Convective and diffusive transport of oxidative species from a plasma jet

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Plasma jet systems based on dielectric barrier discharges are frequently investigated for skin and wound disinfection. TNO has focused on applicability of a proprietary ~300 mm wide linear plasma jet system based on surface discharges covering an elongated ceramic structure. The system allows disinfection of irregular shapes in a short period of time and is motivated by hand disinfection in hospitals, biopharmaceutical industries, sanitary rooms etc. The downstream gas from plasma jets in N2-O2 mixtures contains atomic oxygen and nitrogen, ions such as O2
– and various more stable compounds such as O3. Nature and concentration of those are difficult to determine and depend on flow dynamics, surface morphology and wetting. A plasma jet using Argon has been reported to create reactive species penetrating even in the follicular reservoir as shown in reference [1].
The ability of plasma produced oxidative species to diffuse to areas of skin where convective flow is limited has been studied. Bacterial contaminations (*S. Aureus* and *E. Coli*) have been filtered on membranes (47 mm diameter, 0.45 µm pores) and covered with a 180 µm thick cellulose Whatman filter having a particle retention typically below 4-12 µm. Figure 1 shows a schematic of the set up providing two parallel sheet shaped flows issuing from a 100 µm wide electrical discharge space and a 0.2-0.5 mm wide shielding gas jet. Treatment conditions have been varied by passing the substrate holder below the jets at controlled speed, distance, plasma power, plasma gas and shielding gas flow rates.

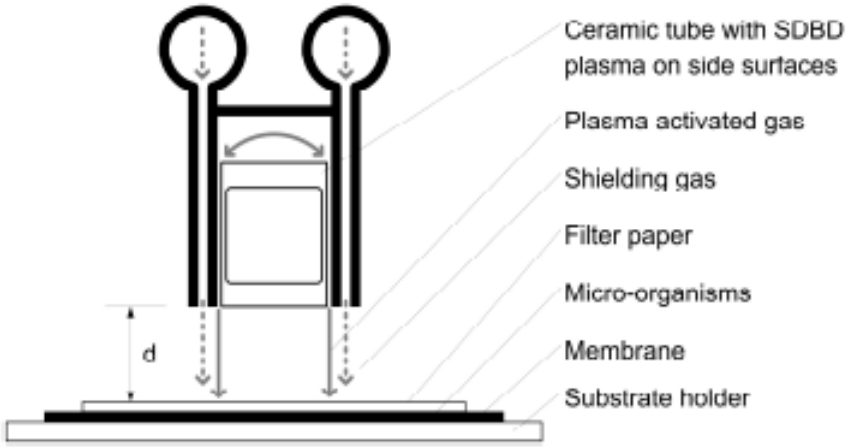

Figure 1: *Electrode system and substrate composition*

CFU count tests show the importance of filter humidity for achieving significant inactivation even at large distance up to 40 mm. Further the paper will describe visualization of methylene blue dye degradation (known as radical dependent) covering an artificial hand.

Reference

[1] J. Lademann et al., Plasma for Bio-Decontamination, Medicine and Food Security, NATO Science for Peace and Security Series A, Edited by Z. Machala et al. (2012), p. 281-291.