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Adhesion Enhancement of Fluoropolymers by Atmospheric Plasma Treatment using Acrylic Acid Vapor

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Abstract:

Fluoropolymers are attracting attention as a material for medical devices and high-frequency circuit boards. But adhesion of them to other materials is difficult due to their chemical stability. In this study, the adhesion of polytetrafluoroethylene (PTFE), one of the most challenging materials to bond, was improved by atmospheric plasma treatment.

For the treatment, atmospheric multi-gas plasma jet developed in our lab. was used. In previous experiments, plasma treatments were performed using argon, nitrogen, carbon dioxide, and oxygen. The plasma was moved parallel to PTFE at 1 mm distance and 1 mm/s velocity. The adhesive strength to polyimide tape with silicone-based adhesive was measured by 180˚ peel test. Adhesion was improved by these treatments. The treatment effect varied significantly depending on the gas species, indicating that the type of reactive species generated in plasma strongly influences adhesion enhancements.

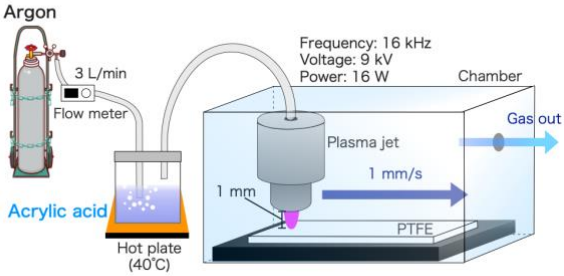

Fig. 1 Schematic of plasma treatment

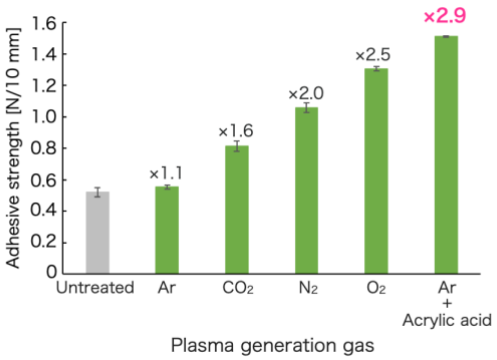

Fig. 2 Adhesive strength of PTFE treated with various gas plasma

Based on this finding, in this study, acrylic acid vapor which is a raw material for adhesives was introduced into argon plasma. The vapor was generated by heating the bottle containing acrylic acid to 40°C to increase its vapor pressure as illustrated in Fig. 1. The adhesive strength was 2.9 times higher than the untreated PTFE, exceeding the treatment effect obtained with other gases as shown in Fig. 2. This improvement is considered to result from graft polymerization of acrylic acid, which formed the adhesive layer on the PTFE surface.

In the presentation, the hydrophilicity of the PTFE surface after the plasma treatment and the surface analysis of PTFE by X-ray Photoelectron Spectroscopy (XPS) will be reported.

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