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Published in:

Technical Digest of the 17th International Vacuum Nanoelectronics Conference, 2004. IVNC 2004.

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version

Publisher's PDF, also known as Version of record

Publication date:

2004

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Schnell, J-P., Minoux, E., Gangloff, L., Vincent, P., Legagneux, P., Dieumegard, D., David, J-F., Peauger, F., Hudanski, L., Teo, K. B. K., Lacerda, R., Chhowalla, M., Hasko, D. G., Ahmed, H., Amaratunga, G. A. J., Milne, W. I., Vila, L., Dauginet-De Pra, L., Demoustier-Champagne, S., ... Michielsen, K. (2004). High current density nanofilament cathodes for microwave amplifiers. In *Technical Digest of the 17th International Vacuum Nanoelectronics Conference, 2004. IVNC 2004.* (pp. 278-279). University of Groningen, The Zernike Institute for Advanced Materials.

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HIGH CURRENT DENSITY NANOFILAMENT CATHODES FOR MICROWAVE AMPLIFIERS

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High current density ($\geq 1\text{A}/\text{cm}^2$) and high emitted current ($\geq 10\text{ mA}$) from cold cathodes are needed for RF power applications.

A dense vertically aligned nanofilament array is theoretically the best configuration. However a good emitter shape uniformity and a high current per emitter are essential to attain such performances.

Two different types of aligned nanofilament array have been studied: first, metallic Nanowires grown by electrodeposition into nanoporous templates at very low temperature ($T < 100^\circ\text{C}$) on a silicon wafer (see figure 1); second, carbon Nanotubes/Nanofibers (CNs) grown by catalytic plasma enhanced chemical vapour deposition (see figure 2).

The fabrication process and the field emission properties of these two types of cathodes will be presented.

Presently, the best results are obtained with CN cathodes. Arrays of $5.8\ \mu\text{m}$ height and $50\ \text{nm}$ diameter CNs exhibit geometrical enhancement factor (h/r) of $240 \pm 7.5\%$. Moreover, currents close to $100\ \mu\text{A}$ per emitter have been measured using a scanning anode field emission microscope. Due to these properties, $0.5 \times 0.5\ \text{mm}^2$ arrays emit a 2mA current corresponding to $0.8\text{A}/\text{cm}^2$, in DC mode.

The same cathodes were tested at $1.5\ \text{GHz}$ in a reentrant cavity experimental set-up, and exhibited $1.2\ \text{A}/\text{cm}^2$ at this frequency.

To our knowledge, that is the first report of a significant current at microwave frequency emitted from CN cathodes.

The use of these cold cathodes in microwave triodes delivering 10 to 50W at $30\ \text{GHz}$ will be discussed for future telecommunication applications.

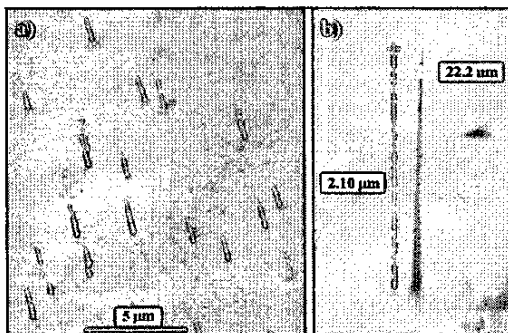


Fig. 1 : Array of $2.1\ \mu\text{m}$ height and $22\ \text{nm}$ diameter Cobalt Nanowires

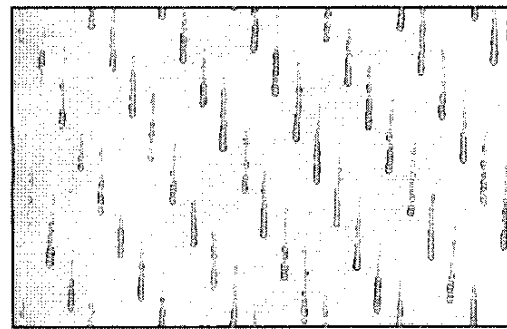
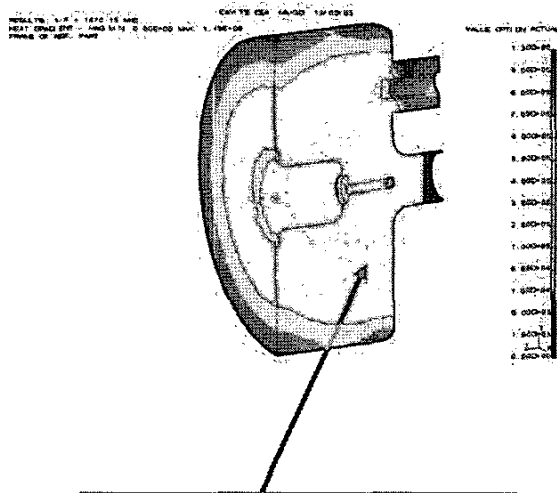


Fig. 2 : Array of $5\ \mu\text{m}$ height and $50\ \text{nm}$ diameter CNs



Carbone nanotubes in a high electric field area

Fig. 3: Calculated electrical field distribution in the 1.5 GHz reentrant cavity.

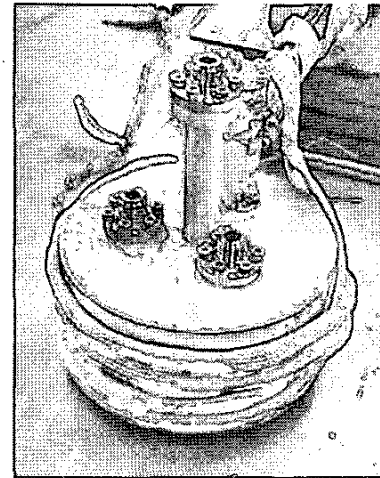


Fig. 4: View of the 1,5 GHz reentrant cavity

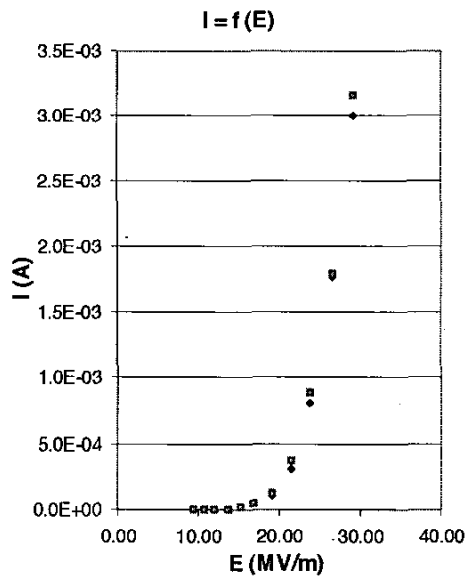


Fig. 5: Experimental I (E) emission current curve from a CN cathode versus the electrical field applied at the frequency of 1.5 GHz.

Acknowledgements : The authors wish to thank M.Desmons and M.Luong from DAPNIA/SACM/CEA Saclay for the disposal of the 1.5 GHz experimental set up.

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