Surface Modification of Polytetrafluoroethylene by Atmospheric Pressure Plasma of Dielectric Barrier Discharge using Argon/Ammonia-Water Vapor Mixture Gas

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Abstract-- Surface modification of polytetrafluoroethylene (PTFE) by atmospheric pressure plasma treatment using a gas mixture of argon and ammonia-water vapor was examined. As a simple method of supplying ammonia, argon gas was bubbled into ammonia water with variation of the concentration from 0% to 20%. A specimen of PTFE sheet was irradiated with the plasma generated by dielectric barrier discharge. After the plasma treatment for 10 seconds, hydrophilic surface of around 57˚ static water contact angle was achieved at the concentration more than 10% while the original PTFE surface showed hydrophobic around 110˚.

I. Introduction

Various methods for hydrophilization of polytetrafluoroethylene (PTFE) surface have been known. In those methods, the chemical treatments have a huge environmental impact, the UV irradiation and the low-pressure plasma treatments have small processing speed, and the electron beam and ion beam irradiation require expensive equipment. The atmospheric pressure plasma treatment has been expected to provide rapid and inexpensive methods.

We have reported surface modification of PTFE by atmospheric pressure plasma using argon gas with liquid vapor of water, alcohol, acetone and water-ethanol [1,2]. In this study, a novel gas mixture of argon with ammonia-water vapor is examined using the same experimental configuration as previous.

II. Material And Methods

Fig. 1 shows experimental setup for plasma treatment of PTFE using argon gas with ammonia-water vapor. Argon gas was bubbled into the ammonia-water which concentration varied from 0% to 20%, and the gas mixture was introduced into the discharge cell. Atmospheric-pressure plasma was generated by dielectric barrier discharge using a pair of copper electrodes placed on the external surface of parallel glass plates. The sample of PTFE sheet was placed on the lower glass plate with leaving 1 mm discharge gap.

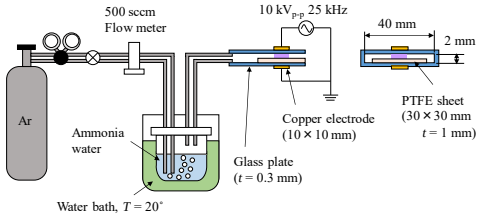

Fig. 1. Experimental setup for atmospheric pressure plasma treatment of PTFE using argon gas with ammonia-water vapor.

III. Results And Discussion

Fig. 2 shows the static water contact angle (WCA) of PTFE treated by the plasma for 10 seconds as a function of the ammonia concentration. By addition of the ammonia-water vapor in argon, the WCA decreased obviously as compared to pure argon. The WCA slightly decreased from 67˚ to 57˚ with increasing the concentration from 0 to 10%. The amount of hydrogen in the plasma which contributes to the surface modification of PTFE, could have been increased [2]. There was no significant difference in the WCA at the ammonia-water concentration more than 10%.

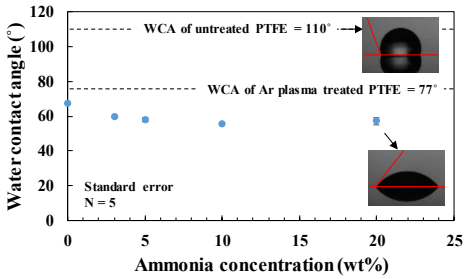

Fig. 2. WCA of the PTFE after 10 seconds treatment by argon/ ammonia-water vapor plasma as a function of ammonia concentration.

IV. Conclusions

The PTFE surface was treated by atmospheric pressure plasma using an argon/ammonia-water vapor mixture gas. The hydrophilization effect was enhanced by introducing ammonia-water vapor into argon as discharge gas and was further improved with increasing ammonia concentration in water until 10%.

References

[1] H. Yajima *et al.*, *Proc. of 16th Int. Conf. on Plasma Surface Engineering (PSE 2018)*, Garmisch-Partenkirchen (Germany), Sept. 2018, p.312.

[2] S. W. Fitriani *et al.*, *Mater. Chem. Phys.*, vol. 282, 125974, March 2022.