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Polystyrene surface modification by active screen plasma nitriding.

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Abstract –Here we describe the use of low energy plasma immersion with active screen as convenient approach for polystyrene (PS) surface modification. The composition, structure and hardness of near surface region of PS specimens could be effectively controlled by selecting the plasma processing parameters and experimental setup. In general, the wettability increased considerably upon exposure to the plasma due to the formation of N- and O-containing polar chemical groups. The surface nanohardness decreased as a consequence of chain scission and structural rearrangements that modified the usual glassy state of PS. The herein reported process is an attractive tool for environment friendly.

Whilst polystyrene (PS) is widely applied in the industry, there is a huge interest in developing surface engineering technologies that could improve some of its properties such as hydrophilic character, hardness, biocompatibility, adhesion, among others. Control over these properties can potentially lead to novel applications, especially in the biomedical field for use as vascular grafts heart valves, implants, biosensor, etc.[1]

Employing a stainless steel cathodic cage coated with carbon in order to prevent the sputtering of iron from the grid and its deposition onto the polymer sample, the physical chemical properties of PS surface could be modified through the plasma-induced incorporation/formation of nitrogen- and oxygen-containing species. The areal densities of these elements depended on the plasma excitation source, as determined by Rutherford backscattering spectrometry (RBS). Newly formed C–O, C–N, and C=O/O=C–O/N–C=O bonds along with C–C linkages from the PS backbone were identified at the near surface region of the specimens by X-ray photoelectron spectroscopy (XPS). [2]

The surface wettability significantly changed after the plasma processing as judged from the contact angle measurements, which revealed a decrease from 103° down to 35° (Fig.1;a) . Such a variation can be attributed to newly formed chemical groups, production of dangling bonds, O and N incorporation, and the increase in the surface roughness [3]. The lowest contact angle was observed for the sample submitted to 15-min pulsed plasma treatment. The surface nanohardness of PS was found to decrease from ~104 ±2.3 MPa down to ~56 ± 1.9 MPa upon plasma treatment. This observation(Fig.) is attributed to structural changes in the near-to-surface chains, where the glassy nature of PS is altered due to moderate chain scission and structural rearrangements.

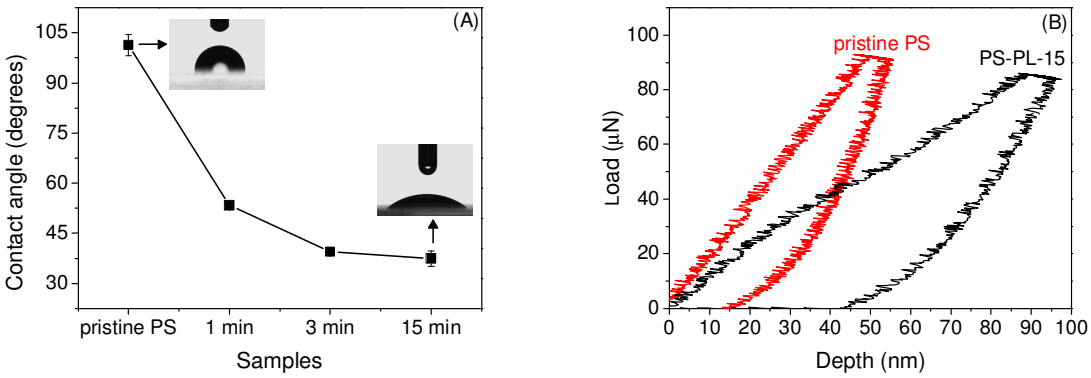

Figure 1: A) Contact angle of PS and pulsed plasma-modified PS as a function of exposure time; B) Indentation curve, load applied to the material's surface vs. the penetration depth of the diamond tip for the non-treated and 15-min pulsed plasma treated PS (PS-PL-15).

References

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