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Surface modification of PTFE for a high adhesive Ag layer by open-air type plasma treatment with graft copolymerization

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We modified polytetrafluoroethylene (PTFE) surface using plasma irradiation and graft copolymerization, for improving the adhesion strength of metal layer on PTFE. In plasma process, we used an open-type plasma system with low cost gases. Ag nano ink was applied to the modified PTFE surface. The adhesion strength of metal layer on PTFE surface was almost reached to 0.6 N/mm, which satisfy industrial requirements. PTFE has a low dielectric loss factor and low dielectric constant, and thus is widely used as materials for high frequency application. However, PTFE are chemically stable and its surface indicates hydrophobicity. Therefore, forming a highly adhesive metal layer on its surface is difficult. In general, a sodium-naphthalene complex solution is used as an etchant to improve the adhesion strength between PTFE and metal layer, but this process has main two problems. The first is that the etchant is harmful to the human body. The second is that the surface roughness of PTFE treated using the etchant becomes as large as the micrometer order. Large surface roughness causes high resistivity and high transmission loss. To resolve these problems, a technique for surface modification of PTFE was developed. The metallization process of PTFE involved the following four steps: (1) formation of peroxy radicals on PTFE through Ar plasma irradiation; (2) graft copolymerization including amino group on the activated PTFE; (3) application of Ag nano ink on the PTFE surface using a spin coating method; and (4) heat treatment for hardening the Ag ink. Optical emission spectra of the plasma were measured by a multichannel spectrometer and a light fiber. Peroxy radicals formed on the PTFE surface were characterized by electron spin resonance spectroscopy. The adhesion strengths of an Ag layer on PTFE were measured using a commercially available peel tester according to JIS K 6854-1. We successfully formed a highly adhesive metal layer on the chemically inert polymer through a low-cost and environmentally friendly process.

Keywords
fluoropolymer
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