CNT-Based Devices Using Thin-Film Technologies (#5806)

A thin-film triode design for CNT-based field emission to reduce the size and increase the efficiency of carbon nanotube (CNT)–based field emission devices

Georgia Tech researchers and ELSYS and SSC Pacific, respectively, have developed a thin-film triode design for CNT-based field emission to reduce the size and increase the efficiency of carbon nanotube (CNT)–based field emission devices, taking a major step toward achieving a portable source for electrons. This innovative triode design uses a dielectric layer to separate a conductive substrate from a counter-electrode (or gate electrode). Isotropic wet etching of an array of micron-scale pits in the dielectric layer enables bundles of CNTs to be synthesized in each pit through chemical vapor deposition. This approach creates a buffer zone around the CNTs, ensuring they are close to—but do not contact—the gate, which would cause a short. This design achieved a current density of 293 uA/cm^2 at 200 V in a lightweight package, enabling the development of portable electron source devices.

Benefits/Advantages

- Requires very low operating voltage
- Yields a compact field emitter package
- Avoids electrical shorts caused by emitter-gate contact
- Offers better fabrication, eliminating construction and emitter growth defects

Potential Commercial Applications

- Spacecraft electric propulsion
- Field emission (flat panel) displays
- X-ray sources
- Telecommunications equipment
- Lighting
- Vacuum electronics devices

Background/Context for This Invention

Having a lightweight, efficient source of electrons is a major goal for spacecraft electric propulsion systems as well as a range of other applications. CNTs offer great promise for improved field emission performance given their very high electrical conductivity, high temperature stability, chemical inertness, and nanoscale geometry. However, CNT-based emitters face significant fabrication challenges. There is a need for a innovation that addresses those challenges.

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More Information

U.S. Patent Issued - 9,058,954

U.S. Patent Issued - 8,604,681

Publications

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Oxygen Plasma Resurrection of Triode Type Carbon Nanotube Field Emission Cathodes, Diamond and Related Materials, 2014

A Thin Film Triode Type Carbon Nanotube Field Emission Cathode, Applied Physics, 2013

Carbon Nanotube Field Electron Emitters Will Get Space Testing, Nov. 13, 2013

ALICE (AFIT LEO iMESA CNT Experiment), NASA mission webpage, Launch Date: 2013-12-06

ALICE, SpaceFlight101.com

ALICE, Gunter's Space Page

For more information about this technology, please visit:
https://licensing.research.gatech.edu/technology/cnt-based-devices-using-thin-film-technologies

Images:

The automated sequential delivery of multiple fluids. A varying number of delay gates imprinted in the branches are shown in the figure.

COVID-19 and flu saliva test on paper: (A) The automatic sequential delivery of multiple reagents required for virus test; (B) Water pouring into the device triggers the virus assay, allowing the presence of SARS-CoV-2 and influenza A & B viruses to be visually identified by the color changes in the corresponding detection spot