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Surface modification using atmospheric-pressure plasma jets for technological applications

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Atmospheric-pressure plasma jets (APPJs) are non-equilibrium, highly reactive plasmas that can operate at room temperature and in open air. This unique combination of characteristics makes them ideal tools for industry, eliminating the need for low-pressure operation as is common in many current techniques.Optimisation of such devices for specific applications is often empirical, making it time-consuming, because of a lack of understanding of both the plasma and its interaction with the surface. Here we present a study into the mechanisms underpinning APPJ plasma chemistry and the interaction with a surface.
Two case studies will be presented; the modification of polymer films for enhanced wettability and the removal of photoresist from wafers for semiconductor manufacturing. Our APPJ is a RF-driven plasma operating in helium gas with small admixtures of O2 (0-1%). The effluent of the APPJ propagates through open air towards the surface that is to be treated. In the case of polymer film treatment the desired effect is an increase in wettability, i.e. reduction of contact angle, of the surface without modifying the bulk properties of the film. For second application, the aim is to completely remove photoresist from a wafer as quickly as possible, again without damaging the underlying surface. We find that we can use the same device for both applications by using different operational parameters to achieve the desired effects.
We link the observed surface modification effects to two-photon absorption laser-induced fluorescence spectroscopy measurements of atomic oxygen density within the APPJ effluent, implying the importance of this radical. Furthermore, Fourier Transform Infrared spectroscopy is applied to assess the details of the surface modifications. It reveals a two-stage mechanism for the production of polar bonds on the surface of the polymer, which is in agreementwith our contact angle measurements. The quality of the photoresist removal was found to be equal to low-pressure standards.

Keywords
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