Carbon films for use as the electron source in a parallel e-beam lithography system

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The overall aim of this work is to produce a parallel e-beam lithography system using an array of field-emitting microguns independently driven by an active matrix array. This paper will describe the work carried out on optimisation of suitable carbon-based materials for use as the electron emitter source in such a system. From initial experiments on field emission from tetrahedrally bonded amorphous carbon (ta-C) and nanocluster carbon films, it has been deduced that emission occurs from nanometre-size sp^2 sites within an insulating sp^3 matrix. Hence, we have carried out a series of experiments to investigate the possibility of deliberately producing such sp^2 regions within a predominantly sp^3 matrix using e-beam irradiation, high energy ion beam irradiation and post deposition plasma processing of ta-C. Unfortunately, although the use of 1GeV uranium ions successfully produced arrays of sp^2 rich regions on the required nanometre scale, no preferential field emission from such sites could be obtained. The final series of experiments were thence carried out using aligned carbon nanotubes (CNTs) as the electron sources. Results on aligned CNTs, grown using a dc plasma technique and a Ni catalyst, are presented. Both the diameter and length of the CNTs are dependent upon the thickness of the catalytic layer used. Field emission from an array of CNTs was obtained.