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Validated Two-Dimensional Modeling of Ablated Carbon Arcs (PhD Oral-24)[1] JIAN CHEN, ALEXANDER KHRABRY, IGOR D. KAGANOVICH, ANDREI KHODAK, VLADISLAV VEKSELMAN, HEPING LI, Princeton Plasma Physics Laboratory — An atmospheric pressure arc discharge is the simplest method for the industrial-scale production of carbon nanoparticles. In this work, we developed a self-consistent model to study the properties of short carbon arcs. The model accounts for the transport of heat and current in both plasma and electrodes as well as multiple surface processes including sheath, carbon ablation and deposition, thermionic emission, and radiation. These processes are similar to those in tokamak diverter, thus ablating arc can be used as a benchmark for diverter codes. Results show that the arc is constricted at the electrodes, leading to the spot formation. We conclude that the anode spot formation is not caused by a plasma instability, as commonly believed in case of other constricted discharges, but occurs due to the highly nonlinear nature of heat balance in the anode. We prove this point with an analytical model and by showing that changing the anode heat conduction affects spot size. We also show that the spot size increases with the arc current. This behavior was confirmed in our experiments. Due to the anode spot formation, a large gradient of carbon gas density occurs near the anode, driving a portion of the ablated carbon back to the anode. This consequently reduces the total ablation rate.

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