TOPICS

Surface Treatment of Polymers by Laser Ablation

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レーザーアブレーションによる樹脂表面の改質

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A new surface treatment of polymers for various useful applications, such as making bonds between surfaces and painting over polymer surfaces thus treated, was demonstrated. Taking note of the strong absorption of the vacuum ultra-violet light (VUV) at the wavelength between 60nm and 80nm in **Fig. 1**, by the carbon 2p electrons, followed by quick loss of surface activity, we discovered a new surface treatment of polymers. Especially, the adhesive property of polymer surfaces was improved by the exposure to VUV and nanometer-sized particles (nm-particles) at the same time. Various polymers have been exposed to VUV light and nm-particles from laser produced plasma in order to improve the adhesive properties of the polymers. This improvement of the polymer surface treated with VUV and nm-particles is caused by the creation of the bonds between nm-particles and carbon atoms on the polymer surface, which is supported by the theoretical calculation of core electron binding energy. This new treatment gives almost all polymers various useful applications scientifically and industrially. For VUV generation, material disc targets were irradiated with a pulsed laser of 532 nm wavelength delivered by an Nd-YAG laser system. The intensity of $4GW/cm^2$ is sufficient for generating VUV light as measured with a VUV spectrometer. The ablators from the irradiated targets were observed by TEM and SEM. In particular, submicron-sized particles were observed in the direction normal to the target surface. An experimental setup for the polymer surface treatment is shown in **Fig. 2**. Carbon, copper and aluminum discs used as targets were irradiated by a focused laser beam. Some polymer substrates exposed to VUV and nanometer-sized particles were bound to a metal rod with a commercially available adhesive. The adhesive properties of the polymer samples were estimated by the pull-off test. The metal rod was pulled off from all samples exposed to VUV and nanometer-sized particles with a force indicating adhesive strength of more than 4.5 MPa, and cohesion failure in the surfaces of the polymers occurred. However, in the case of samples not exposed to VUV, when the metal rod was pulled off from the surfaces of the polymers there was no cohesion failure in the polymer surfaces.

The exposed samples were also directly coated with a conventional paint. After drying the painted samples for one day in an oven at 293K and dipping them for 10 days in a water bath at 313K, the painted films were not torn off from the treated polymer surfaces. On the other hand, without the treatment, painted films were easily torn off from the polymer substrates.

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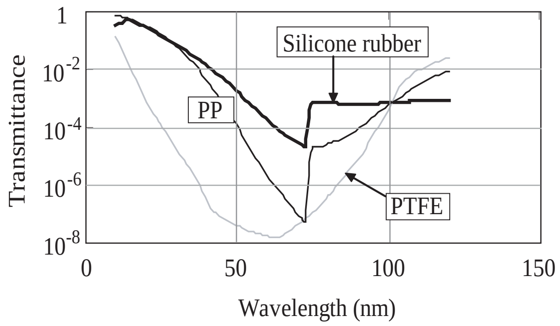

Fig. 1 Calculated absorptions of VUV for polypropylene (PP), silicone rubber and polytetrafluoroethylene (PTFE).

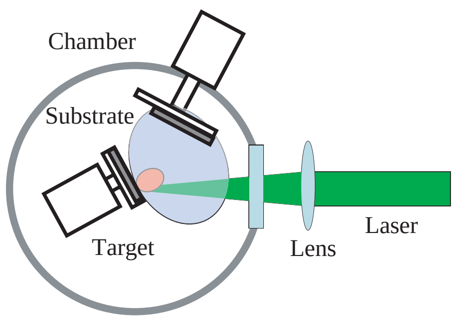

Fig. 2 Schematic setup for the polymer surface treatment with VUV and nanometer-sized particles.