Novel approach for high performance field emission electron sources

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Enhancing the electron emission of multiwall carbon nanotubes (MWCNT) is key for applications ranging from cold cathodes used in high-resolution electron microscopes to portable X-ray imaging systems. In a paper recently published in *Nanotechnology*, a team led by Professor My Ali El Khakani, from the Energie Matériaux Télécommunications Research Centre of INRS (INRS-EMT), has reported an original approach for the development of novel graphenated-MWCNTs with enhanced field electron emission (FEE) properties.

The tips of these MWCNTs are made of deployed graphene sheets. By appropriately decorating those graphene sheets with gold nanoparticles, the INRS-EMT team was able to increase significantly the density of electron-emitting sites, and thereby improve their FEE performance. A transmission electron microscopy (TEM) image of these impressive nanohybrid FEE structures was chosen by the journal editor to be featured on the cover page of the *Nanotechnolgy* journal.

The MWCNTs are excellent field electron emitters due to their stability and electronic conduction at room temperature, but there is still challenges to maximize their emission current at the lowest applied electric field possible. In this context, the two-step growth process developed by INRS researchers was demonstrated to enhance effectively the FEE performance of these new cold electron emitting cathodes.

The team used a plasma-enhanced chemical vapour deposition (PECVD) process to grow the carbon nanotubes, while optimizing the plasma

growth conditions to produce MWCNTs with tips made of deployed graphene sheets. In a second step, by capitalizing on their expertise in the field of laser ablation, they decorated these graphenated-MWCNT (g-MWCNT) structures with 2-3 nm-diameter gold nanoparticles (Au-NP). The new nanohybrid structures (g-MWCNT/Au-NP) have a significantly higher density of electron-emitting sites, which greatly enhances the field electron emission. "The unique electronic structure of graphene along with its particular surface topography make it an ideal substrate for decoration with gold nanoparticles. Those Au-NP contribute positively to the FEE process through the enhancement of the local electron field, which in turn maximizes the electron emission from these g-MWCNT/Au-NP nanohybrid," explains Professor El Khakani.

The development of these new nanohybrid emitters opens new prospects for their application as cold cathodes in portable, low voltage, highly brilliant electron sources.

More information: Field electron emission enhancement of graphenated MWCNTs emitters following their decoration with Au nanoparticles by a pulsed laser ablation process, DOI: 10.1088/0957-4484/26/4/045706

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