

PLASMA-TREATED SUBSTRATES USING ATMOSPHERIC JET AND MULTI-JETS FOR AGRICULTURAL PURPOSE

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We target and report on the use of either single or multi so-called cold atmospheric pressure plasma jets, based on Plasma Gun technology [1], to expose liquid solutions eventually containing seeds or immersed seedlings for agricultural applications. Besides, the upscaling capability of multi jet setups in comparison with single jet devices for the generation of attractive chemicals in solutions, the consideration of the diffusion of plasma produced reactive species in liquid samples is the focus of our investigations. With the single jet configuration, two mode of exposures of liquid samples are considered: a “conventional” protocol where plasma jet plume impinges on the top of the solution and a more rarely investigated and documented method where the plasma jet is “transferred” into gas bubbles exiting from an immersed nozzle [2]. The talk will report on in-bubble plasma generation, water solution treatment using bubble plasma gun device, and the diffusion of reactive species in the liquid container. Using KI coloration as a broad range oxidation reporter, it is measured that while conventional plasma jet exposure leads to very slow and very inhomogeneous reactive species diffusion in the solution, generation of plasma in bubbles induces a sudden, very homogeneous and surprising oxidation of the whole volume of a few mL. Work is in progress to try and simulate the plasma generation in bubble and the consecutive reactive species delivery in the solution. With the conventional protocol, Schlieren visualization indicates that air and helium mixing and flow properties above the liquid surface correlates with the oxidation patterns revealed in the solution. Air entrainment along and inside the plasma plume with plasma jet in free jet mode or impinging over various targets was recently reported with a dielectric barrier discharge based helium plasma jet [3]. Dealing with plasma solution generation using plasma jet and/or treatment of solution containing either attached or suspended cells or samples of interest for agriculture, it is suspected that neither slow diffusion using conventional plasma jet exposure nor opportunity with bubble arrangement were so far considered with sufficient care.

References

- [1] JM Povesle, C Cachoncinlle, R Viladrosa, A Khacef, E Robert, S Dozias, Transient plasma ball generation system at long distance, US Patent 8,482,206
- [2] A. Hamon, C. Douat, S. Dozias, J.M. Povesle, E. Characterization of plasma generation in bubbles with a plasma gun. 22nd International Conference on Gas Discharges and Their Applications GD2018, Inst. Phys. Belgrade; SASA; Univ. Belgrade, Sep 2018, Novi Sad, Serbia. hal-01943383
- [3] Y Morabit, RD Whalley, E Robert, MI Hasan, JL Walsh, Turbulence and entrainment in an atmospheric pressure dielectric barrier plasma jet, Plasma Processes and Polymers, e1900217