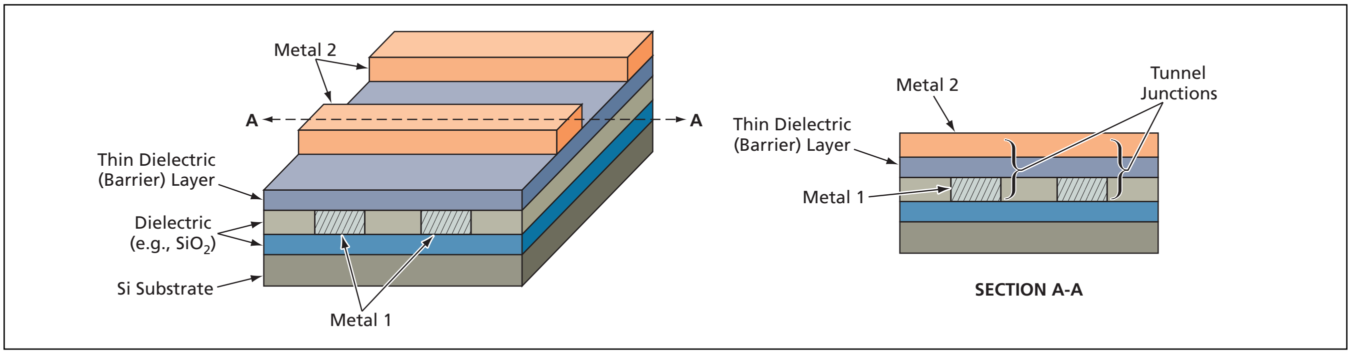

Crossed Nanowires with dielectric barriers between them would constitute quantum-mechanical-tunneling junctions that could be used to detect infrared radiation. This device would be fabricated by a process including electron-beam lithography, deposition of metal, and etching. For simplicity, antennas that would be formed integrally with the nanowires are omitted.

tive to thermionic emission, quantum-mechanical tunneling is a fast process. As described below, the quantum-mechanical tunneling would be exploited to rectify the infrared-frequency alternating signal delivered to the junction from the antenna.

Each nanojunction would be asymmetrical in that the crossing nanowires would be made of two different materials: for example, two different metals, a metal and semiconductor, or the same semiconductor doped at two different levels. The resulting asymmetry and nonlinearity of the tunneling current as a function of voltage across the junction could be exploited to effect rectification of the signal. Because the asymmetry would be present even in the absence of bias, the device could be operated at low or zero bias and, therefore, would demand very little power.

Other advantages of the proposed sensors would include the following:

- High spatial resolution would be achieved by virtue of the density of nanowires and, consequently, of nanojunctions.
- The barriers are expected to keep dark currents very small, leading to high signal-to-noise ratios.
- Different nanojunctions within the same sensor could be fabricated with antennas tailored for different wavelengths, enabling multispectral imaging.

This work was done by Kyung-Ah Son of Caltech; Jeong S. Moon of HRL, LLC; and Nicholas Prokopuk of Naval Air Warfare Center for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Catalytic-Metal/PdO$_x$/SiC Schottky-Diode Gas Sensors

PdO$_x$ layers inhibit the undesired formation of metal silicides.

John H. Glenn Research Center, Cleveland, Ohio

Miniaturized hydrogen- and hydrocarbon-gas sensors, heretofore often consisting of Schottky diodes based on catalytic metal in contact with SiC, can be improved by incorporating palladium oxide (PdO$_x$, where $0 \leq x \leq 1$) between the catalytic metal and the SiC.

In prior such sensors in which the catalytic metal was the alloy PdCr, diffusion and the consequent formation of oxides and silicides of Pd and Cr during operation at high temperature were observed to cause loss of sensitivity. However, it was also observed that any PdO$_x$ layers that formed and remained at PdCr/SiC interfaces acted as barriers to diffusion, preventing further deterioration by preventing the subsequent formation of metal silicides.

In the present improvement, the lesson learned from these observations is applied by placing PdO$_x$ at the catalytic-metal/SiC interfaces in a controlled and uniform manner to form stable diffusion barriers that prevent formation of metal silicides. A major advantage of PdO$_x$ over other candidate diffusion-barrier materials is that PdO$_x$ is a highly stable oxide that can be incorporated into gas-sensor structures by use of deposition techniques that are standard in the semiconductor industry.

The PdO$_x$ layer can be used in a gas sensor structure for improved sensor stability, while maintaining sensitivity. For example, in proof-of-concept experiments, Pt/PdO$_x$/SiC Schottky-diode gas sensors were fabricated and tested. The fabrication process included controlled sputter deposition of PdO$_x$ to a thickness of ≈50 Å on a 400-μm-thick SiC substrate, followed by deposition of Pt to a thickness of ≈450 Å on the PdO$_x$. The SiC substrate (400 microns in thickness) was patterned with photoresist and a Schottky-diode photomask. A lift-off process completed the definition of the Schottky-diode pattern.

The sensors were tested by measuring changes in forward currents at a bias potential of 1 V during exposure to H_2 in N_2 at temperatures ranging from 450 to 600 °C for more than 750 hours. The sensors were found to be stable after a break-in time of nearly 200 hours. The sensors exhibited high sensitivity: sensor currents changed by factors ranging from 300 to 800 when the gas was changed from pure N_2 to 0.5 percent H_2 in N_2. The high sensitivity and stability of these Pt/PdO$_x$/SiC sensors were found to represent a marked improvement over comparable Pt/SiC sensors. More-over, surface analysis showed that there was no significant formation of silicides in the Pt/PdO_x/SiC sensors.

This work was done by Gary W. Hunter and Jennifer C. Xu of **Glenn Research Center** *and Dorothy Lukco of QSS Group, Inc. Further information is contained in a TSP (see page 1).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Innovative Partnerships Office, Attn: Steve Fedor, Mail Stop 4–8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17859-1.

Compact, Precise Inertial Rotation Sensors for Spacecraft

NASA's Jet Propulsion Laboratory, Pasadena, California

A document describes a concept for an inertial sensor for measuring the rotation of an inertially stable spacecraft around its center of gravity to within 100 microarcseconds or possibly even higher precision. Whereas a current proposal for a spacecraft-rotation sensor of this accuracy requires one spacecraft dimension on the order of ten meters, a sensor according to this proposal could fit within a package smaller than 1 meter and would have less than a tenth of the mass. According to the concept, an inertial mass and an apparatus for monitoring the mass would be placed at some known distance from the center of gravity so that any rotation of the spacecraft would cause relative motion between the mass and the spacecraft. The relative motion would be measured and, once the displacement of the mass exceeded a prescribed range, a precisely monitored restoring force would be applied to return the mass to a predetermined position. Measurements of the relative motion and restoring force would provide information on changes in the attitude of the spacecraft. A history of relative-motion and restoring-force measurements could be kept, enabling determination of the cumulative change in attitude during the observation time.

This work was done by David Rosing, Jeffrey Oseas, and Robert Korechoff of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*
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