CONTROLLED MICRO-ARC TREATMENTS IN VACUUM ELECTRON SOURCES WITH CNT CATHODES FOR LONG-TERM EMISSION STABILITY

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ABSTRACT

Prototypes of self-developed electron sources with thick film Carbon Nanotube (CNT) field-emission cathodes suitable for vacuum electronic applications up to about 10 mA in DC operation are presented. Experimental setups, measurement circuits and standard measurements are presented to characterize the electron field emission of CNT cathodes. The characteristics are recorded at a frequency of 10 mHz (measurement duration 100s per characteristic) and are repeated as often as required for endurance tests. From the resulting set of characteristics, the hysteresis behaviour and the long-term constancy of the electron field emission can be evaluated, with the first measurements showing particularly frequent and varied deviations. The most important are vacuum breakdowns, but they only slightly degrade FE properties of thick film CNT field emitters. Based on this experience, controlled micro-arc treatments were performed for more effective conditioning and targeted pre-aging of CNT field emission cathodes with the aim of achieving good long-term emission stability, as shown in the oscillogram of Fig. 1 and discussed in the contribution based on the electrical parameters.
These robust CNT cathodes are very resistant. And such a new research focus to achieve higher emission currents is the nanosecond pulse technique, where the avalanche-like enhancement of electron currents by positive ions up to the ampere range is achieved during the transition from electron field emission (EFE) to plasma discharge, so-called Explosive Electron Emission (EEE) [1].

Reference

[1] G. Gaertner, W. Knapp, R.G. Forbes: Modern Developments in Vacuum Electron Sources. Topics in Applied Physics, Vol. 135, Springer Nature Switzerland AG, 2020, p. 529.

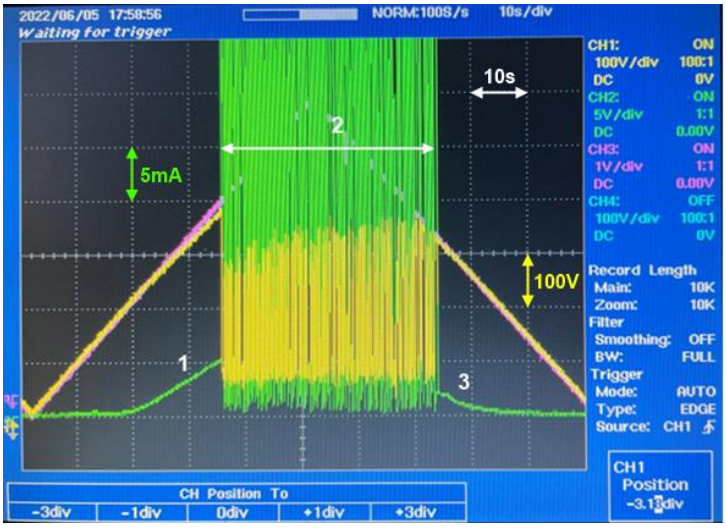

Fig. 1 Micro-arc treatments (2) with FE before (1) and after (3).