GEC15-2015-000797

Abstract for an Invited Paper
for the GEC15 Meeting of
the American Physical Society

Gas Flow and Electric Field Characterization in Plasma Jets for Biomedical Applications: From Single Jet to Multi Jet Arrays

ERIC ROBERT, GREMI, France

This work reports first on time-resolved measurement of longitudinal and radial electric fields (EF) associated with plasma propagation in dielectric capillaries. Plasma propagation occurs in a region where longitudinal EF exists ahead the ionization front position revealed from plasma emission with ICCD measurement. The ionization front propagation induces the sudden rise of a radial EF component. Both of these EF components have a few kV/cm in amplitude for helium or neon plasmas. Their amplitude is kept almost constant along a few tens of cm long capillary. The key role of the voltage pulse polarity and the drastic impact of the presence of a target in front of the plasma jet are discussed from Schlieren images. All these experimental measurements are in excellent agreement with model calculations which are used to infer EF data on capillary axis. EF diagnostics in the plasma plume in the free jet mode but also in contact with various targets is proposed. The combination of intense transient EF, both of ns and s duration, together with significant transient reactive species generation during plasma jet treatments may be reconsidered. Typical EF amplitudes likely to induce electrostimulation, electroporation are indeed probably achieved in many in vivo protocols. Stimulation of tissue oxygenation, blood flow rate modulation and more recently immune system triggering may be examples where EF could play a significant role. The second part of this work is dedicated to the development of multi jets, using two different setups, based on a single plasma source. Plasma splitting in dielectric tubes drilled with sub millimetric orifices, but also plasma transfer across metallic tubes equipped with such orifices are analyzed from ICCD imaging and time resolved EF measurements. This allows for the design of plasma jet arrays but also emphasizes the necessity to account for voltage pulse polarity, target potential status, consecutive helium flow modulation and electrostatic influence between the produced secondary jets. The development of plasma arrays based on combination of plasma splitting within dielectric tubes and plasma transfer across metallic tube is reported leading to the generation of tens of secondary jets from a single PG device, i.e a single DBD reactor flushed with 2 l/mn of helium.