Experimental investigation of ionization growth in the pre-breakdown phase of fast pulsed capillary discharges

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Abstract

We have investigated the pre-breakdown ionization processes in a pulsed capillary discharge using a capacitive probe array to measure ionization growth with time and space resolution. The experimental results indicate that pre-breakdown processes in shielded capillary discharges are characterized by the formation of a fast ionization wave. Depending on voltage polarity, the ionization wave can be associated with a mobile virtual anode with characteristic speed 10^5 m s^{-1}, in the case of positive polarity, or with the propagation of a high speed potential wave, of characteristic speed 10^7 m s^{-1}, in negative polarity case. The time and space evolution of the ionization waves is closely related with the formation of high energy electron beams, which originate due to the hollow cathode geometry of the open end capillary. A qualitative model based on the hollow cathode effect is proposed to explain the initial formation and later time evolution of the observed ionization waves.