SIMULATION OF SPOTS ON Cu-Cr CATHODES OF VACUUM ARCS AND OF THEIR STABILITY*

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This work is concerned with simulation of cathode spots on copper-chromium contacts of vacuum interrupters in the framework of a self-consistent space-resolved numerical model of cathode spots in vacuum arcs developed earlier[1]. Results reported in this work refer to the case where the grain has a hemispherical shape and the cathode surface is flat; a convenient test case for elucidating the underlying physics. The attention is focused on spots attached to Cr grains in the Cu matrix in a wide range of values of the ratio of the grain radius to the radius of the spot. In the case where this ratio is close to unity, parameters of spot are strongly different from those operating on both pure-copper and pure-chromium cathodes; in particular, the spot is maintained by Joule heat generation in the cathode body and the net energy flux is directed from the cathode to the plasma and not the other way round. An investigation of stability has shown that stationary spots are stable if current-controlled, which is the case typical for low-current arc devices and small-scale experiments. However, under conditions of high-power circuit breakers, where the near-cathode voltage is not significantly affected by ignition or extinction of separate spots, the spots are unstable and end up in either explosive-like behavior or destruction by thermal conduction. On the other hand, the time of development of the instability is significantly longer in the case where the grain radius is close to the spot radius. This result is very interesting theoretically and may explain the changes in grain size occurring in the beginning of lifetime of contacts of high-power current breakers. A sensitivity study has shown that variations in different aspects of the simulation model produce quantitative changes but do not affect the results qualitatively.

1. M. S. Benilov, M. D. Cunha, W. Hartmann, S. Kosse, A. Lawall, and N. Wenzel, "Space-Resolved Modeling of Stationary Spots on Copper Vacuum Arc Cathodes and on Composite CuCr Cathodes with Large Grains", IEEE Trans. Plasma Sci. **41** (8), pp. 1950-1958, 2013.

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