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Hydrophilic hydrocarbon film deposited with one-step process

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An amorphous carbon film has a lot of useful properties, and then the film is used in a lot of fields. To obtain a useful property, the deposition process should be controlled. In these days, medical application is one of promising applications. Nakatani, *et al.*(1) showed hydrophilic amorphous carbon film is useful for stent-coating. The film was formed by oxygen plasma exposure after the film deposition with acetylene plasma. This is two step processes: the first step is deposition of film and the second step is surface treatment. *i.e.* oxidation treatment. A chamber gets dirty, after deposition with hydrocarbon plasma. Then, while oxygen plasma is generated after film deposition, hydrocarbon species is also generated. Oxygen plasma exposure process is hard to be controlled. One step is desirable: the hydrophilic amorphous carbon film is deposited without surface treatment. If one step process is realized, the process control would be easy.

This study showed the first trial of deposition of hydrophilic amorphous carbon film with one step process. In this study diisopropylether ($(i\text{-}C_3H_7)_2O$) is used as a source molecule. Ether has C-O-C structure, so that oxygen can be fed into the deposited film simultaneously during film deposition. We have tired many molecules for amorphous carbon film deposition, because we want to know how the bonding configurations of source molecules change into that of the deposited film. In this study, a molecule with high molecular weight was chosen. In these days, molecules with high molecular weight have been attracted because of low damage due to bombardment of the molecule(2).

The hydrophilic property was judged from the contact angles of the film to ultra pure water. The angle was measured after the film deposition. It is important to try a lot of experiments with a lot of source molecules to optimize hydrophilic property of the deposited film. It is also important to know how the film is bonded to oxygen during deposition, because the oxidation of film leads to the hydrophilic property.

Thereby, to clarify the deposition of hydrophilic amorphous carbon film, changes in chemical states of the film were measured with in-situ and real-time MIR-IRAS (multiple-internal-reflection Infrared absorption spectroscopy). In MIR-IRAS method, IR, entered into Si prism, reflected the prism surface at many times from the inside of the prism. IR light can detect the deposited film on the prism, because IR light propagates from the prism surface as evanescent wave. IR can detect surface reaction during plasma because IR light is not disturbed with plasma. The Si prism was set in PECVD chamber, in this study. Thereby, MIR-IRAS method has high detection sensitivity and can be used during plasma. The results would give us variable information about choice of source molecules.

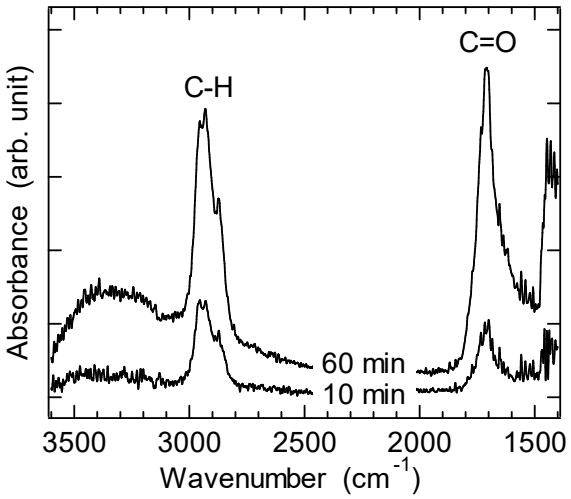

Fig. 1 IR absorption spectra of the deposition process

The source molecule was fed into the PECVD chamber with 1 sccm, to maintain the pressure at 50 mTorr. The source molecules, diisopropylether can evaporate in vacuum without carrier gas, because the molecules has relatively high vapor pressure. Plasma was generated by RF (13.56 MHz) power of 30W. The IR absorption spectra were acquired during plasma exposure. The deposition process was considered from changes in the IR spectra. The contact angle was also measured after the film deposition. The contact angel of the film is much smaller than methane plasma deposited film, indicating that film was oxidized.

Fig. 1 shows the IR absorption spectra of Si prism exposed to the plasma. Peaks are observed around 2900 cm^{-1} and around 1700 cm^{-1}. The former peak is attributed to the sp^3-CH_X components and the latter peak is to the C=O components. Intensity of the former peak is larger at 10-min exposure than that of the latter peak, while that of the former peak is smaller at 60-min exposure than that of the latter peak. Of course, the amount of the component cannot be compared from the different peak intensity, because the vibration strength is different between sp^3-CH_X components and C=O components. However, the results suggested that hydrocarbon and oxidizing agent are separately fed into the prism; if the oxidizing hydrocarbon components are linked, the ratio of peak intensities is the same during the exposure. We discuss the deposition process with oxidation of the film in the presentation.

References

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