INVESTIGATION OF NANOSECOND REPETITIVELY PULSED DISCHARGES IN WATER VAPOR FOR HYDROGEN PRODUCTION

Florent P. Sainct, Deanna A. Lacoste and Christophe O. Laux
Laboratoire E.M2.C. CNRS UPR 288, Ecole Centrale Paris Châtenay-Malabry, France

Mike J. Kirkpatrick, Emmanuel Odic
SUPELEC – E3S Department of Power and Energy systems, Gif-sur-Yvette Cedex, France

High-voltage nanosecond pulses with reduced electric field in the range of 100 to 300 Td are a very efficient way to produce active chemical species in air\(^1\). We seek to explore whether interesting chemical species can be produced in water vapor.

Nanosecond Repetitively Pulsed (NRP) discharges were produced by short duration (15 ns), high-voltage (0-30 kV) pulses at Pulse Repetition Frequency (PRF) of 1-100 kHz with a FID Technologies pulser. NRP discharges were generated between two pin-electrodes separated by a gap distance of 1 cm, perpendicular to the gas flow. Two quartz windows allow optical access to the discharge zone.

We first studied how PRF and applied voltage affect the regimes of operation of the NRP discharge in water vapor. The results were obtained with water vapor at a temperature of 450 K and flow velocity of 0.15 m/s. At low PRF, spark breakdown occurs for an electric field of about 30 kV/cm. The breakdown voltage decreases with the applied discharge PRF with an asymptote at about 13 kV/cm at 100 kHz. Corona breakdown occurs at about 20 kV/cm at low PRF and decreases at about 6 kV/cm at 100 kHz. There seems to be a narrow region with gap filling glow discharge, but additional measurements are needed to actually confirm the glow nature\(^2\) of the discharge.

We investigated on the nature of the discharge with respect to the electrode distance and the water vapor temperature. We will also determine the temperature of the emitting species (OH, …) by optical emission spectroscopy.

We have performed preliminary emission spectroscopy measurements in the spark regime, at about 200 Td. They show the presence of OH, O and H, thus indicating that the discharge dissociates water vapor.