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# Field emission spectroscopy of SiC

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**Abstract.** Experimental set up for the natural experiment and measurement model are presented to obtain the feld emission energy distribution spectrum out of silicon carbide in case of the macro-sample having a macroscopic shape of a tip. The prototype of feld emission 6H-SiC monolithic cathode is proposed for spectroscopy measurements, and characterised by current-voltage dependence at macroscale interelectrode distance.

## 1. Introduction

Energy distribution spectrum of field electrons is directly connected to electron properties of solid bodies. From studying the emitted electron distribution by their total energies one can obtain data on zone structure of the emitter and energy levels of adsorbate.

This article assesses field electron sources based on monolithic silicon carbide, whose mono-crystals have exceptional emission characteristics but, due to their two-element composition, are potentially vulnerable to modifications of emission surface. In particular, Ohmic heating in process of electron field emission can lead to sublimation of silicon and forming of graphene-like carbon coating on emitter surface.

Determining the transitional regimes connected to the silicon carbide surface graphitization in process of field electron emission is an important fundamental problem that also has a broad range of practical applications [1], [2].

The objective of this work is the development of natural model of electrophysical system for energy analysis and study of prototype of field emission 6H-SiC monolythic cathode supposed for spectroscopy measurements. While the potential of the SiC field emission material is recognized, only a few experimental attempts have been made to fabricate and measure emission characteristics of monolithic SiC cathodes. Field emission characteristic of 4H-SiC monolithic structure is reported in [3] and [4] reports strong and stable field emission properties of monolithic 6H-SiC pillar field emission array (FEA). Crystalline p-type 6H-SiC tips in a regular patterned FEA with very noisy emission current (only a few emitters were measured in FEA) is reported in [5] and also [6] reports voltage-current characteristics of monolithic SiC FEA.

While the number of publications on the issue of monolithic SiC field electron emission is scarce, there is no papers at all on field emission energy distribution measurements for both nanostructured or monolithic silicon carbide, as far as we know, i. e. the considered problem is undoubtedly actual.

## 2. Current-voltage characteristic of 6H-SiC monolithic macro-sample emitter and set up of the natural experiment

Monolithic macro-sample was obtained as a result of split of plane monocrystal 6H-SiC FEA [3], so that tip macroshape of emitter was suitable to current-voltage characteristic measurement at macroscopic interelectrode distance. High voltage up to 10 KV was applied to the anode. The vacuum was at -6 or -7 power of Pa for the duration of the experiment. Figure 1 shows current-voltage characteristic plotted in Fawler-Nordheim coordinates (measured in static mode) and macro-sample view in optical microscope and sample fixation system. It is necessary to note, that there were previously attempts of emission current measurements directly from plane FEA in macroscopic diode configuration (microdiode was studied in [3]), and the emission emerged to the greater part along the margin of the cathode due to electrostatic amplification in macroscopic distribution of the electrical field (as it was calculated in [7], [8]).

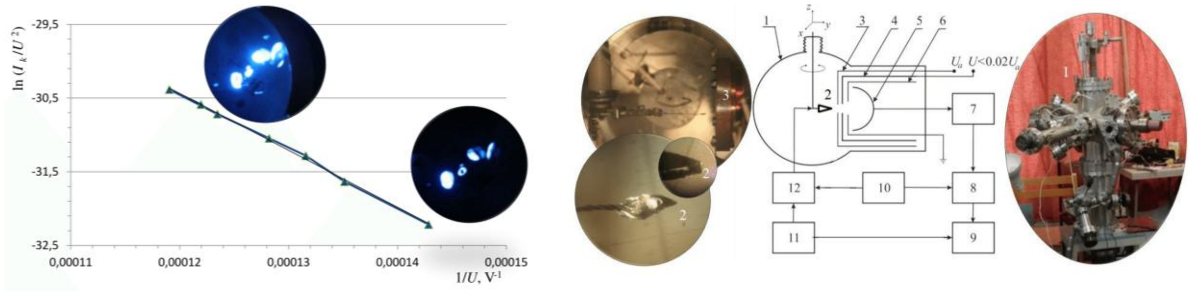


**Figure 1(a, b). (a)** Current-voltage characteristic and emission images of silicon carbide monolithic macro-sample emitter; **(b)** The principal schematic of the experimental set up, where 1 denotes vacuum chamber, 2 is cathode node, 3 – anode, 4 − electrostatic lens, 5 − hemispherical collector, 6 − protective cylinder, 7 − electrometric amplifier, 8 − synchronous detector, 9 − registering device, 10 − modulation block, 12 − signal adder.

## 3. Conclusion

This article discussed the problem of measurement of field emission energy distribution from silicon carbide by the retarding potential method. A description of a natural experiment setting is presented as well as a model of its electrophysical system of field emission current differentiation by modulated retarding potential. Prototype of field emission 6H-SiC monolithic cathode is studied and current-voltage characteristic is presented. Future work is characterisation of proposed silicon carbide cathode by field emission spectroscopy measurements in described experimental set up and methodology.

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