562a Tailoring Metal-Insulator-Semiconductor Devices for Selectivity

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Real-time hydrogen detection is very important in various industrial settings. Solid-state metal-insulator-semiconductor (MIS) sensors are excellent candidates for this purpose. These sensors are prepared by depositing a film of catalytic metal onto a thin layer of gate insulator material that has been grown on a semiconductor substrate. The basic H_2 sensing mechanism for MIS devices can be briefly described a follows: (1) gas-phase H_2 dissociates on the surface of the catalytic metal to form H atoms; (2) the H atoms rapidly diffuse through the metal film to the metal-insulator interface, where they are preferentially trapped in stabilized adsorption sites; (3) a layer of interfacial hydrogen is created by this process, which exists in a dipole layer, creating an additional voltage drop across the MIS sensor. The voltage change can be measured as either a shift in the capacitance-voltage curve of a capacitor, or in the current-voltage characteristic of a diode.

Previous work has proven that MIS sensors that are highly responsive to H_2 can be reproducibly prepared. However, the development of MIS sensors for industrial applications is still challenging because of the cross-sensitivity to other gases, such as carbon monoxide , ethylene, acetylene, and oxygen [7]. One approach for improving selectivity to H_2 is by adding a surface modifying layer that selectively permits sorption of hydrogen into the sensor. In an effort to improve H_2 selectivity for industrial applications, we have investigated the use of various modifying films deposited as top layers on MIS devices. Addition of these layers greatly enhances selectivity for hydrogen detection, and furthermore indicates that the polymer layer improves selectivity primarily by modifying the catalytic properties of the metal surface. Certain top modifying layers have been shown to be especially promising for challenging applications that require submerging a sensor into a solvent or oil for dissolved gas analysis.