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Modeling of High-voltage Breakdown in Helium LIANG XU, University of Science and Technology of China, ALEXANDER KHRABROV, IGOR KAGANOVICH, Princeton Plasma Physics Laboratory, Princeton, NJ 08543, USA, TIMOTHY SOMMERER, General Electric Research, Niskayuna, New York, USA
— We investigate the breakdown in extremely high reduced electric fields (E/N) between parallel-plate electrodes in helium. The left branch of the Paschen curve in the voltage range of 20-350kV and inter-electrode gap range of 0.5-3.5cm is studied analytically and with Monte-Carlo/PIC simulations. The model incorporates electron, ion, and fast neutral species whose energy-dependent anisotropic scattering, as well as backscattering at the electrodes, is carefully taken into account. Our model demonstrates that (1) anisotropic scattering is indispensable for producing reliable results at such high voltage and (2) due to the heavy species backscattered at cathode, breakdown can occur even without electron- and ion-induced ionization of the background gas. Fast atoms dominate in the breakdown process more and more as the applied voltage is increased, due to their increasing ionization cross-section and to the copious flux of energetic fast atoms generated in charge-exchange collisions.

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