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CHEMICAL SENSING AND CATALYSIS BY ONE-DIMENSIONAL METAL-OXIDE NANOSTRUCTURES

Andrei Kolmakov and Martin Moskovits
Department of Chemistry and Biochemistry, University of California, Santa Barbara, email: akolmakov@chem.ucsb.edu, mmoskovits@ltsc.ucsb.edu

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■ **Abstract** Metal-oxide nanowires can function as sensitive and selective chemical or biological sensors, which could potentially be massively multiplexed in devices of small size. The active nanowire sensor element in such devices can be configured either as resistors whose conductance is altered by charge-transfer processes occurring at their surfaces or as field-effect transistors whose properties can be controlled by applying an appropriate potential onto its gate. Functionalizing the surface of these entities offers yet another avenue for expanding their sensing capability. In turn, because charge exchange between an adsorbate and the nanowire can change the electron density in the nanowire, modifying the nanowire's carrier density by external means, such as applying a potential to the gate, could modify its surface chemical properties and perhaps change the rate and selectivity of catalytic processes occurring at its surface. Although research on the use of metal-oxide nanowires as sensors is still in early stages, several encouraging experiments have been reported that are interesting in their own right and indicative of a promising future.

INTRODUCTION

Chemical and biological sensors have a profound influence in the areas of personal safety, public security, medical diagnosis, detection of environmental toxins, semiconductor processing, agriculture, and the automotive and aerospace industries (1–4 and references therein). The past few decades have seen the development of a multitude of simple, robust, solid-state sensors whose operation is based on the transduction of the binding of an analyte at the active surface of the sensor to a measurable signal that most often is a change in the resistance, capacitance, or temperature of the active element.

The evolution of gas sensors closely parallels developments in microelectronics in that the architecture of sensing elements is influenced by design trends in planar electronics, and one of the major goals of the field is to design nano-sensors that could be easily integrated with modern electronic fabrication technologies. For