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Improvement of Hydrophilicity of Various Polymer Surfaces Using Plasma Source Ion Implantation

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When polymeric materials are used in industrial applications, a variety of interactions can occur between the polymer surface and the industrial environment. The hydrophilicity of the polymer surface can play an important role in determining how these interactions proceed. Thus, in order to gain more hydrophilic surface, various modification methods have been developed. This study used new technique, namely Plasma Source Ion Implantation (PSII) to modify the polymer surfaces.

Plasma ion implantation experiments were performed using different plasma gases and varying the treatment time. In order to effect specific reactions on the surface which would enhance the wettability, the plasma operating parameters were controlled properly. Plasma ion-implanted polymer surfaces were characterized using contact angle measurements and Time-of-Flight Secondary Ion Mass Spectrometry (TOF-SIMS).

Contact angles for untreated and plasma ion-implanted polystyrene were measured as a function of treatment time. Oxygen, nitrogen and argon plasma ion treatment caused a drastic reduction of water contact angles. Contact angles for untreated polystyrene were 79° and after the treatment they were reduced to below 10° .

As demonstrated in recent papers, TOF-SIMS has the potential to provide molecular structure and composition information from the uppermost layers of polymer surfaces. Positive and negative ion TOF-SIMS spectra for the modified polystyrene showed an enhancement of the low mass fragments and introduction of oxygen containing functional groups. SIMS profile also indicated that plasma ion-implanted polystyrene surfaces involved more abundant CO containing species and less hydrocarbon fragments than the controlled polystyrene.

The rate and extent of hydrophobic recovery was studied as a function of ageing time using water contact angle measurement. PSII method was also applied to modify the surfaces of other polymers, such as poly(ethylene terephthalate), polyethylene, poly(vinylchloride), poly(ethylene naphthalene), polycarbonate, and silicone rubber. This study shows that PSII is a potentially powerful technique for the modification of polymer surfaces to improve the hydrophilicity and to stabilize the treated surfaces.