National Aeronautics and
Space Administration

Novel Nanoionic Radiofrequency Switches

Compact, robust, and reliable nanoelectronic circuitry for automotive applications

TECHNOLOGY OPPORTUNITY

Scientists at NASA's Glenn Research Center have developed nanoionics-based radiofrequency (RF) switches for use in communications, sensing, and control systems in automotive vehicles. These innovative nanoionic devices have the potential to replace microelectromechanical systems (MEMS) and conventional RF semiconductor devices in automotive systems. Nanoionic switches offer the superior RF performance and low power consumption found in MEMS switches, with higher reliability and without the need for higher electrical voltages. Nanoionics-based RF switches also offer the durability, high-speed operation, and low cost of semiconductor devices.

BENEFITS

- **Low power:** Requires 1 volt versus 50 to 60 volts for microelectromechanical's (MEM's)
- **Lower cost:** Less expensive than MEMS and uses conventional integrated-circuit fabrication techniques, with as little as five processing steps
- **Simpler:** Nonvolatile—meaning no power is required to maintain a particular state (e.g., ON or OFF)
- **Faster:** Comparable in speed to solid-state electronics
- **Rugged:** Maintains superior performance as compared to a mechanical connection
- **Reliable:** Has no moving parts, providing greater reliability and longer mean time before failure (MTBF)
- **Better RF performance:** Has the potential to circumvent RF performance limitations associated with solid-state switches

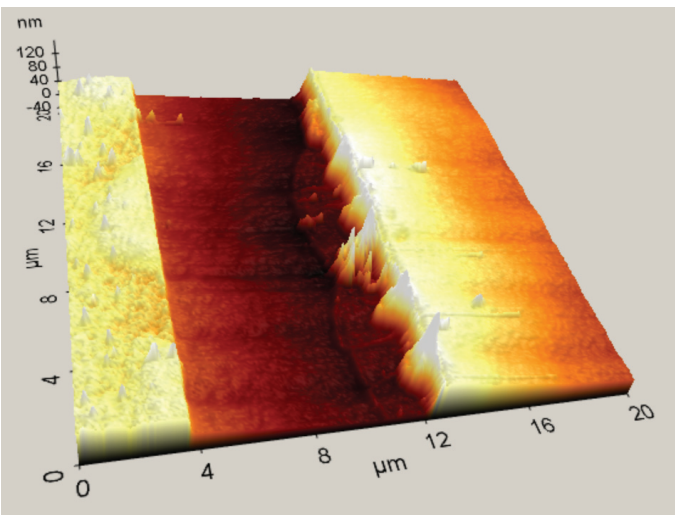
APPLICATIONS

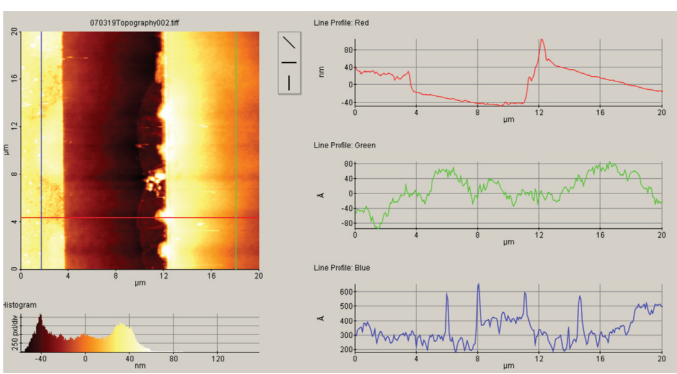
- Conformal antennas for collision avoidance systems (e.g., ranging and autonomous deceleration) and navigation (e.g., Global Positioning System (GPS))
- Communications and data storage
- Smart keys and safety devices
- Automotive sensing and diagnostic systems (e.g., engine performance, fuel consumption, emissions, cabin temperature control, tires, windows, etc.)

HOW IT WORKS

Nanoionic switches exploit the properties of some amorphous materials that can incorporate relatively large amounts of metal and behave as solid electrolytes. The ionic conductivity of such a material can be of the same order of magnitude as the electronic conductivity of a semiconductor. Ions are formed at an anode and migrate into the solid electrolyte while electrons are injected from a cathode, thereby causing the growth of metal nanowires through the electrolyte from the cathode to the corresponding anode.

Once a nanowire has grown sufficiently to form an electrically conductive path between the electrodes, there is no need to continue to apply electric power to maintain the connection. The process of making the connection can easily be reversed by applying a reverse bias to re-oxidize the metal atoms in the solid electrolyte to recreate the insulating amorphous layer. Thus, a nanoionics-based switch is a reversible electrochemical switch that can have geometric features as small as nanometers. The process time for making or breaking the connection is about a nanosecond.





Electrochemical switch—before turn-on.

WHY IT IS BETTER

- Nanotechnologies collect, process, and communicate more data than conventional semiconductor and MEMS devices with less size, weight, and power consumption.
- Reliable, durable, and low-cost nano-electronic circuitry can be embedded into a vehicle's wireless communications, navigation, entertainment, and onboard sensing systems to improve performance and enhance product features and benefits.
- Inexpensive, low-voltage, high-speed nano-electronic logic circuits have better RF performance than conventional semiconductor devices.

PATENTS

Glenn has patented this technology (U.S. Patent No. 7,923,715).

LICENSING AND PARTNERING OPPORTUNITIES

Glenn's Office of Technology Partnerships and Planning seeks to transfer technology to and from NASA to benefit the space program and U.S. industry. NASA invites companies to consider licensing the Nanoionics-Based Switches for Radio Frequency Applications (LEW–18313–1).

FOR MORE INFORMATION

For more information about this and other technology licensing opportunities, please contact

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