OR0705

Surface modification of polytetrafluoroethylene (PTFE) by heat-assisted atmospheric pressure plasma treatment for improving adhesion of PTFE to isobutylene-isoprene rubber (IIR)

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We modified polytetrafluoroethylene (PTFE) surface via plasma irradiation with heating simultaneously (heat-assisted atmospheric pressure plasma treatment) in order to improve the adhesion strength between the PTFE and isobutylene-isoprene rubber (IIR). PTFE, known by the trade name of Teflon® and used as a coating material for a flying pan, has the lowest surface energy. Therefore, it is very hard to make it adhere to other materials. Helium plasma was irradiated to PTFE at atmospheric pressure, and then the plasma-treated PTFE and unvulcanized IIR was heat-compressed. Then T-peel test was performed to measure the adhesion strength of IIR/PTFE composite. In the case of plasma treatment at 363 K, PTFE didn't adhere to IIR at all. In contrast, in the case of plasma treatment at 533 K, PTFE adhered strongly to IIR and material failure of IIR happened. We successfully adhered PTFE to IIR without using any adhesives. These results indicate that surface temperature of PTFE during plasma treatment greatly affect the adhesion property of PTFE. In addition, surface hardness was measured using a nanoindenter. The surface hardness increased with increasing the surface temperature. The result of surface hardness indicated that cross-linking was promoted by heating during plasma treatment. PTFE has a low molecular layer called as a weak boundary layer. In fact, the weak boundary layer was recovered by cross-linking, which resulted in formation of a tightly fixed layer containing hydrophilic functions and peroxide radicals. As a result, adhesion strength between PTFE and IIR increased drastically without using any adhesives.

Keywords
Adhesion
Atmospheric pressure plasma
Heat
Surface hardness
Polytetrafluoroethylene (PTFE)