Tungsten carbide emitting nanoprotrusions as effective field emission point sources of the electrons and ions

Golubev O.L.

Ioffe Physico-Technical Institute, 194021 St. Petersburg, Russia
e-mail: O.Golubev@mail.ioffe.ru

The field emitters with high degree of emission localization within small solid angles can be of considerable interest as effective sources of electrons and ions for various high resolution beam devices. With the purpose of creating of the stable point sources the form changes of a field emitter from tungsten carbide at simultaneously action of strong electric fields F and high temperatures T (thermo-field treatment) were studied. It was shown that to create on an emitter surface the some emitting nanoprotrusions with the radii of curvature about r ~ 1-5 nm by means of thermo-field treatment is not so difficult problem. The emitters with many nanoprotrusions on a surface can be realized by thermo-field treatment in wide range of F and T changes, these emitters allow to create the electron sources “watering-pot” type with many separate electron beams. However the formation of a single nanoprotrusion on the emitter surface and point source creation is a certain problem [1]. A single nanoprotrusion on a tungsten carbide emitter surface can be produced by the specially procedure of change of F value at definite value of T. The single tungsten carbide nanoprotrusion can emit of the electrons with such stability as the emitters from carbon materials. The values of emission currents, current densities, emission angles and reduced brightnesses of the emitter are comparable with the values typical for the carbon nanotubes emitters. But the evident advantages of the tungsten carbide nanoprotrusion is the possibility to recover its performance by repeating the procedure of thermo-field treatment as described above. Moreover, the tungsten carbide nanoprotrusions (in contrast to carbon nanotubes) can operate as the point emitter of ions under the simultaneous action of high T and F in the regime so-called high-temperature field evaporation.

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[1] O.L. Golubev, *Technical Physics Letters* **35**(6), 545 (2009).