Radiation characteristics observed at the initial stage of nanosecond discharge in liquid water

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Time-resolved experiments using ICCD microscopy and spectroscopy [1, 2, 3] revealed characteristic emission fingerprints associated with the initial evolution of the luminous phase of nanosecond discharge in liquid water. Principal characteristics of the radiation collected from the developing luminous filaments during the first hundreds of picoseconds consist of a sharp decrease in the emission intensity at the short-wavelength side of the spectra, followed by a maximum and subsequent decrease in intensity towards near-infrared wavelengths. Recently, it was demonstrated that an overwhelming fraction (>95%) of the total registered photon flux originates from the water bulk, indicating that the sources of radiation are predominantly the luminous filaments developing far away from the anode surface [3]. These radiative features can be explained by considering the electron–neutral bremsstrahlung produced by a bell-like energy distribution of the electrons, which is coherent with the concept of electric field emission into electrostriction-induced nanovoids [4]. Such electron emission can correspond to electrons originating from hydroxide detachment since hydroxide density increases significantly at the nanovoid's cathode-side boundary [5]. Moreover, the presence of a short-wavelength cut-off at about 500 nm observed in experimental spectra [1, 2] suggests also another important mechanism for electron emission, such as the photodetachment from hydroxides possessing an energy threshold of 1.8 eV.

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