EMISSION PROPERTIES OF PtSi-COATED SILICON NANOCONES IN THE TRANSITION REGIME

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ABSTRACT

Modern research on cold field emitters focuses on both fundamental understanding of the emission process and characterization of materials and operating conditions. The practical aim is to determine emission materials that show high efficiency and good temporal stability [1]. Typical experimental systems are operated *in vacuo* and consist of at least a fixed-gap cathode-anode setup. Another way to locally probe the field emitter array is to make use of a scanning probe technique. In this study, we focus on silicon nanocones obtained through standard silicon (Si) device fabrication methods and sequentially coated them with sputter deposition of platinum to obtain a ~5 nm thick platinum silicide layer (PtSi) after a thermal silicidation step. Using PtSi, the aim was to prevent the formation of interfacial oxide present on silicon surfaces, form an ohmic contact with the p-type Si, and sustain a chemically inert and mechanically hard interface with good thermal stability. The fabricated structures were characterized using a scanning tunnelling microscope (STM), Fig. 1 a) - d). The procedure was to first approach the sample using a feedback controller bringing the probe into direct tunnelling distance, after which the feedback loop is switched off and I(V)-curves are recorded. The experiments are performed at different tip-substrate separations. Measurements were recorded on four different samples being the flat and nanostructured surfaces both with and without PtSi coating, yielding vast differences between the observed I(V)-curves. To understand the emission properties of the fabricated structures different barrier models were applied, Fig 1 e) – g). Also, a numerical study was performed. From these, it was observed that emission from the PtSi-coated Si nanocones is initially barrier limited (0 to ~-2V), after which (-2 to -8V) it is bulk transport limited [2]. The presence of a PtSi-coated nanostructure increases the barrier transparency and thus leads to the faster obtention of the bulk limited transport regime.

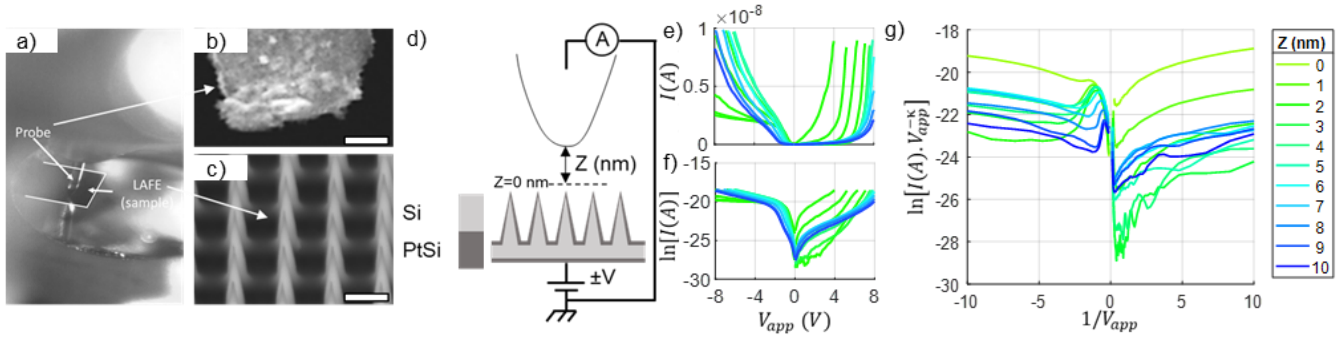

Figure 1: a) photograph of the STM probe above a large are field emitter (LAFE) electrode. b) SEM image of a Platinum Iridium tip used for STM measurements recorded after usage. c) SEM image of the PtSi-coated Si nanocone array. Scale bars in b) and c) represent 200 nm. d) schematic representation of the measurement setup, bias, V_{app}, is applied to the sample. Figures e) to g) show the recorded V,I spectra, and coordinate transformation for the Thermionic and Murphy-Good emission model, respectively. The legend shows that the curves are recorded from 0 to 10 nm relative z-distance, where z=0 is the setpoint found after the approach sequence.

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[2] L. M. BASKIN *et al*, J. Phys. Stat. Sol. (b) (1971) 47, 49