technology ■ opportunity

National Aeronautics and Space Administration
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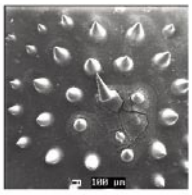
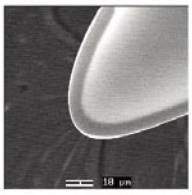
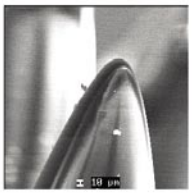
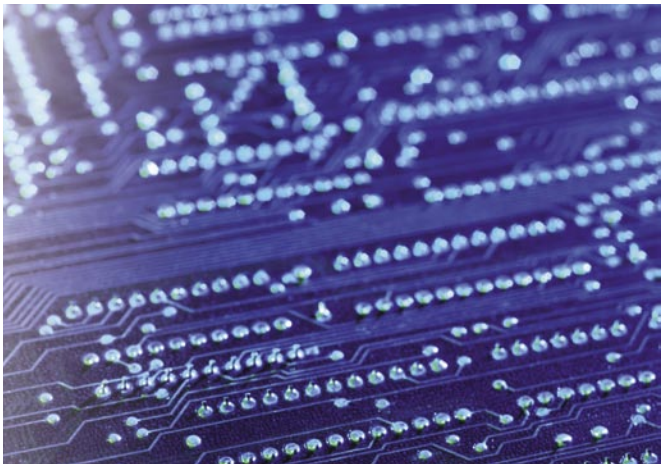
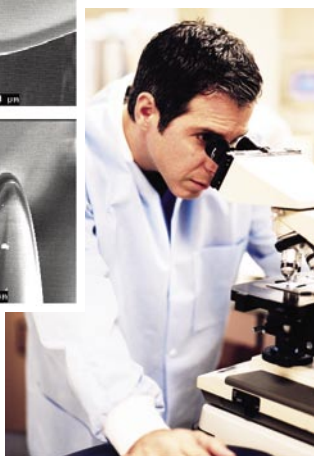
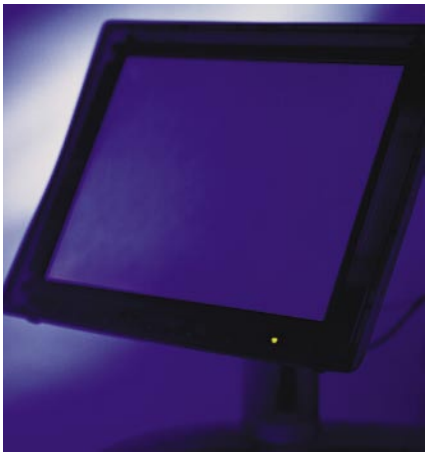
electronics

Simple, Low-Cost Method for Producing Submicron-Sized Tips

...for field emitters and atomic microscope styli



NASA Goddard Space Flight Center invites companies to license this method for producing arrays of pointed structures or cones used in a wide variety of electronic and mechanical equipment applications. This low-cost, simple method yields a template containing large numbers of cones that are uniform in size and equally spaced. This template then can be easily coated with metals or semiconductors to tailor the mechanical and electrical properties of the tip.

Benefits

- **Low cost**: This method uses basic equipment and an inexpensive, commercially available material to produce the pointed-tip arrays.
- **Versatile**: The template can be formed on a wide variety of substrates (e.g., glass, quartz, sapphire) and can be coated with various materials (e.g., zinc oxide [ZnO] and other semi-conductors, metal).
- **Scalable**: Unlike other methods which yield arrays of limited size, this process has the potential for large-scale (>4") fabrication of pointed-tip arrays.
- **Simple**: This three-step process is an easy alternative to materials synthesis and etching techniques, which are the current standards for making pointed-tip arrays.
- **Consistent**: The method yields a template of needle-like tips uniformly aligned and with a high aspect ratio.

Applications

This technology is expected to provide a low-cost electron source useful in a wide range of electronics and mechanical equipment applications:

- Field emission displays
- Field emission devices
- Photocathodes
- Scanning tunneling microscopes
- Atomic force microscopes
- Far ultraviolet (UV) photolithography
- Low-power propulsion systems

Technology Details

How it works

Micron- and submicron-sized pointed structures are used in electrical and mechanical equipment applications where sharp tips are needed. However, existing methods to produce these structures—materials synthesis and etching—are plagued with difficulties. The equipment (e.g., deep reactive ion etching) can be very expensive, and the resulting arrays are small with tips/cones of varying heights and aspect ratios. However, a researcher at NASA Goddard Space Flight Center has developed a new, cost-effective process for producing large numbers of uniform point structures.

This innovative, low-cost process involves dropping or spinning a ferrofluid (i.e., a liquid containing Fe_2O_3 particles) onto a glass, quartz, or other substrate. A magnetic field is then applied using simple permanent or electro-magnets, causing the ferrofluid to form pointed structures that are uniformly aligned with a maximized aspect ratio. The ferrofluid then is dried at room temperature. The result is a template that can serve as a substrate for subsequent film growth through any standard thin-film deposition technique, including evaporation, sputtering, or chemical vapor deposition. (Templates have survived vacuum testing at 10^{-6} Torr.) The conformal films applied to the template will reflect its pointed structure.

NASA's ferrofluid technique may be particularly useful for creating emitters to be coated by wide bandgap semiconductors, which can absorb and emit electrons in the ultraviolet light bands. These materials, such as readily available ZnO, are an excellent alternative for the traditional large, high-voltage photocathode systems. Coating the templates created with Goddard's technology with ZnO or other oxides avoids the oxidizing properties associated with metals typically used in photocathodes (e.g., tungsten, chromium). Therefore, the photocathodes are less susceptible to contamination, decay, and radiation damage and may be more chemically and structurally stable.

NASA Goddard is pursuing patent protection for this technology.

Partnering Opportunities

This technology is part of NASA's Innovative Partnerships Program, the goal of which is to transfer technologies into and out of NASA to benefit both NASA space missions and the American public. NASA invites companies to consider licensing this process for use in commercial applications.

For More Information

If you are interested in more information or want to pursue transfer of the method for producing submicron-sized tips (GSC-14871-1), please contact:

Office of Technology Transfer
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submicron-tips@gsfc.nasa.gov

More information about working with NASA Goddard's Office of Technology Transfer is available online:
http://techtransfer.gsfc.nasa.gov