ELECTRON EMISSION FROM REFRACTORY AND NON-REFRACTORY CATHODES

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ABSTRACT

Electron emission from cathodes occurs when electrons in the conduction band of the cathode overcome a certain potential barrier. Depending on the physical conditions enabling the release of electrons from the cathode, the mechanisms of electron emission are categorized as resulting from individual events (ion bombardment) or collective effect [1].

This contribution is concerned with the emission of electrons from cathodes made of selected materials (Cu, W, Cd, Zn, Ir) that occurs by collective effects (high temperature in the cathode, high electric field on the cathode surface). These effects characterize the arc regime of operation of electric discharges that are relevant to cathodic arcs, electric arcs in switching devices to mention a few application fields. In order to obtain the electron emission current for operation with cathodes of the aforementioned materials, the transferred matrix method is applied [2]. This method is applicable to arbitrary shapes of the surface potential barrier. The selected materials considered in this work represent both refractory and non-refractory cathodes.

The results obtained indicate that cathodes made of Ir and W, which can withstand high temperatures before melting, provide a field-enhanced thermionic electron emission with current density of (10^6-10^7) Am^{-2} even for electric fields in the order of 10^7 Vm^{-1} (W) or 10^8 Vm^{-1} (Ir). For cathodes made of Cu, such current densities can be reached at temperatures below and slightly above the melting point of Cu (1358 K) provided the electric filed is in the range (2-3)×10^9 Vm^{-1}. Cathodes made of Cd and Zn start melting at temperatures of 594 K and 692 K, respectively. For these materials, electron emission current density in the order of (10^6-10^7) Am^{-2} is predicted for electric field of about 3×10^9 Vm^{-1}. An increase of the temperature up to the corresponding values for melting or even up to the boiling point does not give a rise of the current density for weak electric fields since the main mechanism of electron emission is field emission.

The work is funded by the German Research Foundation (DFG) Project number 548964199.

References

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