



Plasma synthetic jet actuators: active species and charged particles transport enhancement

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Non-thermal plasmas generated by Dielectric Barrier Discharge (DBD) reactors are nowadays utilized in a wide variety of treatments for sanitification and sterilization purposes. Indirect treatments are typically utilized when samples characterized by complex geometries are used or when direct contact with plasma filaments must be avoided. Usually, in this kind of treatments, only diffusion processes of neutral long-life reactive species are considered. Our research group recently developed a Plasma Synthetic Jet Actuator (PSJA) able to produce a tubular induced jet perpendicular to the face where the surface DBD is ignited. This jet propagates at several meters per second enhancing species transport with respect diffusion process solely, allowing to perform an anisotropic indirect treatment. Moreover, the induced jet advects free positive charges hitting the treated sample. Biological tests carried out with *Candida Guilliermondii* showed an increment of 1 CFU log reduction when advected charges have been left free to reach the sample [1]. Recently, an experimental campaign has been conducted to investigate the role of both relative humidity and applied electric field on free charges advected by the PSJA toward a target surface (Fig. 1). Relative humidity (HR) was varied in the range 5÷80%. This parameter showed negligible influence into the discharge regime and a limited increment in the maximum value of deposited charges by decreasing HR value. This result allows to state that this typology of actuator can be utilized in ambient air without decreasing its biocidal effect partially due to the presence of free charges, making it suitable for real-life decontamination purposes. Conversely, when supplied with higher voltage and lower frequency, despite the same average power and fluid-dynamic effects, the PSJA can transport a higher amount of free charges. In firsts hundreds of milliseconds of discharge, the number of charges has been found to increase of about four times (Fig. 2). This could lead to an increment of biocidal effects without increasing power consumption.

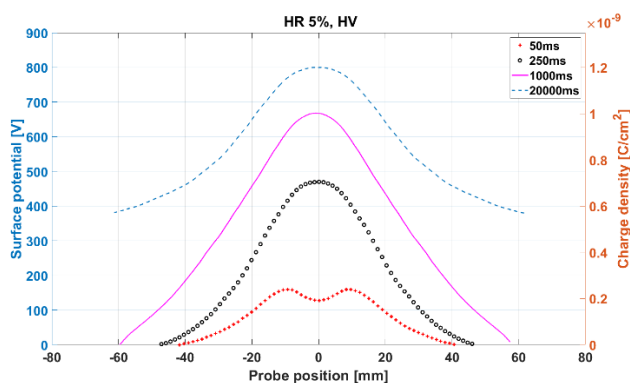


Fig. 1 Induced surface potential and charge density distribution for increasing plasma on-time at HR=5%.

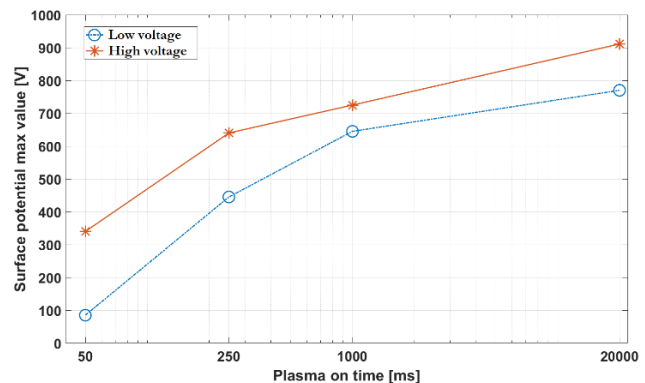


Fig. 2 Surface potential induced by advected charges vs plasma on-time for two supplying voltages.

References

- [1] Neretti G *et al*, Plasma Medicine Journal, 2018, 8 255-268



Plasma Synthetic Jet Actuator (PSJA) able to produce a tubular induced jet perpendicular to the face where the surface DBD is ignited. This jet enhances species transport with respect diffusion process solely, allowing to perform an anisotropic indirect treatment. Moreover, the induced jet advects free positive charges able to increase the sterilization effect of this typology of actuators. Relative humidity does not play a key-role in the amount of advected charges. Conversely, utilizing a higher applied voltage, maintaining unchanged average power and fluid-dynamic effects, allows to increase the amount of transported charges of about four times.