

ESTIMATIONS OF CRITICAL TEMPERATURE OF METALS FROM VACUUM ARC PLASMA PARAMETERS

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Vacuum arc cathode spot consists of ensemble of explosive electron emission pulses resembling the 'boiling' of metal surface. The plasma parameters of these splashes strongly vary in time and space within nanoseconds and micrometers, as can it be seen in experiments. However, there are some nearly invariant characteristic that depends on the element. In particular, the plasma expansion velocity vary in narrow range from about 5 to 20 km/s, and the average ions' charge vary from +1 to +3 for different metals. We have developed model for estimation of plasma parameters from parameters of the critical state of metal [1-3]. The model includes

- (i) a Saha-like equation for the average charge of a weakly nonideal plasma,
- (ii) two-temperature calculations with finite $e-i$ relaxation rate, and
- (iii) the current density evolution derived from a liquid-jet tearing model

Estimations for the ions kinetic energy and their average charge have been obtained

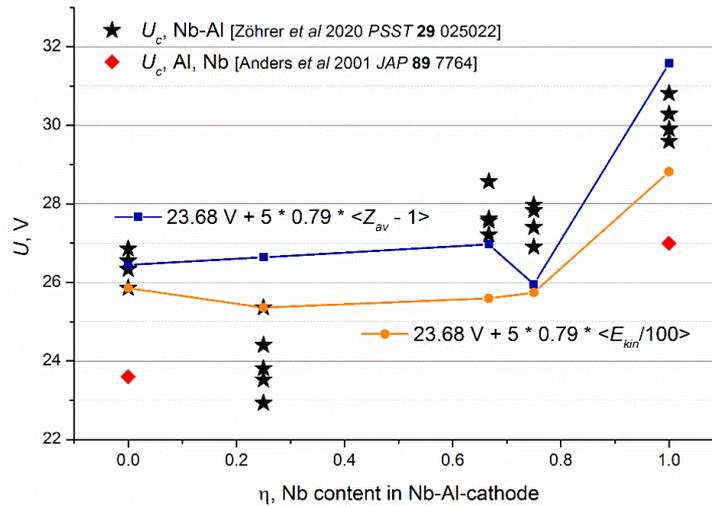
$$E_{kin} \approx 100 T_{cr} \quad (1)$$

$$Z_{av} \approx 1 + T_{cr}/eV \quad (2)$$

where T_{cr} – is the critical temperature of metal. Both estimations agree with typical experimental results for the T_{cr} values obtained by Fortov *et al* [4].

One may propose to evaluate critical temperature of metal T_{cr} and the corresponding cohesive energy $E_{coh} \approx 5 T_{cr}$ from the experimentally measured vacuum arc plasma parameters – E_{kin} and Z_{av} .

It was found that the cathode voltage deviates from the 'cohesive energy rule' for Nb-Al composite and intermetallic cathodes [5]. Estimations by (1) and (2) from experimentally measured average charge and kinetic energy give T_{cr} and corresponding E_{coh} lower than that was calculated by DFT and USPEX in [5]. Values T_{cr} are close to that for Al for various cathode composition Nb/Al = 1/4, 2/3, 3/4. Deviation of character of cathode voltage from nearly linear dependence could be described by 'cohesive energy rule' with our new estimations of T_{cr} (and E_{coh}) from measurements of average ion charge and their kinetic energy by our model.



Measured cathode fall voltage values U_c for Nb-Al and estimations by average charge and kinetic energy of the vacuum arc plasma ions.

REFERENCES

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