Experimental Studying of CNT Field Emission Array with Double Insulator

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We present the results of experimental investigations of cathode-gate structure containing carbon nanotubes (CNTs). In order to create devices with instantaneous readiness time including low-voltage gate control, triode microcells with a vertical location of CNTs are necessary to form linear pencil or sheet electron beams. These field-emission triode designs of microcells should provide the required value of the electric field at the tips of the CNT and the minimum perturbation of the beam due to the lens effect of the extracting gate. Studies of cathode-gate triode structures with CNTs with gate on a silicon oxide insulator remain topical. These studies should define the way of reducing the effect of mutual field shielding and the emittance of the beam to build linear RF devices with low-voltage control of the beam.

The field emission cell was modified using a double film of silicon dioxide to eliminate leaks in the cathode-grid circuit and to verticalize CNT bundles. A 500 nm thick dielectric lower film was fabricated using ICP-PECVD plasma chemical deposition. The largest raster is created at the upper layer of silicon dioxide, while locally grown nanotubes do not touch the surface of the dielectric groove, which made it possible to increase the breakdown voltage of the cathode-grid in experiments. The field emission triode microstructures were fabricated using lithographic processes on a silicon substrate with titanium film gate deposited on silicon oxide (Fig. 1). CNT bundles obtained locally by a process called PE-CVD (plasma enhanced) at a temperature up to 500°C. The synthesis was conducted in an argon flow in the presence of ethylene as a reagent at a reactor pressure of 1 Torr.

Investigations of the current–voltage characteristic of performing FEC based on the cathode–grid structure with diameter of 0.8 mm demonstrated that the field emission current easily had achieved the level of 14 mA. Measurements were conducted in a vacuum test camera, at which it was possible to register I-V characteristics in pulse mode (fill factor of 0.5%, duration of pulse of 50 um) at a pressure of 10^{-7} Torr. Figure 2 presents field emission characteristic of the electron gun based on CNT cathode located at the center of assembly. The measuring of the current was conducted at fixed 200 V anode voltage.

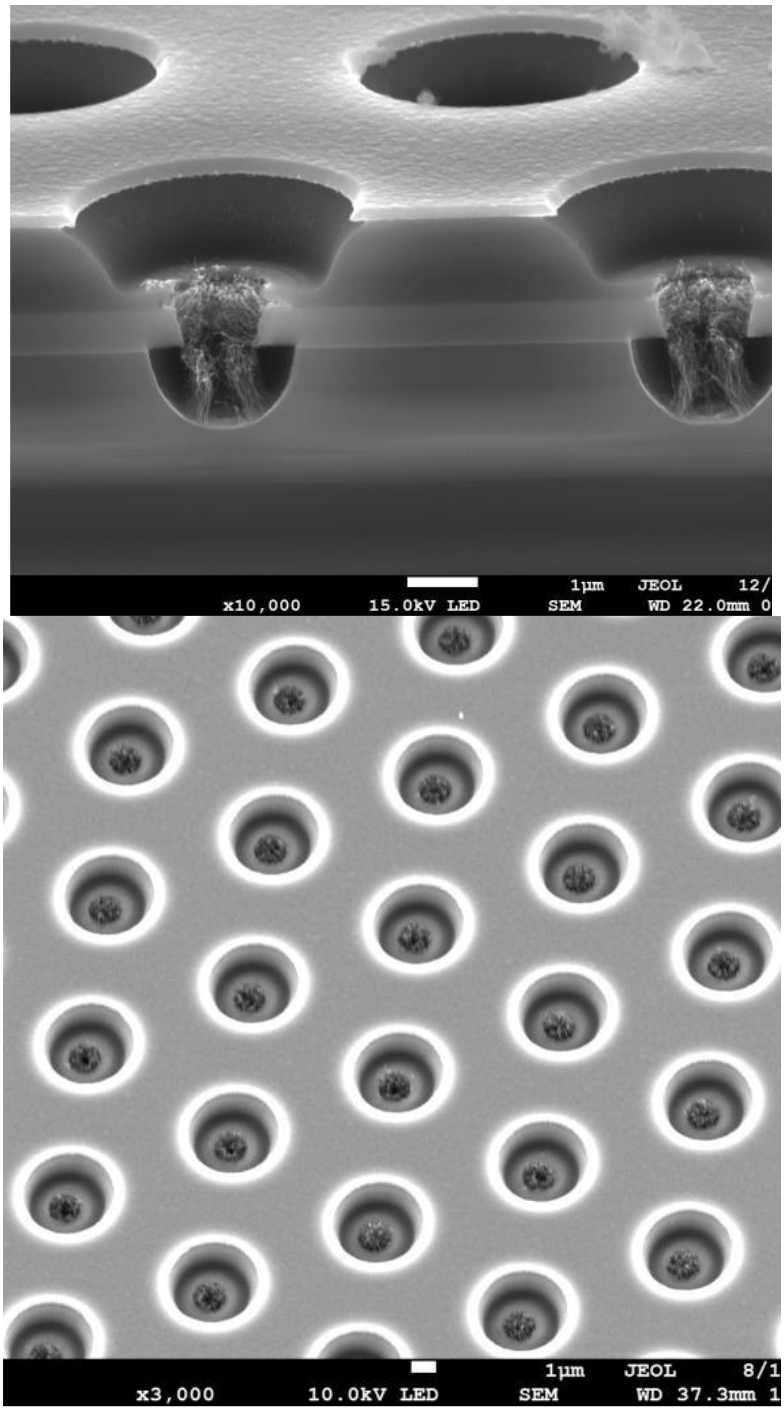

Figure 1: Configuration of a CNT cathode-gate structure and enlarged image.