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Deposition of functional coatings on glass substrates using a recently-developed atmospheric-pressure microwave plasma jet

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In recent years, atmospheric-pressure plasmas have gained a lot of interest in view of their interest for fast treatment of materials over large area wafers. While such plasmas are typically based on corona or dielectric barrier discharges (DBDs) for processing of thin samples (for example roll-to-roll systems), a number of applications require the treatment of thicker samples and thus the use of plasma jet configurations. We have recently developed a new, atmospheric-pressure plasma source using a surfaguide sustaining simultaneously 3 tubular plasmas based on the propagation of an electromagnetic surface wave. Operated at 2.45GHz, these tubular plasmas are characterized by much higher electron densities (10ˆ13-10ˆ14cm-3) than conventional DBDs (10ˆ9-10ˆ10 cm-3), thus allowing very high fragmentation rates of precursors intended for PECVD, even in a jet configuration. In the waveguide system used in this study, since only the fundamental mode (a cosine maximum of the electric field on the axis of the large section of the rectangular waveguide) is propagating, the first two tubes were placed off-axis, while the last one was placed just after, on the axis. Such configuration enabled important power absorption by the latter tube even if significant amount of power was already used by the first two. Through the displacement of a plunger located at the end of the transmission line, after the surfaguide, selective lengths of the first-row tubes and second-row tube can be achieved. This phenomenon is ascribed to the displacement of the maximum electric field intensity of an established stationary wave in the transmission line. For short tube lengths downward of the surfaguide, a peculiar spatial structure was observed in which off-axis plasma filaments close to the wave launcher converged towards a single on-axis point near the exit followed by a diffuse plasma plume.

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