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## Final Report

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### AASERT Program

UR Account No. 5-27979-27916

G. W. Wicks

*The Institute of Optics, University of Rochester, Rochester, NY*

The AASERT Program supports graduate students working on research projects funded by other DoD grants. In the present case, three PhD students were supported on the AASERT grant, David Hilton, Gary Miller and Neil Watkins. The former two students were in the PhD Program of The Institute of Optics; the latter was in the PhD Program of the Physics Department.

The students conducted research in conjunction with Prof. Wicks' ONR program, "Refractory Semiconductors." Major findings of the students' research are listed below:

1. Native oxidation of AlN and GaN surfaces. Unlike the other Al- or Ga-containing III-V's, air exposure of AlN and GaN does not form a several-monolayer-thick Ga<sub>2</sub>O<sub>3</sub> surface layer.
2. Boron can be incorporated into GaAs up to concentrations of several percent. Some of the boron incorporates on the growth III site, increasing the bandgap; some incorporates on the growth V site as a double acceptor.
3. Boron can be substitutionally incorporated into GaN and AlN up to concentrations of a few percent. Lattice constant shrinks and bandgaps increases with increasing boron concentrations, but material quality degrades.
4. Boron Nitride grown by MBE is fine grain polycrystalline.
5. GaN and AlN can be grown crack-free on silicon substrates if layer thickness is kept less than a micron and growth temperature is limited to 675°C or lower.
6. Lateral epitaxial overgrowth of GaN on patterned SiO<sub>2</sub> is possible with ammonia-based MBE, but not with nitrogen plasma-based MBE.

#### Publications:

1. "Oxidation study of GaN using x-ray photoemission spectroscopy," N.J. Watkins, G.W. Wicks, and Yongli Gao, *Appl.Phys.Lett* **75**, 2602 (1999).
2. "Molecular beam epitaxial growth of BGaAs ternary compounds," V. K. Gupta, M. W. Koch, N. J. Watkins, Yongli Gao and G. W. Wicks, accepted by *J.Electronic Materials* (2000).

#### Conference Presentations

1. "X-ray Photoemission Spectroscopy study of Oxidation of GaN", N.J. Watkins, Yongli Gao, G.W. Wicks, 1998 MRS Fall Meeting.
2. "Evolution of the Electronic structure of GaN during oxidation", N.J. Watkins, Yongli Gao, G.W. Wicks, 1999 MRS Fall Meeting.

3. "XPS study of the oxidation of GaN", N.J. Watkins, Yongli Gao, G.W. Wicks, 1998 SOMR Meeting (Symposium on material research).
4. "Study of GaN Oxidation by X-ray Photoemission Spectroscopy", N.J. Watkins, G.W. Wicks, Yongli Gao, APS Centennial Meeting.