Field-induced electron emission from graphitic nano-island films at silicon substrates

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Numerous carbonic nano-structured materials were reported to demonstrate electron emission in moderate electric field (1 kV/mm or less), even if their surface morphology shows no edges or tips capable of strong local field enhancement. In many such cases, the actual mechanism of emission facilitation remains unclear, partially due to complex structure of the investigated materials usually representing a 3-dimensional system of domains with different properties. In the presented work we investigated a somewhat simpler, quasi-2d system, presumably providing better possibilities for unambiguous description of the emission mechanism. The sample emitters were produced by chemical deposition of small amounts of carbon at silicon substrates. Depending on deposition conditions, the coating layer had different structure and different average thickness. For some samples, the threshold electric field (corresponding to 1 nA current extracted from a few mm^2 area) was as low as 0.4 kV/mm. Other samples yielded no current in the field up to 10 kV/mm. We investigated correlation between emission efficiency and carbon layer morphology determined via AFM imaging. According to our observations, the property of low-field emission was associated with the presence nm-sized carbon islands isolated from each other (see Fig.1). Facilitated emission wasn't observed if the carbon domains merged to form a continuous film. The best emission properties were obtained for samples deposited at p-type substrates with high electric resistance. Results of these experiments could be explained within the bounds of the model proposed earlier for other nano-carbon systems [1].

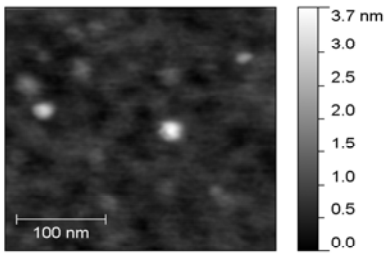

Figure 1. AFM image for a sample demonstrating low-field electron emission (threshold field is 0.38 kV/mm). The bright spots presumably represent isolated graphitic islands.

[1] A.V. Arkhipov, P.G. Gabdullin, M.V. Mishin, *Fullerenes, Nanotubes and Carbon Nanostructures* **19**(1-2), 86 (2011).