AD A053116

DDC FILE COPY

Washington University
Box 1115
Saint Louis, Missouri 63130

# IMPURITY AND DEFECT BEHAVIOR IN HIGH-PURITY EPITAXIAL GaAs

Interim Scientific Report No. #2
For The Period:
January 1, 1977, to December 31, 1977

## Research Objectives

The objective of this work is to provide a better understanding of impurity and defect behavior in epitaxial GaAs, which should lead to more reproducible, uniformly-doped material for microwave device applications. To fulfill this objective various measurements are performed to investigate and identify impurities, defects, and their interactions; to determine how they are incorporated into the layer during growth; and to examine the effects of growth parameters on their behavior.

## Significant Accomplishments

During the period covered by this report, we have obtained the following results: (1) a quantitative model of impurity incorporation for epitaxial layers grown on heavily-doped substrates was completed and published in Applied Physics Letters. This model shows that thin interfacial p-regions are inherent to the growth process. The model also predicts impurity gradients at the outer surface which has been verified experimentally. We are in the process of publishing this experimental verification since it provides additional proof that

DISTRIBUTION STATEMENT A
Approved for public release;
Distribution Unlimited

DDC
APR 25 1978
A

Unclassified (9) Interim rept. 1 Jan - 31 Dec 77

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

## REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

| | | |
|---|---|---|
| 1. REPORT NUMBER | 2. GOVT ACCESSION NO. | 3. RECIPIENT'S CATALOG NUMBER |
| 4. TITLE (and Subtitle) (6) Impurity and Defect Behavior in High-Purity Epitaxial GaAs. | | 5. TYPE OF REPORT & PERIOD COVERED Interim: January 1, 1977 to December 31, 1977 |
| | | 6. PERFORMING ORG. REPORT NUMBER |
| 7. AUTHOR(s) (10) C. M. Wolfe | (14) SCIENTFIC-2 | 8. CONTRACT OR GRANT NUMBER(s) (15) AFOSR-76-2950 |
| 9. PERFORMING ORGANIZATION NAME AND ADDRESS Washington University Box 1115 Saint Louis, Missouri 63130 | | 10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS (16) 2306 (17) B1 61102F |
| 11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Office of Scientific Research Building 410 (NE) Bolling Air Force Base, D.C. 20332 | | 12. REPORT DATE (12) 5p. |
| | | 13. NUMBER OF PAGES 4 |
| 14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) (11) 31 Dec 77 | | 15. SECURITY CLASS. (of this report) UNCLASSIFIED |
| | | 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE |

16. DISTRIBUTION STATEMENT (of this Report)

~~The United States Government is authorized to reproduce and distribute this report for Governmental purposes.~~

...ON STATEMENT A
... public release;
...ution Unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Epitaxial GaAs, Impurities, Stoichiometric Defects, Impurity Incorporation, Interfacial Regions.

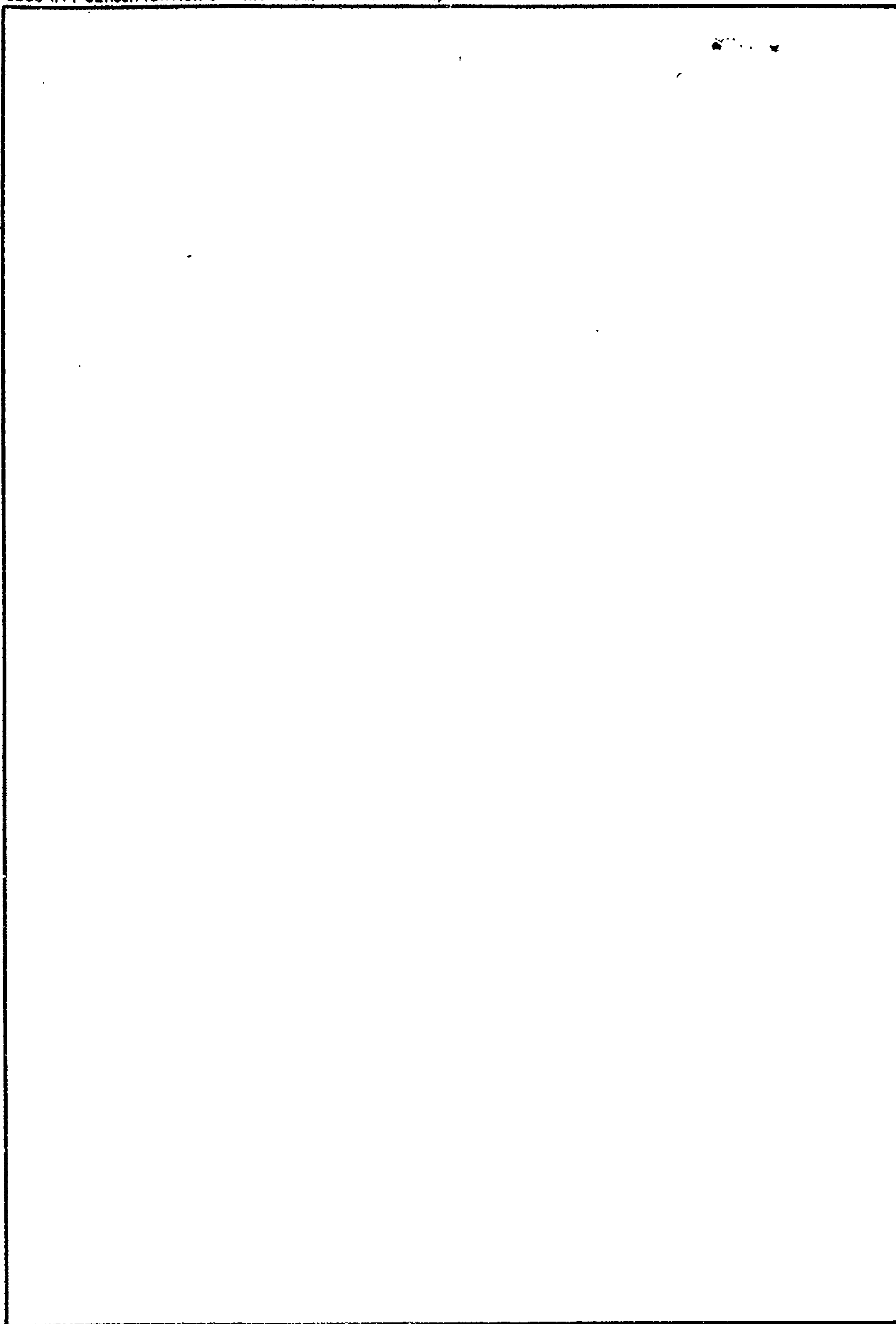
20. ABSTRACT (Continue on reverse side if necessary and identify by block number)


This report summarizes research performed in an effort to obtain a better understanding of impurity and defect behavior in epitaxial GaAs. This work includes the identification of residual defects, the development of a model for impurity incorporation, and an examination of impurity gradient effects.


DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

370 CCC JCB



SECURITY CLASSIFICATION OF THIS PAGE(When Data Entered)

impurity incorporation is controlled by surface states. (2) Techniques were developed for the fabrication of ring-dot Schottky barrier configurations. This technology is required to perform photocapacitance spectroscopy of deep levels and to obtain impurity profiles of expitaxial layers grown on semi-insulating substrates. (3) A high-temperature Hall measurement apparatus was designed and constructed. This equipment is being used to perform annealing experiments to identify impurities and defects in the epitaxial layers. (4) The photoresponse of Schottky barriers on high-purity samples has been found to have a transition which is initiated by avalanche multiplication. This is believed to be a forbidden transition between states of the dominant acceptor complex and the results have been published.

ACCESSION
NTIS
DDC

## Personnel

The personnel working under this grant during this period were

Charles M. Wolfe, Professor; and
Kirby H. Nichols, Research Assistant.

Mr. Nichols is currently working towards a D.Sc. degree.

## Scientific Papers


1. C. M. Wolfe, G. E. Stillman, and D. M. Korn, "Residual Donors in High Purity GaAs", Proc. 6th Int. Symp. GaAs (Inst. Phys., London, 1977) p. 120.
2. C. M. Wolfe and K. H. Nichols, "Impurity Gradients Caused by Surface States and Substrate Doping in Epitaxial GaAs", Appl. Phys. Lett. 31, 356 (1977).
3. K. H. Nichols, W. S. C. Chang, C. M. Wolfe, and G. E. Stillman, "GaAs Waveguide Detectors for 1.06 μm", Appl. Phys. Lett. 31, 631 (1977).
4. K. H. Nichols and C. M. Wolfe, "Impurity Gradients and Impurity Incorporation in Epitaxial GaAs", (to be submitted to J. Electrochem. Soc.).

## Scientific Interactions

Scientific interactions in the area of this research grant include informal discussions with G. McCoy, C. Litton, D. Reynolds, S. Nam, and R. Almassy of the U.S.A.F. Avionics Laboratory during June 16 and 17, 1977; discussions with G. Stillman of the University of Illinois during January and August 1977; and discussions with many people at the IEEE Device Research Conference and the AIME Electronic Materials Conference in Ithaca, New York, during June 1977.