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LOW POWER 50 HZ ARGON GLOW DISCHARGE FOR SURFACE MODIFICATION OF POLYSTYRENE AND POLYTETRAFLUOROETHYLENE

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The characteristics of a low power 50 Hz argon plasma for surface treatment of polystyrene (PS) and polytetrafluoroethylene (PTFE) films will be presented. The current-voltage behavior of the discharge and time-varying intensity of the discharge showed that a DC glow discharge was generated in reversed polarity at every half cycle. At discharge power between 0.15 W to 1 W, the measured electron temperatures, T_e were 2 –2.5 eV at argon pressure of 60 Pa and 1.5 – 2 eV at 120 Pa with the electron density, n_e ~108 cm^{-3}. While n_e increased with discharge power, T_e remained relatively unchanged. The intensity of the optical emission lines increased with discharge power, indicating a corresponding rise in plasma density. The optical emission spectrum of the argon plasma showed the presence of 'impurity species' such as OH, N_2 and H, which presumably originated from residual air in the discharge chamber.

The 50 Hz argon glow discharge plasma was used to treat the surface of polystyrene (PS) films. Plasma treatment for 3 min produced the best hydrophilic enhancement, doubling the surface energy. At 45 Pa and flowrate of 44 sccm, the water contact angle (WCA) attained its lowest value of 21□ at discharge power of 0.15 – 0.25 W. The increased hydrophilicity was attributed was attributed to the incorporation of oxygen-containing functional groups on the PS surface and an increase in surface roughness, as analyzed by AFM. Although treated samples exhibited rapid hydrophobic recovery upon exposure to air, the WCA stabilized after 72 hours and remained more than 30° below the pristine value.

For PTFE films, exposure to the 50 Hz argon glow plasma at 120 Pa and discharge powers between 0.5 and 1 W resulted in a 4% to 20% reduction in water contact angle (from an initial 114°), indicating an improvement in surface wettability. This reduction in WCA correlated with increased treatment time. The enhanced wettability was attributed to the incorporation of oxygen-containing functional groups and a reduction in fluorine content, as confirmed by XPS analysis. Additionally, surface roughness increased, as observed in AFM images. Upon storage in ambient air, the increased wettability was retained.

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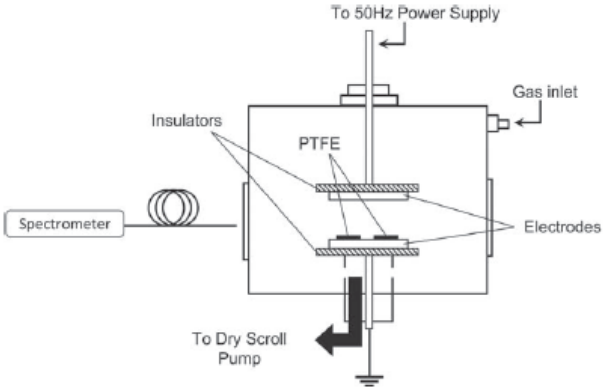

Figure Schematic of the glow discharge plasma chamber and PTFE samples which are placed on the bottom electrode.

Keywords: 50 Hz glow discharge, plasma surface treatment, polystyrene, PTFE, hydrophobic recovery