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On the source of primary electrons at the initial stage of nanosecond breakdown in water XUEWEI ZHANG, Texas AM University, Kingsville, MIKHAIL SHNEIDER, Princeton University — Recent studies have proposed cavitation due to negative pressure created by electrostriction in inhomogeneous field as the mechanism of nanosecond breakdown initiation in water. Initial plasma channel formation results from the multiplication of collisionless electrons in the nanovoids. Here we discuss possible sources of primary electrons that trigger the multiplication process. It is estimated that cosmic background radiation and field ionization of water molecules are unlikely to produce enough electrons even in a field of 5 V/nm, while electron detachment from hydroxide can generate much more electrons. Considering a spherical nanovoid in water, this work shows how the processes in and out of the nanovoid interact and seed the electron multiplication. Solving a fully coupled Poisson-Nernst-Planck model of charge migration, we find that the hydroxide concentration on the cathode-side wall of the void will be enhanced from its equilibrium level without field, which may increase electron generation under realistic field of 0.5 V/nm. The emission of electrons into the nanovoid will shift the equilibrium of water autoionization rightwards. The emitted electron will gain energy before hitting the anode-side wall of the void to release more charges. This mechanism of primary electron generation can be self-sustained depending on the background field and nanovoid size. This work only considers one nanovoid and its vicinity; further studies can be conducted in scenarios involving multiple nanovoids.

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