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P2.3004 Helix jet - a novel glow plasma jet for surface treatment and PECVD at atmospheric pressure

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We present the helix jet - a stable plasma source with a large homogeneous plasma volume at atmospheric pressure. Challenging applications of material science in high-tech technology implement sources combining homogeneity and stability of vacuum based techniques with a multidimensional flexibility and instrumental modularity of atmospheric pressure plasma sources. In particular, scalable sources generating non-contracted glow discharges are a subject of great interest. The typical glow discharges are designed in planar geometry [1]. However, steep gradients of light emission and other plasma parameters occur perpendicularly to the surface or, in a cylindrical geometry, radially to the plasma channel. Based on the investigation of the self-organized behaviour of a filamentary plasma jet [2], we derived a double helix electrode configuration. The helix jet represents a capacitively coupled radiofrequency plasma source operating at 27.13 MHz. The argon gas flows through a pipe with a diameter of 9 mm at flow rates between 1 and 0.1 slm. The glow discharge has been ignited homogeneously in the whole volume at the surprising length of approximately 10 cm at powers between 40 and 100 W. The radial homogeneity of the discharge has been certified by a high-speed camera with an exposure time of 3 ns. The stability of the glow mode has been tested during an operation for eight hours. Additionally, a computer simulation of the electrostatic potential has been performed. The results show that the electric field exhibits a homogeneous channel with low field magnitude along the axis of the jet which favours the formation of a glow like plasma throughout the full length of the plasma tube discharge. Hence, the helix jet is a suitable plasma source for homogeneous treatment of small 3D objects like powders, seeds or for an upscaled thin film deposition, e.g. PECVD of silicon dioxide films for anticorrosive protection of surfaces. Here, we show the deposition rates and morphological structure of SiOx nanostructures by means of SEM and microgravimetry. Octamethylcyclotetrasiloxane was used as precursor for the PECVD of the coatings. The resulting films are extremely smooth and laterally homogeneous.

[1] F. Massines et al., https://doi.org/10.1063/1.367051
[2] J. Schäfer et al., https://doi.org/10.1088/1361-6587/aa8f14

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