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Analysis of Atmospheric Pressure Plasma Reaction Process
大気圧プラズマの反応プロセスの解析

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It has been investigated that the reaction processes of atmospheric pressure plasma on the surface of the Si substrate, with the infrared spectroscopy in multiple internal reflection geometry (MIR-IRAS). The infrared spectra indicated that the quantity of OH-group on the surface of Si substrate was increased with the plasma exposure.

1. Introduction

The atmospheric pressure plasma has advantages that the plasma can be generated without vacuum system at low costs. The atmospheric pressure plasma is used in various fields such as medical field, environment field and so on. This is because the atmospheric pressure plasma has abilities of the antiseptic effect, the surface reformation and etc…However, it has not been understood that what has happened in process of the reaction. In order to extend application of the atmospheric pressure plasma, an understanding of the mechanism of the reaction is required.

2. Experiment

Figure 1 is the image of experimental set up used in this study. This set up contains Dielectric Barrier Discharge type atmospheric plasma source .The atmospheric plasma was generated in the air, using 10kHz high voltage power source.

Changes in the chemical states during the plasma exposure were monitored with infrared spectroscopy in multiple internal reflection geometry (MIR-IRAS).

Si prisms for MIR-IRAS were used as the substrate of this study. The substrate was set downward the electrode of DBD.

The Si prisms were made of n-type Si (100) wafers. The prisms had a dimension of 0.5×10×40mm, with mirror-polished 45° bevels on each of the short edges. The prism was treated with conventional RCA cleaning to remove surface contamination.

In order to investigate the plasma exposure process due to the surface condition, the two types of surface conditions were prepared. One is the chemical oxide covered surface, produced in boiled H_2SO_4/H_2O_2 solution. The other is hydrogen terminated surface lined with HF solution.

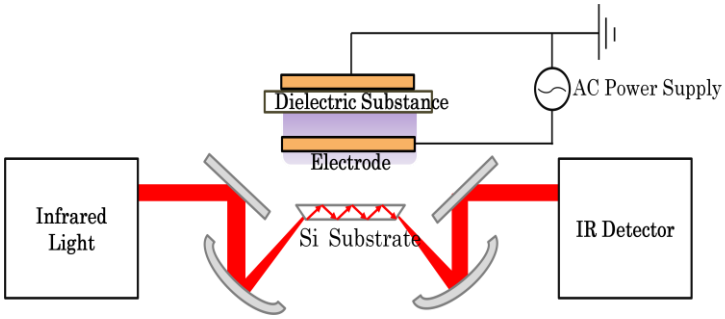

Fig.1 Experimental equipment

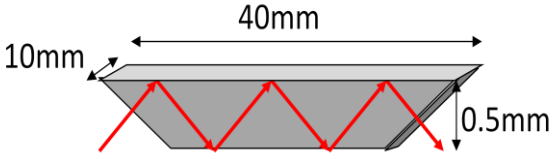

Fig.2 Dimension of Si substrate

3. Result and Discussions

Figure 3 shows the infrared spectra of the chemical oxide covered Si substrate, exposed to the atomspheric plasma at different exposure times. The infrared spectra have broad peak located between 3000 and 3600cm^{-1}. This peak is assigned to O-H stretching mode. The results showed that the amount of OH-group on the substrate surface was increased with the plasma exposure time.

Figure 4 shows the infrared spectra of the HF-treated Si substrate, exposed to the atomspheric plasma at different exposure times. In this graph OH peak was also observed, but the intenstiy was weak, compared with the oxide-covered surface. The adsorption of OH species generated in the atmospheric plasma was seppressed on the HF-treated Si surface. which indicates hydrophobic property.

Thereby, it is suggested that H_2O was generated in DBD-type atmopheric plasma in the air.

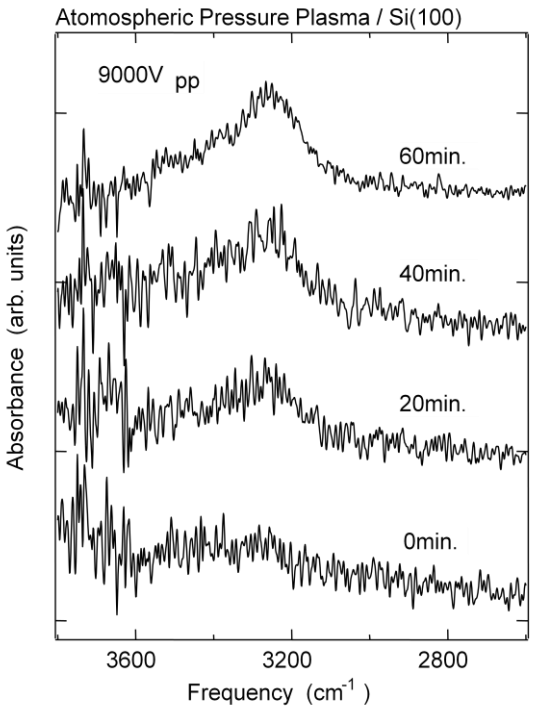

Fig.3 Infrared absorption spectra of the Si substrate covered chemical oxides

4. Conclusion

The chemical species on Si substrate during DBD-type atmospheric plasma exposure was observed with infrared spectroscopy in multiple internal reflection geometry (MIR-IRAS).

OH-group was observed on Si surface during plasma exposure. The amount of OH-group on the surface of the Si substrate was increased as time advances. Thereby, it is suggested that H_2O was generated in DBD-type atmopheric plasma in the air.

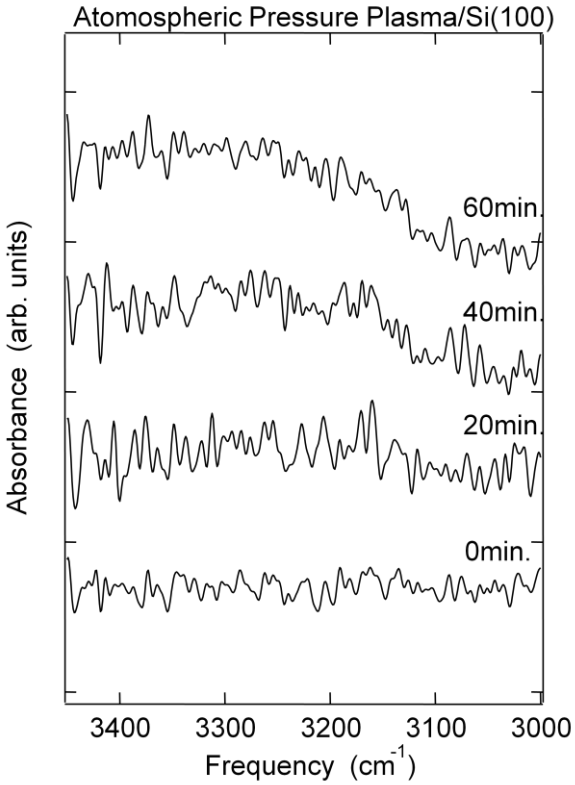

Fig.4 Infrared absorption spectra of the Si substrate covered with hydrogen

Acknowledgments

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