Texas Space Grant Consortium Project

Summary of the Effort I

Project title: Compact III-V Nitrides-Based Integrated Multifunctional Optoelectronic Sensors for Contaminant Characterization in Enclosed Space Environments.

Place of performance: Space Vacuum Epitaxy Center, University of Houston

Project dates of service: January 1, 2000-January 1, 2001

PI and Co-PI: Abdelhak Bensaoula, Ph.D., Associate Research Professor, University of Houston, Space Vacuum Epitaxy Center -***Principal Investigator*** David Starikov, Ph.D., Senior Research Scientist, University of Houston, Space Vacuum Epitaxy Center - ***Co-Principal Investigator*** , Igor Berishev, Ph.D., Research Scientist, University of Houston, Space Vacuum Epitaxy Center, ***Co-Principal Investigator***

Proposed is a new III-V Nitrides-based compact multifunctional optoelectronic sensor for environmental contaminants characterization. The sensor's performance is based either on absorption of the UV light or excitation of fluorescence from contaminants induced by a UV/blue light emitting diode integrated with a photodetector and Multi Quantum Well optical filters on the same chip in a single technological process. For the sensor development we will use III-V Nitride materials growth technologies developed by the Nitride Materials and Devices Group /SVEC (University of Houston).

This chemical sensor will be integrated in the first stage of a miniature ORthogonal extraction Time of-Flight (ORTOF) mass spectrometer developed by our collaborator, Ionwerks, during a phase II NASA SBIR grant. The combination of the optical chemical sensor and the ORTOF will allow unique sensitivity and chemical specificity to a variety of environmental contaminants.

The following research team of the University of Houston will work on the project: A. Bensaoula, Full Research Professor; D. Starikov, Senior Research Scientist; N. Medelci, Research Scientist; N. Badi, Research Scientist J.-W. Um, graduate student; V. Zommorodian, undergraduate student.

Summary of the Effort II

Project title: Compact III-V Nitrides-Based Integrated Multifunctional Optoelectronic Sensors for Contaminant Characterization in Enclosed Space Environments

Project dates of service: January 1, 2001 - January 1, 2002

PI and co-PI: Abdelhak Bensaoula, Ph.D., Full Research Professor, University of Houston, Space Vacuum Epitaxy Center, ***Principal Investigator*** , David Starikov, Ph.D., Senior Research Scientist, University of Houston, Space Vacuum Epitaxy Center, ***co-Principal Investigator***

On the first stage of this project we concentrated our efforts on development of a new III-V Nitrides-based multifunctional sensor for environmental contaminants characterization. During the first quarter we have fabricated and characterized individual emitters and detectors based on GaN grown on sapphire, and tested the Miniature Time of Flight Mass Spectrometer (MS). During the next three project quarters we will continue to work on the improvement of the transparent contacts, integration of the

emitter and detector on the same sapphire substrate and testing them in various solutions. As a part of this project we will test the ultimate resolution of the miniature MS with relevant contaminant gases. Sensor structures that will be developed on this project have an advantage of UV light transmission (emission and reception) through optically transparent sapphire substrates.

Our recent results indicate that high quality III-V Nitride layers can be grown on Si wafers. Employment of commercial Si wafers for optoelectronic sensors fabrication can provide the following unique features and benefits:

- Much lower fabrication costs
- Compatibility with the standard Si processing equipment
- Employment of Si-based junctions in the optoelectronic structure that can extend the spectral range of the sensor into the visible and nearIR regions.
- Possibility of sensor integration with other silicon-based semiconductor devices or Micro Opto-Electro- Mechanical Systems (MOEMS)..

The ultimate goal of this project is to implement the technology developed on first stage of the project for fabrication of nitride-based optoelectronic sensor structures on silicon wafers. This goal will be reached through modification of the MBE growth in order to achieve high quality nitride layers on Si, improvement of the UV transparent electrodes to provide effective light transmission from the structure surface, development of the Reactive Ion Etching (RIE) technique equipped with a miniature ORthogonal extraction Time of-Flight (ORTOF) mass spectrometer developed by our collaborator, Ionwerks, and Optical Emission Spectrometer (OES) to improve the processing of the optoelectronic sensor structures. The optoelectronic structures will be tested with the ORTOF integrated with the testing system on the first stage of the project.

The following research team of the University of Houston will work on the project: A. Bensaoula, Full Research Professor; D. Starikov, Senior Research Scientist; N. Medelci, Research Scientist; N. Badi, Research Scientist; Chris Boney, Post Doctoral Fellow, J.-W. Um, graduate student. Our collaborator, Ionwerks, will provide the expertise in the ORTOF operation and maintenance, partial support of the PI A. Bensaoula, and 100 % of support of the co-PI D. Starikov through other ongoing joint projects.