vapor deposition (PECVD) process. Then, the films have been used in industry. Moreover, the addition of other kinds of atoms induces the different film property. The film shows hydrophilic property if the oxygen atoms were inserted into the film; as a result, the films show hydrophilic property. Oxidation of amorphous carbon films is one of the effective oxidation method. Although there were not many reports on oxidation of amorphous carbon, Yates et al. investigated oxidation process of the KBB-type amorphous carbon film due to ozone [1]. However, the detailed oxidation process of amorphous carbon film was insufficiently understood. Then, we investigate the qualitative oxidation process of amorphous carbon films in oxygen plasma to understand the oxidation process. We employed “in-situ” “real-time” infrared absorption spectroscopy in multiple internal reflection geometry (MIR-IRAS) in this study.

Experiments

The PECVD chamber was equipped with an MIR-IRAS monitoring system. The oxygen plasma was generated by RF power of 10W in 50 mTorr. To investigate the

oxygen radical effects, the substrate bias was not applied; on the other hand, to investigate the oxygen ion effects, the substrate bias was applied. We collected the IRAS spectra. All spectra were recorded at 4 cm^{-1} resolutions.

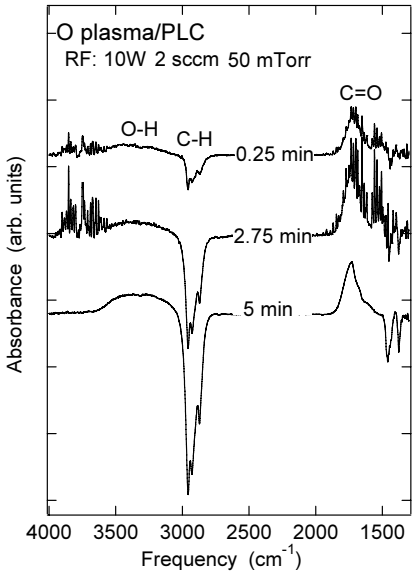

Fig. 1. IRAS spectra of oxidation process of an amorphous carbon film

Results and Discussions

Figure 1 shows the infrared spectra of the oxidation process of the amorphous carbon film due to the oxygen radical exposure. Theses spectra also acquired using the spectrum of the as-deposited carbon film as the reference spectrum. Thereby, the changed portions due to oxidation can be detected. The infrared spectra showed the decreases of intensity of the C-H peaks located between 2800 and 3000 cm^{-1}, with the longer exposure to oxygen plasma; on the other hand, the infrared spectra showed the increases of intensity of the broad O-H peak located between 3000 and 3400 cm^{-1}. It suggests that O atoms would insert into C-H bonds, to form O-H bonds.

Conclusions

We observed the oxidation process of the amorphous carbon films, using infrared spectroscopy in multiple internal refection geometry (MIR-IRAS). The data indicate the oxygen atoms would insert into the C-H bonds to form O-H bonds during Oxygen plasma.

Acknowledgments

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