Detecting Airborne Mercury by Use of Palladium Chloride

These sensors can be regenerated under relatively mild conditions.

NASA's Jet Propulsion Laboratory, Pasadena, California

Palladium chloride films have been found to be useful as alternatives to the gold films heretofore used to detect airborne elemental mercury at concentrations of the order of parts per billion (ppb). Somewhat more specifically, when suitably prepared palladium chloride films are exposed to parts-per-billion or larger concentrations of airborne mercury, their electrical resistances change by amounts large enough to be easily measurable. Because airborne mercury adversely affects health, it is desirable to be able to detect it with high sensitivity, especially in enclosed environments in which there is a risk of leakage of mercury from lamps or other equipment.

The detection of mercury by use of gold films involves the formation of gold/mercury amalgam. Gold films

Detecting Airborne Mercury by Use of Gold Nanowires

Mercury has been detected at concentrations as low as 2 ppb.

NASA's Jet Propulsion Laboratory, Pasadena, California

Like the palladium chloride (PdCl₂) films described in the immediately preceding article, gold nanowire sensors have been found to be useful for detecting airborne elemental mercury at concentrations on the order of parts per billion (pppb). Also like the PdCl₂ films, gold nanowire sensors can be regenerated under conditions much milder than those necessary for regeneration of gold films that have been used as airborne-Hg sensors. The interest in nanowire sensors in general is prompted by the expectation that nanowires of a given material covering a given surface may exhibit greater sensitivity than does a film of the same material because nanowires have a greater surface area.

In preparation for experiments to demonstrate this sensor concept, sensors were fabricated by depositing gold nanowires, variously, on microhotplate or microarray sensor substrates. In the experiments, the electrical resistances were measured while the sensors were exposed to air at a temperature of 25 °C and relative humidity of about 30 percent containing mercury at various concentrations from 2 to 70 ppb (see figure). The results of this and other experiments have been interpreted as signifying that sensors of this type can detect mercury at ppb concentrations in room-temperature air and can be regenerated by exposure to clean flowing air at temperatures <40 °C.

The responses of the experimental sensors were found to be repeatable over a period of about 4 months, to vary approximately linearly with concentration from 2 to 20 ppb, and to vary somewhat nonlinearly with concentration above 20 ppb. Although mercury concentrations were found to be measurable down to 2 ppb, the limit of sensitivity may be lower than 2 ppb: Experiments at lower concentrations had not yet been performed at the time of reporting the information for this article.

This work was done by Marigret Ryan, Abhijit Shevade, Adam Kisor, and Margaret Homer of Caltech; Jessica Solar of Glendale City College; and Nosang Myung and Megan Nix of the University of California, Riverside, for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1). GSC-15368-1

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