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Electrochemical Sensor of Gas Phase Iodine

C. R. Perez, K. C. Klavetter, J. J. Coleman, and M. P. Siegal (Sandia National Laboratories)

We report on a nanoelectrode array sensor for the detection of gaseous iodine at levels below 20 ppb within short exposure times. The sensor is constructed on a free-standing anodic aluminum oxide wafer with 120 nm diameter, 50 um length nanopores. On each wafer surface, continuous metal films are deposited: on one surface, a gold film is deposited such that it covers the nanopores, and, on the opposite surface, a platinum film is deposited such that the nanopores remain open and their volumes in contact with the environment. The gold film serves as the working electrode and the platinum film serves as the auxiliary and pseudo-reference electrode. The nanopores are filled with a pH 9 buffer aqueous solution to create an array of billions/cm2 electrochemical cells in parallel. Ionic conductivity is maintained for environments with relative humidity levels greater than ~30%. Here we report on sensor performance improvements that allow using this sensor in more arid environments, as well as in the presence of other relevant interferent analytes (e.g. Cl2).

The detection mechanism is the electrochemical oxidation of anionic species formed by the dissolution and subsequent hydrolysis of gas phase I2 in pH 9 buffer electrolyte. Gas phase I2 dissolves in the buffer following Henry's Law and then is hydrolyzed to several species, including the anionic species iodide and tri-iodide. The hydrolysis mechanism of I2 in the pH 9 buffer enables it to function as a concentrator for the anionic species. When the sensor is exposed to a gas stream containing iodine, continuous accumulation of the electrochemically detectable anionic species is possible, enabling preconcentration of the incoming flow-stream by several orders of magnitude.

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