The field emission mechanism of carbon nanotube at a small anode-cathode distance

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It is known the distance between the neighboring point cathodes into the matrix Spindt cathode is a few microns. For this reason the distance between the anode and the cathode is less than 1 micron. If the anode-cathode distance is less than the nanotube length, the anode and the nanotube cathode are united as the electrical dipole. The charge of the nanotube tip is formed the point charge on the anode surface. In this case the anode may emit the electrons like the nanotube at low voltage. If we change the polarity of the electrodes the I-V characteristic will be a symmetrical function.

In this study we investigated the field emission from carbon nanotubes when the distance between nanotube and anode less 1 mkm. The model of nanodiode was assembled into a scanning electron microscope Carl Zeiss NEON 40 and contained the nanotube emitter with diameter of 10 nm and a length 1 mkm which was attached to the surface of the Ni cathode. The end of tungsten anode has a diameter 200 nm. The nanotube-cathode distance was equal to 700 nm. The I-V characteristics were measured at voltages below 10 V with step 30 mV. It was found the emission current is observed at the change of the polarity of the electrodes of nanodiode when the vacuum gap between the anode and the nanotube is less than the length of the nanotube. It should be noted, that often the magnitude of emission current from the anode is more than the one from nanotube, what may be explained the good ohmic contact of 3D anode with 3D electron source. We observed the resonance peaks near Van Hove singularity and the threshold voltage on I-V characteristic.

The mechanism of the observed phenomenon will be discussed.