



1.0



1.1



1.25



1.4



2.0



2.2



2.5



2.8



3.2



3.6

RESOLUTION TEST CHART

2.8

3.15

3.5

4.0

4.5

1.8

1.6

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REPORT N00014-84-C-0758(F)

SCHOTTKY BARRIER PHOTOELECTRODES
WITH A VARIABLE BARRIER HEIGHT

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| FIELD | GROUP | SUB-GROUP | | | | |
| 19. ABSTRACT (Continue on reverse if necessary and identify by block number) This program has dealt with characterizing junctions formed between semiconductors and "insertion compounds." Examples of the latter are H _x WO ₃ and H _x IrO ₂ , which have a variable work function according to the stoichiometry parameter, x. Specific applications of the structures to optically activated light modulators and to chemical sensors have been demonstrated. | | | | | | |
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chosen to yield decomposition products which spontaneously insert into the WO_3 and change both its work function and electrical resistivity. This bilayer can then be incorporated into a variety of metal-oxide-semiconductor, metal-semiconductor and metal-oxide-metal diode structures and the chemical response detected as resistance or capacitance. For example, a H_2 sensor was fabricated by employing Pd as the catalyst. The negative free energy associated with the transfer of H atoms from Pd to the WO_3 permits the device to operate smoothly at room temperature, unlike previously existing solid state H_2 sensors. Furthermore, devices with Pt appear to be more sensitive to higher hydrocarbons and alcohols when the WO_3 is present to supply this extra thermodynamic boost. The high mobility of H^+ in the amorphous WO_3 further ensures a very rapid response and little baseline drift.

The "xerogel" nature of the thin film oxides prepared at low temperature also makes them susceptible to exchange reactions, much like silica gels. The adsorption of H_2O into the internal pore structure of the films can readily be detected by ac methods as a change in dielectric constant and ion conductivity. Thus, a new series of humidity sensors was demonstrated with an unusually wide dynamic range.

A matrix of sensitivities of some of the devices developed on this program is provided in Table 1.

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Reports: Internal technical progress reports were submitted quarterly to the Scientific Officer, ONR.

Publications and Presentations:

Properties of Schottky Diodes using H_xWO_3 as a Variable Work Function Metal, T.L. Rose, S.N. Benoit and R.D. Rauh, Paper 55, Fall Meeting of the Electrochemical Society, Las Vegas, 1985.

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Variable Barrier Height Semiconductor/ H_xWO_3 Diodes, R.D. Rauh T.L. Rose and S.N. Benoit, Appl. Phys. Lett. 48, 362 (1986).

TABLE 1
SENSITIVITIES OF MOS INSERTION SENSORS TO VARIOUS GASES

| Structure | T(°C) | 5% H ₂ O | 5% H ₂ | (Sat. 25°) (H ₃ OH) | (Sat. 25°) C ₂ H ₅ OH | (2000 ppm) CO |
|---|-------|------------------------|----------------------|-----------------------------------|--|------------------|
| | | | | | | |
| p-Si/SiO ₂ (500Å)/M ₃ (3000Å)/Pt (200Å) | 25 | + | + | + | + | - |
| | 150 | - | + | + | + | - |
| p-Si/SiO ₂ (500Å)/M ₃ (3000Å)/Pt (200Å) | 25 | + | + | + | + | - |
| | 150 | - | + | + | - | - |
| p-Si/SiO ₂ (500Å)/M ₃ (3000Å)/Au (200Å) | 25 | + | - | - | + | - |
| | 150 | - | + | + | - | - |
| n-Si/SiO ₂ (500Å)/M ₃ (3000Å)/Pt (200Å) | 25 | N/A | + | + | + | - |
| | 150 | N/A | + | + | + | - |
| n-Si/SiO ₂ (500Å)/M ₃ (3000Å)/Pd (200Å) | 25 | N/A | + | + | N/A | N/A |
| | 150 | N/A | + | + | N/A | N/A |
| n-Si/SiO ₂ (500Å)/M ₃ (3000Å)/Au (200Å) | 25 | + | - | + | N/A | N/A |
| | 150 | - | + | - | N/A | N/A |
| p-Si/SiO ₂ (500Å)/Pt (200Å) | 25 | - | + | - | - | - |
| | 150 | - | + | + | - | - |
| p-Si/SiO ₂ (500Å)/Pd (200Å) | 25 | - | + | - | - | - |
| | 150 | - | + | - | - | - |
| p-Si/SiO ₂ (500Å)/Au (200Å) | 25 | - | - | - | - | - |
| | 150 | - | - | - | - | - |
| n-Si/SiO ₂ (500Å)/Pt (200Å) | 25 | N/A | + | + | - | - |
| | 150 | N/A | + | + | + | - |
| n-Si/SiO ₂ (500Å)/Pd (200Å) | 25 | N/A | + | - | - | - |
| | 150 | N/A | + | - | - | - |
| n-Si/SiO ₂ (500Å)/Au (200Å) | 25 | N/A | - | - | - | - |
| | 150 | N/A | - | - | - | - |

Patent Filed: Chemical Sensor, U.S. Patent Appl. No. 894,285, August 7, 1986
(R. David Rauh).

Invited Presentation: Chemical Insertion Sensors, Plenary Lecture, 6th
International Conference on Solid State Ionics, Garmisch-Partenkirchen,
Federal Republic of Germany, Sept. 6-11, 1987.

Chemical Sensitivity of Si|WO_3 and $\text{Si|SiO}_2|\text{WO}_3$ Diode Structures, R. David
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