LA-UR 12-00592

Licensable Technologies

A Photo-Stimulated Low Electron Temperature High Current Diamond Film Field Emission Cathode

Applications:

- Medical X-ray devices
- High through-put industrial electron sheet beam processing
- High volume electron beam food and material sterilization
- High power RF systems
- General replacement of thermionic electron devices

Benefits:

A new generation of vacuum electronic devices with an order of magnitude increase in power and frequency.

- Higher power density
- Uniform electron beam emission
- Single pulse, D.C., and high frequency operation
- Widely variable from factor
- Very low maintenance
- Longer lifetime
- Robust for harsh environments

Contact:

Marcus Lucero
(505) 665-6569
marcus@lanl.gov

tmt-2@lanl.gov

Technology Transfer Division

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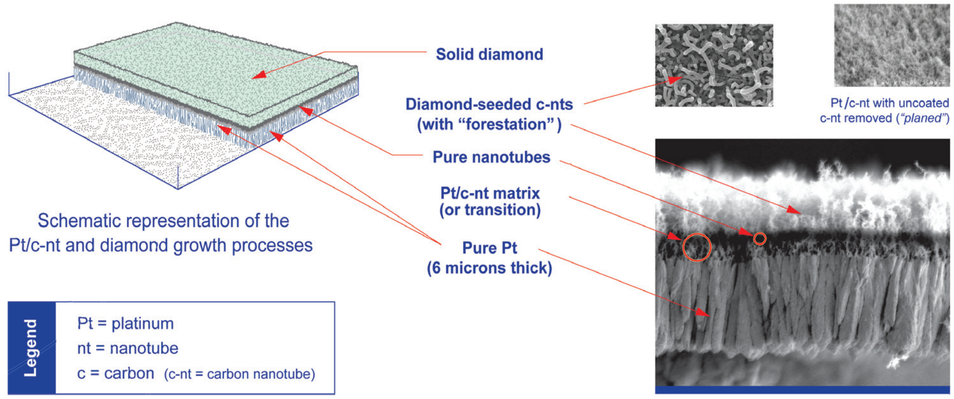

Summary:

For the past 50 years, vacuum electronics have enabled technological innovations; including microwaves, x-rays, and cathode ray tubes. Thermionic cathodes and photocathodes are the two standard sources of the essential electron beams that amplify or create radiation used in vacuum electronics. Both now face obsolescence because of their inherent properties. For example, thermionic sources require high heat to expel electrons, and photocathodes require a laser driver and use highly reactive alkali metal compounds. Both cathodes have power limitations, too. Today's high-power, high-frequency vacuum electronics is hampered by these restrictions, and industry also demands better beam quality, a longer lifetime, and less maintenance.

Researchers at LANL have developed a novel, ultra-high-quality, robust electron source, which uses nanostructured polycrystalline diamond in a matrix with single-walled carbon nanotubes (SWCNs).

Diamond has a high thermal conductivity—five times that of copper—which makes it an ideal solution for application in harsh environments and high-duty-cycle systems. The diamond cathode does not require the heat needed by thermionic cathodes or the laser-driver requirements of photocathodes. Release from these restrictions simplifies our cathode's use in high-power RF systems and extends its capabilities by at least an order of magnitude in terms of power and frequency.

Nanostructure diamond cathodes can operate at relatively moderate vacuum pressures due to the inert surface/vacuum interface. This n-type device is particularly adaptable to high-frequency systems with periods on the order of a nanosecond or less. The ability to illuminate the cathode back surface with a variable power continuous wave laser promotes a uniform charge mobility within the diamond bulk and subsequent high brightness electron beam emission.

Development Stage: (Experimental)

Patent Status: Patent pending

Licensing Status: Los Alamos National Laboratory is seeking partners interested in joint collaborative and/or exclusive or nonexclusive licensing opportunities.

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