

Source Molecular Effect on Amorphous Carbon Film Deposition

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Abstract

We investigated deposition process of amorphous carbon films using acetylene and methane as a source molecule, by using infrared spectroscopy in multiple internal reflection geometry (MIR-IRAS). We found that deposited film structures were different due to source molecules.

Keywords:

Acetylene, Methane, Plasma, Amorphous carbon film, Deposition process, Infrared spectroscopy

Introduction

An amorphous carbon film is used in many fields because it has various useful characteristics. The films were often deposited by using acetylene (C_2H_2) as a source gas as well as by using methane. We think the film structures have a relation with the structure of source molecule. Then, we investigate the difference of deposition process of the films due to source molecules: acetylene (C_2H_2) and methane (CH_4). We used “in-situ” and “real-time” infrared spectroscopy in multiple internal reflection geometry (MIR-IRAS).

Experiments

Figure 1 shows the experimental setup used in this study. Source gases,

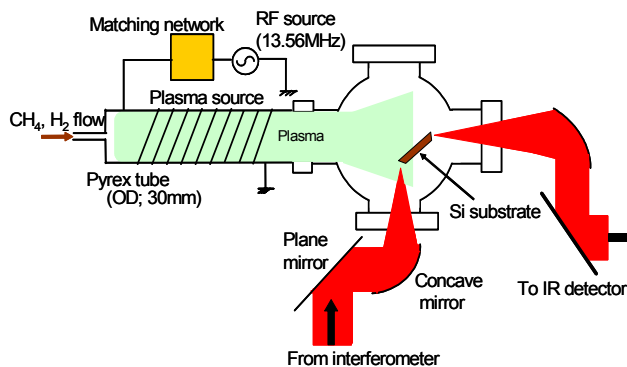


Fig 1. Experimental setup

such as C_2H_2 or CH_4 , were introduced from the glass tube into the vacuum chamber. Plasma excitation was accomplished by RF power (13.56 MHz) to the coil wrapped around the glass tube via the matching box. Si substrate (10×40 mm) that grinds the short edges to 45 degrees is mounted as shown in the figure. The infrared light traveled into the Si sample with internal multiple reflections. This MIR-IRAS has high sensitivity to the surface reaction even during plasma.

Results and Discussions

When CH_4 was used as a source gas, we observed the large peaks due to the sp^3-CH_x ($x=1 \sim 3$) species and the small peaks due to the sp^2-C species. On the other hand, when C_2H_2 was used, we observed the large peaks due to the $sp-CH$ species, the $sp-C$ species, the sp^2-C species, and the sp^3-CH_x species, in addition to the peak due to the sp^3-CH_x species.

These results indicated that the sp - species is easily formed when C_2H_2 was used. We considered that a CH_4 molecule is composed of sp^3-CH bond in itself; on the other hand, a C_2H_2 molecule contains an sp -bond in itself. This difference leads to the film structures. It means that the decomposition of source molecules during plasma is also different.

Conclusions

Deposition process of amorphous carbon films using acetylene and methane as a source molecule was investigated by using infrared spectroscopy in multiple internal reflection geometry (MIR-IRAS). Films deposited using acetylene contained a lot of the sp -species such as the $sp-C$, $sp-CH$ species. On the other hand, films deposited using methane contained a lot of sp^3-CH_x species and less the sp -species.

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