Title: Development of Advanced Solid State Sensor Technology Base for Vision 21 Systems

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During the first two quarters of this research work has focused on two major areas. The first involves an investigation of the effects of surface and interface control on gas sensor performance (program Task 1). As a part of this work we have investigated the deposition of very thin 3C-SiC films on Si (100) substrates using gas source molecular beam epitaxy (GSMBE) (subtask 1.2.3). In addition, the GSMBE system has been modified with a new source flange / shutter assembly which allows the deposition of thin films of metals such as palladium (Pd) and platinum (Pt).

Thin 3C-SiC films have been deposited on Si(100) substrates using dimethyl-silane (DMS) and trimethyl-silane (TMS) for substrate temperatures of 973 K and 1073 K. The composition and structure of these films has been characterized by in-situ Auger electron spectroscopy (AES) and reflection high energy electron diffraction (RHEED). The exact thickness of these films will be determined in the very near future using high magnification field emission scanning electron microscopy (FESEM). Surface roughness will be determined using atomic force microscopy (AFM).

These thin film growth studies are laying the groundwork for the next major effort (subtask 1.3), which is the deposition of metal/semiconductor heterostructures. Those structures to be studied include metal/3C-SiC/Si, metal/6H-SiC, and metal/SiO_2/6H-SiC. In research funded by other sources, we are developing the capability for producing what we believe to be damage free, stoichiometric, hydrogen-terminated 6H-SiC substrates. It is possible that the electrical characteristics and thermal stability of the heterostructures formed on these surfaces may be significantly better than those fabricated on conventional (vendor supplied) 6H-SiC substrates.

The second area of research during the past two quarters relates to the design of specific sensors – a gas sensor (subtask 2.1) and a temperature sensor (subtask 2.2). The sensor design effort to date has concentrated on the development of the theoretical foundation that will be used in the design phase of the project. Based upon previous research, both published and carried out at WVU, we decided to use a Schottky diode structure for the gas sensor and a p-n diode for the temperature sensor.

As the signal of the Schottky diode gas sensor will be a convolution of the signal related to the gas concentration and a noise signal associated with temperature variations, we performed an analysis to determine the expected noise signal. Prototype gas sensors fabricated in silicon should be completed by the end of May with devices fabricated in 6H-SiC substrates completed shortly afterwards. The metal-semiconductor junction will be formed using sputtered metallization. The sputtered metal-semiconductor junction should be non-ideal due to interface states. These states are created as a result of process damage during the sputtering process, patches of native oxide between the metal and SiC, and mechanical damage in the substrate from the substrate fabrication process. The performance of these devices will be compared against those fabricated using the in-situ deposited metal junction at a later point in this project.

From the analysis performed for subtask 2.2, we have determined the optimal doping concentrations to minimize leakage currents and maximize the change in voltage at a constant current of an Schottky diode over a temperature range from room temperature to 573 K. Higher temperature operation is possible. However, we constrained ourselves to this temperature range initially in order to use contact metallizations that have already been developed at WVU. The epitaxial structure will be ordered shortly.