Nanowire Field Emitters Fabricated Using Helium Ion Microscopy Methods

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Field emission is a phenomenon on which many nanosensors can be based. The reason for this are small structural dimensions and low energy consumption. The required nanocomponents, like sharp nanowire field emitter (NW FE) electrodes, can be fabricated using a focused ion beam induced deposition (FIBID) process in a helium ion microscope (HIM). The advantages of this technology are nanometer resolution, flexibility and the possibility of easy integration with microelectromechanical systems (MEMS).

This contribution presents NW FEs fabricated by the FIBID process using a Zeiss Orion NanoFab HIM and a $W(CO)_6$ precursor. Calibration of the growth of tungsten NWs with a diameter of about 50 nm was performed. After confirming the absence of leakage currents of the MEMS structures, the NW FEs were deposited on a Si_3N_4 microcantilever – Figure 1. Using MEMS it was possible to test the performance of the fabricated FE nanosensor for measuring microcantilever deflection. For a cathode-to-anode distance of 120 nm, field emission was measured from a threshold voltage of 70 V. Stability tests of the studied phenomenon in the time domain and the response of the current value to a distance change between the electrodes were performed. Transmission electron microscope images showed non-significant changes in the structure of the NWs after field emission measurements.

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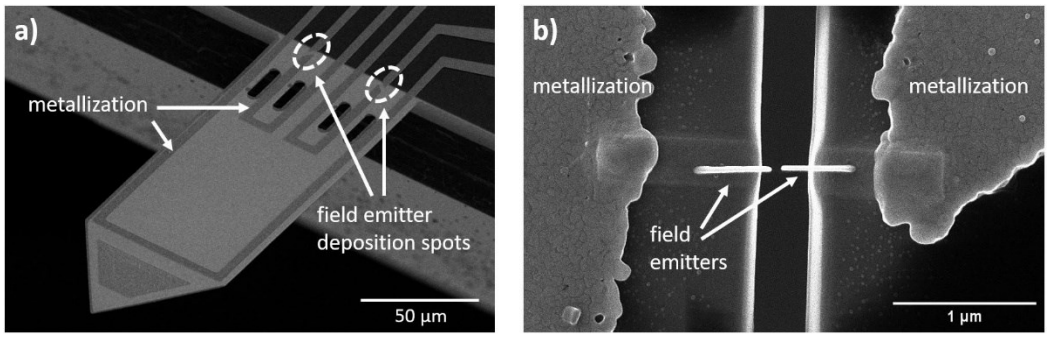

Figure 1: (a) Cantilever as a platform for depositing field emitters; (b) tungsten nanowire field emitters deposited by helium ion microscope.

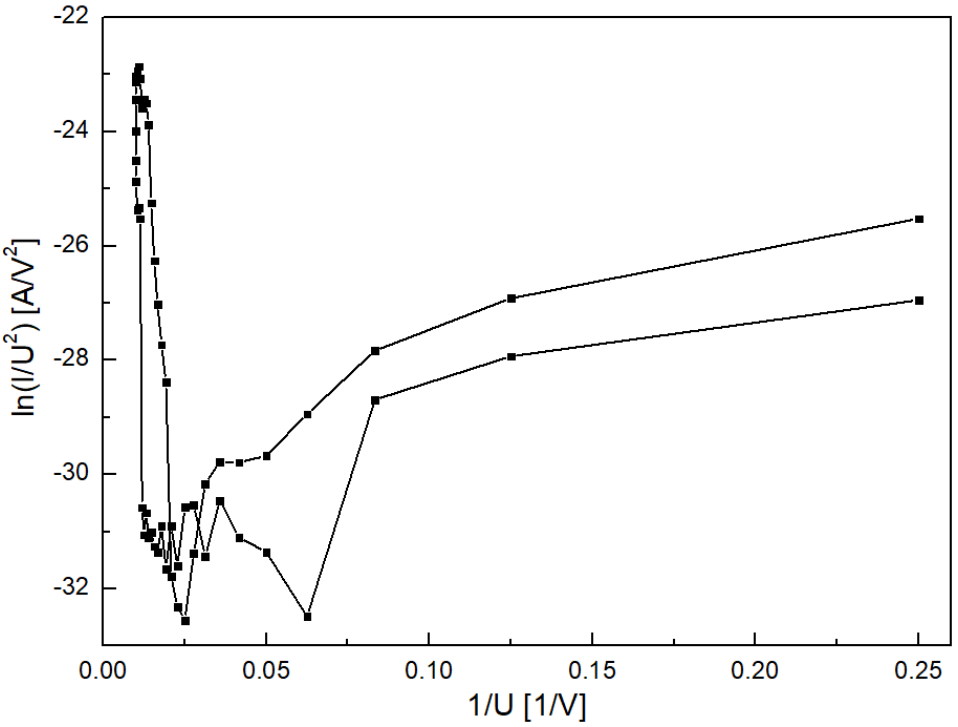

Figure 2: Fowler-Nordheim diagram for a tungsten field emitter biased from 0 V to -100 V and from -100 V to 0 V. The linear range corresponds to the field emission, from 70 V.