Dissertation

STUDY OF ELECTRICAL AND DIELECTRIC PROPERTIES OF DIELECTRIC BARRIER DISCHARGES (DBD) GENERATED BY SILICON DIODE FOR ALTERNATING CURRENT (SIDAC) IN WATER

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Abstract

This work deals with dielectric barrier discharge (DBD) generated in bubbles in water using Silicon Diode for Alternating Current (SIDAC). Dielectric-barrier discharge (DBD) is a discharge obtained in gas space between two electrodes, in which at least one of the electrodes is covered by a dielectric material. The dielectric layers in the configuration of the DBD reactor make this discharge characterized as a capacitive load, self-terminated discharge, which is generated by a high frequency alternating voltage source or a high frequency repetitive pulse power source. SIDAC or Silicon Diodes for Alternating Current is a bidirectional high voltage switching device designed for direct interface with the power line. It has high break-over voltage and power handling capabilities. The high-speed switching characteristic of SIDAC has been used for generating low-cost high voltage pulses with tens of kV derivation that have been effectively applied to DBD generation.

In this study, DBD plasmas in water were investigated as a sequence of a bubble formation and an electronic process within the bubbles. A cylindrical electrode inside a glass tube with a number of microsize holes and an inexpensive circuit using a number of SIDAC connected to a high voltage transformer at commercial frequency have been used. The gas bubbles are simply produced at initial stage by gas flow through microsize glass holes. When applied voltage meets or exceeds breakover voltage of the series connecting SIDACs, these SIDACs switch from a blocking state to a conducting state. Then, high voltage pulses with tens of kilovolt derivation are generated, as the bubble formed an electrical breakdown instantaneously takes place within the bubble. The generation of such DBD plasma should be analyzed sufficiently when its characteristics are governed by two switches: the SIDAC switching characteristic and the dielectric layers.

Additionally, one of the constraints DBD application to waste water treatment is the requirement of the expensive and complex power source configurations that could make the DBD installation expensive and selective. The prospect of an increase in the market share of the application of DBD generation still faces the challenges oriented with the need of the compact and affordable power supplies. Therefore, this work also focused on design, construction, and optimization of configuration of a novel high

voltage pulse power source for large-scale dielectric barrier discharge (DBD) generation by using a device called Silicon Diodes for Alternating Current (SIDAC) and the self-terminated characteristic of DBD without external controlling. The DC power supply has been designed in a simple modular structure, non-control requirement, the transformer elimination, minimum number of levels in voltage conversion required to achieve the desired operating condition leading to a reduction in size, weight, simple maintenance and high scalability of the DBD generator. Fundamental results and conclusions achieved during this work have been published in scientific journal, presented at conferences and attached in Appendices

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