Abstract Submitted
for the GEC20 Meeting of
The American Physical Society

Electron generation and multiplication at the initial stage of nanosecond breakdown in water XUEWEI ZHANG, Texas AM University-Kingsville, MIKHAIL SHNEIDER, Princeton University — Pulsed breakdown in water has important applications as potential plasma sources and is fundamental to pulsed power systems design. There have been many theoretical and experimental studies on pulsed breakdown in water under inhomogeneous nanosecond electric fields. Electrostrictive cavitation has been proposed as the mechanism of breakdown initiation at nanosecond timescale. There are still missing links between the cavitation inception and the formation of the first plasma channel. We first analyze the generation of the primary or seed electrons. Among the possible sources, the electron dissociation from hydroxide is the most probable process to release electrons from the cathode-side pole to the interior of a nanocavity, especially when the hydroxide concentration is increased at the pole. Next, consider a linear chain of nanocavities along the electric field line, we theoretically model the processes of electron gaining energy traversing the nanocavity, hitting the opposite cavity wall, and generating more electrons before entering the next nanocavity. The rate of electron multiplication is a function of the nanocavity size, density, as well as the background field. Although the work mainly focuses on breakdown with positive impulse applied to a needle tip, similar electron multiplication processes also exist in negative-polarity breakdown.

Xuewei Zhang
Texas A
M University-Kingsville

Date submitted: 16 Jun 2020 Electronic form version 1.4