REPORT DOCUMENTATION PAGE

1. AGENCY USE ONLY (Leave blank) 2. REPORT DATE 3. REPORT TYPE AND DATE COVERED
July 28, 1997 Final

4. TITLE AND SUBTITLE
Light Emission and Energy Transfer in Nanoscale Semiconductor Photonic Devices

5. FUNDING NUMBERS
DAH04-93-G-0254

6. AUTHOR(S)
Dr. Robert M. Kolbas

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)
North Carolina State University
Department of Electrical and Computer Engineering
Raleigh, NC 27695-7911

8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Army Research Office
P.O. Box 1211
Research Triangle Park, NC 27709-2211

10. SPONSORING / MONITORING AGENCY REPORT NUMBER
ARO 31958-21-EL-SDI

11. SUPPLEMENTARY NOTES
The views, opinions and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy or decision, unless so designated by other documentation.

12a. DISTRIBUTION / AVAILABILITY STATEMENT
Approved for public release: distribution unlimited.

12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)
The overall objective of this experimental program is to control the light emission properties and energy transfer mechanisms in nanoscale semiconductor structures in order to realize new or improved photonic devices. For nanostructures that are defined by buried heterojunction interfaces the focus is to define the regimes in which scattering and carrier collection dominate the performance of quantum well and superlattice devices. For nanostructures with exposed surfaces the focus is to understand the fundamental light emission mechanisms. The proposed research impacts device development and system architectures by demonstrating light emitters for wavelength division multiplexing, three dimensional IOEC structures, broadly tunable lasers, and low loss waveguides. Most recently the impact of these phenomena have been studied in the wide bandgap AlGaN material system. We have demonstrated stimulated emission in GaN, InGaN thin films and quantum well heterostructures. We have also done absorption measurements and observed multiple excitons.

14. SUBJECT TERMS
semiconductors, stimulated emission, lasers, light emitting diodes, wide bandgap, quantum well, GaN, AlGaN, InGaN, GaAs, nanostructures

15. NUMBER OF PAGES 9

16. PRICE CODE
UL

17 SECURITY CLASSIFICATION OR REPORT
UNCLASSIFIED

18 SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

19 SECURITY CLASSIFICATION OF ABSTRACT
UNCLASSIFIED

20 LIMITATION OF ABSTRACT

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89) Prescribed by ANSI Std. 239-18
208-102
Light Emission and Energy Transfer in Nanoscale Semiconductor Photonic Devices

FINAL PROGRESS REPORT

Dr. Robert M. Kolbas

July 28, 1997

U. S. Army Research Office

DAAH 04-93-G-0254
Proposal Number: 31958-EL-SDI

North Carolina State University

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION UNLIMITED.

THE VIEWS, OPINIONS, AND/OR FINDINGS CONTAINED IN THIS REPORT ARE THOSE OF THE AUTHOR(S) AND SHOULD NOT BE CONSTRUED AS AN OFFICIAL DEPARTMENT OF THE ARMY POSITION, POLICY, OR DECISION, UNLESS SO DESIGNATED BY OTHER DOCUMENTATION.
FINAL PROGRESS REPORT

1. ARO PROPOSAL NUMBER: 31958-EL-SDI
2. PERIOD COVERED BY REPORT: 1 July 1993 - 14 March 1997
3. TITLE OF PROPOSAL:
   Light Emission and Energy Transfer in Nanoscale Semiconductor Photonic Devices
4. CONTRACT OR GRANT NUMBER: DAAH04-93-G-0254
5. NAME OF INSTITUTION: North Carolina State University
6. AUTHORS OF REPORT: Robert M. Kolbas
7. LIST OF MANUSCRIPTS SUBMITTED OR PUBLISHED UNDER ARO SPONSORSHIP DURING THIS REPORTING PERIOD, INCLUDING JOURNAL REFERENCES:


Conference Presentations


8. SCIENTIFIC PERSONNEL SUPPORTED BY THIS PROJECT AND DEGREES AWARDED DURING THIS REPORTING PERIOD:
Frederick Reed (Ph.D. 1997)
Dahua Zhang (Ph.D. 1993)
Irina Shmagin (Ph.D. expected Fall '97)
John Muth
Dr. Robert Kolbas (PI)

9. REPORT OF INVENTIONS (BY TITLE ONLY):

BRIEF OUTLINE OF RESEARCH FINDINGS

The overall objective of this experimental program is to control the light emission properties and energy transfer mechanisms in nanoscale semiconductor structures in order to realize new or improved photonic devices. For nanostructures that are defined by buried heterojunction interfaces the focus is to define the regimes in which scattering and carrier collection dominate the performance of quantum well and superlattice devices. For nanostructures with exposed surfaces the focus is to understand the fundamental light emission mechanisms. The proposed research impacts device development and system architectures by demonstrating light emitters for wavelength division multiplexing, three dimensional IOEC structures, broadly tunable lasers, and low loss waveguides. Most recently the impact of these phenomena have been studied in the wide bandgap AlGaN material system. We have demonstrated stimulated emission in GaN, InGaN thin films and quantum well heterostructures. We have also done absorption measurements and observed multiple excitons.

Major advances resulting from this program include:

- The first demonstration of a three terminal semiconductor light emitter where the optical output intensity is controlled by the voltage applied to one of the terminals and the color is controlled by the voltage applied to the other terminal. (Bias Induced Color-Tuned Emitter, BICE)
- Demonstration of optical memory effects in InGaN that has potential applications for optical memory storage and optical signal processing.