NANOWIRES AND NANOTUBES FOR FIELD EMISSION DISPLAYS, PARALELL E-BEAM LITHOGRAPHY AND MICROWAVE AMPLIFIERS

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According to T. Utsumi[1], the ideal electron emitter's shape for field emission application is a vertically aligned nanocolumn. For such emitters, the geometrical electric field enhancement at the emitter apex can be very high, which leads to electron emission at low voltage.

For application requiring emitter arrays, the ideal design is an array of identical and vertically aligned nanocolumns spaced apart by twice their height[2]. If the emitter density is higher, then a field screening effect appears leading to a dramatic reduction of electron emission.

We have studied aligned nanocolumn arrays of two different types : first, metallic Nanowires[3] grown at room temperature by electrodeposition into nanoporous templates; second, carbon Nanotubes/Nanofibers[4] (CNs) grown at 700°C by catalytic plasma enhanced chemical vapour deposition.

The Nanowire fabrication process allows to grow stochastic arrays of 2 µm height and 20 nm diameters vertically aligned Cobalt Nanowires with a predetermined density (see fig.1). As this type of array is grown at room temperature with a large area fabrication process, we think that this technology is particularly adapted to Field Emission Display requirements.

The CN fabrication process leads to the ideal array's growth, i.e. a regular array of nearly identical and vertically aligned emitters (see fig.2). Individual emitter can emit up to 80 µA and a current density of 1.2 A/cm^2 has been obtained at 1.5 GHz from a 0.5 x 0.5 mm CN cathode.
These results demonstrate that Carbon Nanotubes are excellent candidates for a new generation of cold cathodes which may be used in electron devices as Microwave amplifiers.

Fig. 3 shows that CN gated microcathodes using a self aligned process can be fabricated. The use of such electron sources for parallel e-beam lithography will be discussed.

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References:

[1]T. Utsumi et al., IEEE Transactions on electronic devices, **38** 2276 (1991).
[2]L. Nilsson et al. Appl. Phys. Lett. **76** 2071 (2000).
[3]L. Vila et al., Nanoletters **4** 521 (2004).
[4]K. Teo et al., Nanotechnology **14** 204 (2003).

Figures:

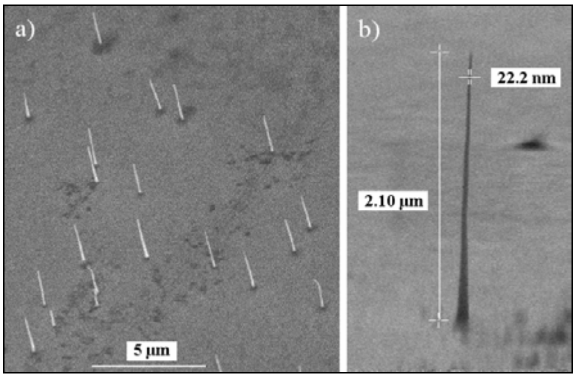

Fig. 1 : Array of 2.1 µm height and 22 nm diameter Cobalt Nanowires

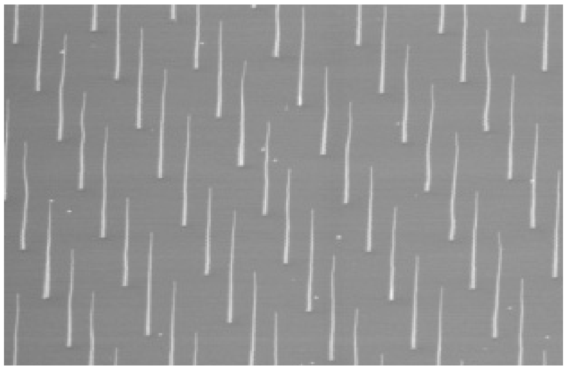

Fig. 2 : Array of 5 µm height and 50 nm diameter CNs

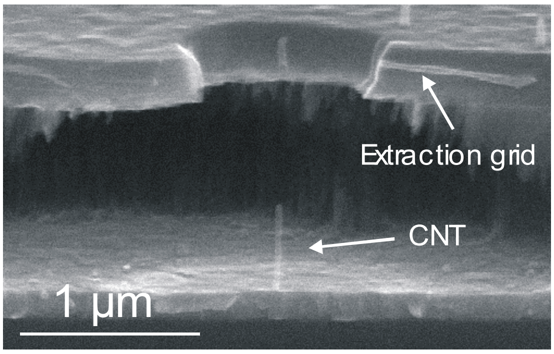

Fig. 3 : Tilted SEM view of a gated microcathode after growth of a 0.5 µm height CN.