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Erosion of carbon arc cathodes operating in the thermo-field electron emission mode

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Abstract: Steady-state modelling and experimental results are given on the electric arc attachment on cold carbon cathodes working at low pressure. The modelling results are compared with the case of copper cathodes and with experimental data on vacuum arc erosion characteristics for graphite materials. A region of existence of a physically meaningful solution for self-sustained operation of the steady-state cathode spot is given in the electron temperature?cathode spot plasma pressure space. A solution domain comprised between Te ? 1.2?1.5 eV and p ? 2?45 atm corresponding to carbon surface temperatures in the range 4200?4900K is found. Values of the local heat flux to the cathode surface are evaluated in the range 1?20 ? 10^10Wm^?2, and ratios of the various contributions to this flux and current density are given. Also given are the cathode spot radii and upper/lower limits for the erosion rate through vapourization, these being compared with experimental data. It is shown that the cathode spot pressure conditions can provide a mechanism for the control of macroparticle emission on carbon. This effect is used experimentally through cathode spot plasma confinement for the reduction of the microdroplet emission in arc sources used for diamondlike film deposition. Experimental data obtained on graphite materials are in agreement with the model-based design guidelines.