



Contribution ID: 110

Type: Oral

Investigations of the transition from field electron emission to plasma discharges (glow discharges and micro-arcs) with extended use of the Fowler-Nordheim plot

Monday 16 September 2019 11:10 (20 minutes)

The commonest method of characterising a cold field electron emitter is to measure its current-voltage characteristics, and the commonest method of analysing these characteristics is by means of a Fowler-Nordheim (FN) plot [1]. For example, the field enhancement factor can be calculated. But for novel investigations of the transition from field emission to plasma discharges an extended use of FN plot is proposed. For this, the inverse voltage (x-axis of the FN plot) was extended with factor $1 = (I \cdot t)/(I \cdot t)$:

$$1/V = (I \cdot t)/(V I \cdot t) = Q/E \quad [1/V = A_s/W_s] \quad (1),$$

where V is the Voltage, I the current, t the time, Q the sum of all transported charges (cathode - anode) and E the energy required for this. The relation Q/E is a possible option for energetic evaluation. Fig. 1 shows an example of the energetic evaluation with FN plot (see attachment). It can be seen that the micro-arc discharge has a charge transfer with the least energy input. This energetic evaluation, further and improved measurements, an illustrative “energy compass” for a simple FN plot analysis and novel approaches for comparative energetic evaluations of charge transfers (electrons, ions) will be presented and discussed.

References

- [1] R. G. Forbes, J. H. B. Deane, A. Fischer, M. S. Mousa, “Fowler-Nordheim Plot Analysis: A Progress Report”, *Jordan Journal of Physics* 8 (3) 125-147 (2015).
- [2] D. Wenger, W. Knapp, B. Hensel, S. T. Tedde, „Transition of Electron Field Emission to Normal Glow Discharge“, *IEEE Transaction on Electron Devices* 61 (11), p. 3864 (2014).
- [3] M. A. Bilici, J. R. Haase, C. R. Boyle, D. B. Go, R.M. Sankaran, “The smooth transition from field emission to self-sustained plasma in microscale electrode gaps at atmospheric pressure”, *J. Appl. Phys.* 119 223301 (2016).
- [4] W. Knapp, M. Lindner, C. Langer, R. Schreiner, “Investigations of transition from field electron emission to stable plasma discharge in a micro electron source at vacuum pressure”, Poster contribution, IVNC 2017, 10-14 July, Regensburg, Germany.

Author: Dr KNAPP, Wolfram (Otto-von-Guericke-Universitaet Magdeburg)

Presenter: Dr KNAPP, Wolfram (Otto-von-Guericke-Universitaet Magdeburg)

Session Classification: Field Emission - Modeling and Simulations

Track Classification: Field Emission