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13. SUPPLEMENTARY NOTES

14. ABSTRACT
Instrumentation was acquired from the DURIP grant to set up a system for the growth and characterization of metal nitride materials. This instrument system was installed in extensively renovated laboratory space to meet the specialized needs of the equipment and is now fully functional. The instrumentation has been tested and shown to produce high-quality thin film materials with excellent photonic properties, and has also been used to prepare and characterize metal nitride nanowire materials for nanophotonic studies. The capabilities opened up by this new instrumentation enhance dramatically the scope of the P.I.'s AFOSR-funded research program.

15. SUBJECT TERMS
Nanowires; photonics; heterostructures; gallium nitride; ultraviolet emission; photoluminescence; MOCVD

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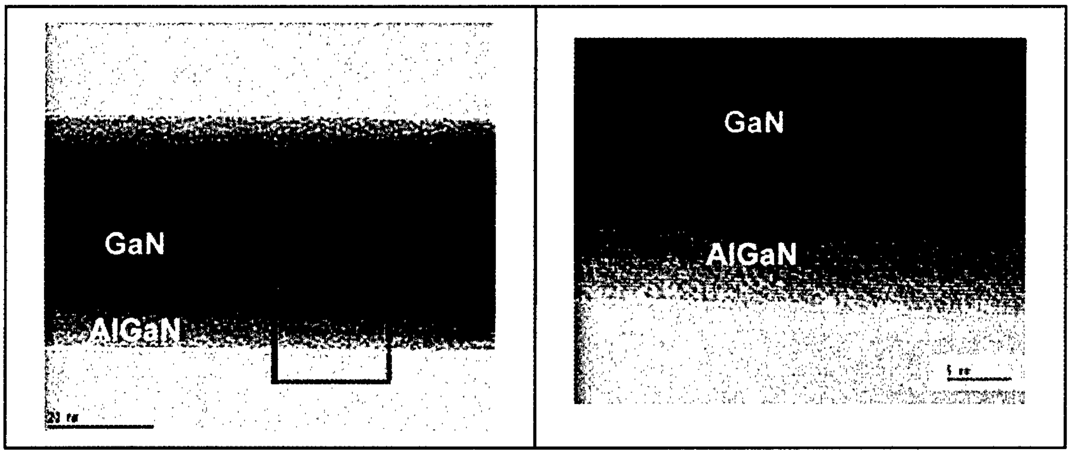
I. Summary of Equipment Acquired.

Item	Equipment	Manufacturers	Cost ($)
1	3x2 CCS MOCVD system	Thomas Swan Scientific Equipment	218,750
	Institutional Cost Sharing		-50,000
Total Cost of Instrumentation			**168,750.00**

II. Summary of Research and Education Utilizing DURIP Equipment.

The instrumentation acquired from the DURIP grant has made very significant impact on growth and characterization of semiconductor nanowires and photonic devices assembled from these nanowires in the P.I.'s laboratory. Specific to P.I.'s AFOSR-funded research program, this instrumentation is being used to grow novel gallium nitride based nanowires and thereby provide the key building blocks for novel nanophotonics devices. A summary of our efforts area as follows. First, the instrumentation has been used for growth and characterization studies of homogenous n-type and p-type gallium nitride materials. We have shown that using metal nanocluster catalyzed vapor-liquid-solid growth that we can prepare in single crystal form nanowires that are i-type (intrinsic with few carriers), n-type (electron carriers) and p-type (hole carriers). The new instrumentation is particularly important in these studies since enables reliable control of the key electronic and photonic properties of the basic nanowire building blocks for the first time. We have used laser spectroscopy system to characterize the photoluminescence properties of these nanowires. This has demonstrated that ultraviolet band-edge emission is observed at low-dopant concentrations, and moreover, that at higher dopant concentrations lower energy emission is also observed from dopant levels. In addition, we have used these p- and n-type materials to assemble crossed nanowire p-n junctions. Electrical transport measurements have shown that the p-n junctions are rectifying as expected of diodes, and significantly exhibit strong blue to ultraviolet emission in forward bias. Hence, this has enable us to demonstrate the first nanoLED in the important short wavelength regime of the optical spectrum.

More recently, we have begun to exploit the this new instrumentation to prepare and characterize novel nanowire heterostructures consisting of a core of one material, such as GaN, and one or more shells of a second material with distinct composition and/or dopant. The motivation for these studies is the fact that preparation of p-n core-shell radial heterostructures could form diode structure electrically-driven light emission and even lasing. The radial core-shell structure is particularly attractive one for achieving this latter goal since it can enable facile and uniform injection of electrons and holes, which then recombine to produce light with an energy determined by the band-gap of the material. In the case of the aluminum-gallium-indium family of materials it is possible to tune the band-gap from the deep UV all the way to the green/red region of the electromagnetic spectrum, and hence this work could open up a new concept for creating multicolor, self-assembled light-emitting diodes and lasers. To begin to explore this new approach we have focused on the growth of gallium nitride/aluminum-gallium nitride core/shell nanowires. Significantly, initial experiments and structural characterization demonstrate that it is possible to prepare this new heterostructures, and represent an



exciting advance in the growth and characterization of novel nanostructure building blocks.

Lastly, this new instrumentation has provided substantial new educational opportunities for graduate students working on the AFOSR funded project. The state-of-the-art growth system provides unique introduction to an essential system for nanomaterials growth that will be critical to developing human infrastructure for leading DoD research in nanoscience and nanotechnology in the future.