Carbon Sp^2/Sp^3 Nanocompounds as Promising Materials for Field Emission

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The unique field emission properties of nanocarbons make them promising to become the base for the new generation of vacuum electronic devices and especially for flat electroluminescent displays and light sources.

However, in spite of intensive investigations there is no significant progress in this field. The main conclusion of the most publications on field emission from nanocarbons is that one cannot explain the observed levels of emission current by simple Fowler-Nordhaim model. To fit the experimental values of current one needs to use the unrealistic values of work function (0.1-0.01 eV) and has to assume the local concentration of electric field with aspect ratio more than 1000. However, the direct calculation gives the noticeable drop down of work function for instance, for the edges of the separate graphene sheets, only at the applied field 10^{11}-10^{12} V/cm. Moreover, it is well-known, that the emission current from nanocarbon concentrates in a number of local points (emission centers) while the rest surface of the nanocarbon emitter remains passive and keeps the value of work function in agreement with calculations. The application of phonon drag effect in local area [1] is restricted by the requirement on excessively high value for temperature gradient along emitter.

We have investigated the field emission in the layers of 2 types of carbon materials: diamond-like films (DLF) and ultrananocrystalline diamond (UNCD). All of them have shown the similar distribution of emission centers and the same value of the effective work function, derived by Fowler-Nordhaim expression from the measured field-current dependences.

The main feature of field emission from all mentioned materials was that to obtain the observed values of the emission current and threshold electric field one had to perform so-called activation of the emission by short time applying extra value of field to the sample. Such action caused the break down-like appearance and increasing of the emission current. After activation the current – field dependences of the material still remain stable and reproducible during several hours and then the vanishing of emission had taken place. The repeated activation returned the same value of emission current. Such a behavior of the emission is quite similar to the effect of anomalous secondary emission, observed by Malter [2].

We have compared different theoretical approaches for explanation of high field electron emission from nanocarbon materials [3-4] and suppose that the models suggested in [1, 2], have to be modified for adequate description of that field electron emission from nanocarbons.

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