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X-ray Micro-Discharges Fine Dynamics in a Vacuum High Voltage Experiment

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The High Voltage Padova Test Facility (HVPTF) is an experimental device for investigating High Voltage Direct Current insulation in vacuum, in support of the realization of MITICA, the prototype of a neutral beam injector for ITER. Inside a high vacuum chamber, two stainless steel electrodes, separated by a few centimeters gap, can achieve a voltage difference up to 800 kV. During the conditioning process of the electrodes, current micro-discharges (MD) and associated X-rays are observed, along with a global increase of gas emission (in particular, H2 and CO2 have been detected by the Residual Gas Analyser). During the last five years, different X-rays detectors have been installed on HVPTF, with the aim to investigate the physical processes behind the conditioning.

In this contribution, the fine dynamics of the micro-discharge phenomenon is studied with the purpose to sketch a possible physical interpretation of MD mechanism: data suggest that after a first burst of electrons, some gas is emitted by the anode and ionized. Then, the generated ions, hitting the vacuum chamber and the electrode supports, produce secondary electrons, partly collected by the anode. This could be the reason of the measured asymmetry between MD current values at positive and negative electrodes. Experimental observations and theoretical evaluations supporting the hypothesis of gas emission from the anode are presented.

A first study about the statistical behavior of micro-discharge phenomenon is introduced. In particular, the distribution of the time intervals between successive MD suggests the occurrence of almost two different trigger mechanisms, evolving during the electrode conditioning.

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