

**Stony Brook University
The Graduate School**

Doctoral Defense Announcement

Abstract

Biomarker Sensing using Nanostructured Metal Oxide Sensors

By

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Resistive Chemical sensors are those gas sensitive materials, typically semiconducting metal oxides, that change their electrical properties in response to a change in the ambient. The key features of a chemosensor are sensitivity, selectivity, response time and sensor stability. The hypothesis of this work is that, since metal oxides are polymorphic compounds, the crystal structure of the specific polymorph determines the relative gas selectivity of the material; also that the morphology of the sensing element determines the gas sensitivity limit. This work focuses on the synthesis of nanostructured metal oxides for chemosensors used in selective 'biomarker' detection. Biomarkers are chemical compounds, products of human metabolism which act as specific disease markers. The biomarkers studied in this work include NO, isoprene, NH₃, ethanol and acetone which can all be found in exhaled human breath and which allow the non-invasive detection of a range of diseases.

Sensors based on three different metal oxides-MoO₃, WO₃, and TiO₂ were fabricated using sol-gel, electrospinning and spray pyrolysis techniques and tested both as single elements and in an array configuration (electronic nose). The effects of the processing method used, grain size and shape and crystal phase of the material produced, and temperature effects of postsynthesis processing and sensing have been evaluated. Structural characterization has been carried out using X-Ray Diffraction, Scanning and High Resolution Transmission Electron Microscopy, while spectroscopic measurements using XPS, Raman and In-situ FTIR provide valuable information about the surface-analyte interactions.

This work has shown that the use of monoclinic polymorph of WO₃ yields a selective response to NO, while the other phase of the same oxide give a non-selective chemical response. The orthorhombic phase of MoO₃ exhibits specificity to NH₃. An explanation for the variable sensing properties is given based on the gas interactions with the given polymorph involving adsorption/reaction processes. Another major finding of this work is that there was orders of magnitude increase in gas sensitivity when high aspect ratio nanowires as opposed to nanoparticles of the same diameter were used.

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