SF 298 MASTER COPY KEEP THIS COPY FOR REPRODUCTION PURPOSES

REPORT DOCUMENTATION PAGE

Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY *(Leave Blank)*	2. REPORT DATE	3. REPORT TYPE AND DATES COVERED
	February 1996	Final Technical Report - 11/18/94 - 11/17/95

4. TITLE AND SUBTITLE

Focused Ion Beam Workstation Facility

5. FUNDING NUMBERS

DAAH04-95-1-0031

6. AUTHOR(S)

William E. Wood

7. PERFORMING ORGANIZATION NAMES(S) AND ADDRESS(ES)

Department of Materials Science and Engineering
Oregon Graduate Institute of Science & Technology
P.O. Box 91000
Portland, OR 97291-1000

8. PERFORMING ORGANIZATION REPORT NUMBER

MSE102

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(S)

U.S. Army Research Office
P.O. Box 12211
Research Triangle Park, NC 27709-2211

10. SPONSORING/MONITORING AGENCY REPORT NUMBER

ARO 33760.1-EL-RIP

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.

19960522 111

13. ABSTRACT *(Maximum 200 words)*

An FEI Company 610 series, Focussed Ion Beam (FIB) instrumentation facility has been installed. This ultrahigh resolution nanoscale technology system can remove/deposit material on submicron lateral and vertical scales, and allows precise lateral and vertical etch/deposition and cross sections of device features and structural defects that are either impossible of impractical by conventional cleaving or lapping techniques. Using gallium LMI technology, computer controlled positioning and ultrafine machining deposition, the FIB system can perform multiple cross sections on the same sample, expose subsurface nodes, form probe pads for electrical analysis, and prepare ultra precise samples for high resolution TEM/STEM.

The research supported by this instrumentation concentrates on but is not limited to advanced electronic device manufacturing development. Additional, more general research areas include analysis of ceramic materials, titanium aluminide composites, ultra low temperature brazing alloy development, and molten metal-ceramic interactions.

14 SUBJECT TERMS	15. NUMBER OF PAGES
Focussed ion beam micromachining, nanostructures, micromilling	6
	16. PRICE CODE

17. SECURITY CLASSIFICATION OR REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
UNCLASSIFIED	UNCLASSIFIED	UNCLASSIFIED	UL

STATEMENT OF PROBLEM STUDIED

The focussed ion beam workstation has been used to prepare precisely positioned cross sections of interfaces for TEM analysis. Materials and systems studied include buried defects in GaAs devices, failure analysis in active matrix electroluminescent conventional displays on glass, micro-displays directly on silicon, gate oxide interfaces in silicon based devices, and multilayered microjoining interfaces between glass-metallization-solder systems. Precise cross sectioning of these interfaces is essential for TEM analysis of the interface. The focussed ion beam has been used to develop cross sectioning techniques without mechanical sectioning, lapping, electrochemical thinning or even bulk ion beam machining. Current efforts are directed at removal of FIB produced electron transparent thin areas from the device such that they can be directly inserted in the TEM/STEM.

SUMMARY OF MOST IMPORTANT RESULTS

The use of the FIB workstation has allowed identification of buried micron size contaminants in shorted micro-capacitors on GaAs devices. The FIB was able to precisely remove layers and to isolate by micro machining around the contaminant for subsequent TEM analysis. Similar analysis has been carried out to identify failure mechanisms of active matrix electroluminescent micro-displays built directly on Silicon and on more conventional electroluminescent display thin film stacks on glass. The micro "rewiring" capability of the FIB has been used to rewire microelectronic devices to test redesigns of the device without the time and expense of fabrication system changes.

The FIB has been used to prepare TEM cross sections of SiGe nanostructures deposited onto Silicon by Pulsed U.V. Laser induced epitaxy and to determine the high resolution microstructures developed during metallization and heat treatment of thin gate oxide materials for use in submicron MOSFETS.

LIST OF PUBLICATIONS AND TECHNICAL REPORTS

- Process Development for Si Based Nanostructures using Pulsed U.V. Laser Induced Epitaxy, Chaodan Deng, Ph.D. Thesis, OGI, Oct 1995.
- The Microstructural Effects of Metallization and Heat Treatment on Thin Gate Oxide for Use in Sub-micron MOSFETS, John McCarthy, Ph.D. thesis, OGI, November 1995.
- Microstructural Characterization of Al-.5Cu and Al-1Si on 0.6nm TCA SiO^2/Si Following Heat Treatment at 400°C in N_2, Jack McCarthy, MRS Symposium Proc V382, Apr 95, Structure and Properties of Multilayered Thin Films.

LIST OF PARTICIPATING SCIENTIFIC PERSONNEL

Name	Position	Degree obtained
Jack McCarthy	Professor, OGI	Ph.D. Degree
Jun Ding	Sr. Research Associate	
Daya Sing	Post-Doctoral Fellow	
Lu Fang	Sr. Research Associate	
Jim Van Winkle	Graduate Research Asst.	Ph.D. (in progress)
Ajay Chaddha	Completed Studies	Ph.D. Degree
David Christilaw	Graduate Research Asst.	Ph.D. (in progress)
Chaodan Deng	Studies Completed	Ph.D. Degree
James Parsons	Professor, OGI	
Anthony Bell	Professor, OGI	
Sanjay Shendye	Sr. Research Associate	
Chris Barbero	Graduate Research Asst.	Ph.D. Degree
Jack Devletian	Professor, OGI	
Paul Clayton	Professor, OGI	
Tom Sigmon	Professor, Arizona State	
David Grainger	Professor, Colorado State	

REPORT OF INVENTIONS

None

BIBLIOGRAPHY

See List of Publications/ Presentations/ Reports

APPENDIXES

None

TITLE

FOCUSSED ION BEAM WORKSTATION FACILITY

FINAL PROGRESS REPORT

AUTHOR(S)

WILLIAM E. WOOD

DATE

FEBRUARY 1996

U.S. ARMY RESEARCH OFFICE

CONTRACT/GRANT NUMBER

DAAH04-94-0031

INSTITUTION

OREGON GRADUATE INSTITUTE OF SCIENCE & TECHNOLOGY

THE REPORT IS TO INCLUDE:

1. FOREWORD (OPTIONAL)

2. TABLE OF CONTENTS (IF MORE THAN 10 PAGES)

3. LIST OF APPENDIXES, ILLUSTRATIONS AND TABLES (IF APPLICABLE)

4. BODY OF REPORT WHICH SHOULD INCLUDE THE FOLLOWING:

   A. STATEMENT OF THE PROBLEM STUDIED

   B. SUMMARY OF THE MOST IMPORTANT RESULTS

   C. LIST OF ALL PUBLICATIONS AND TECHNICAL REPORTS

   D. LIST OF ALL PARTICIPATING SCIENTIFIC PERSONNEL SHOWING ANY ADVANCED DEGREES EARNED BY THEM WHILE EMPLOYED ON THE PROJECT*

5. REPORT OF INVENTIONS (BY TITLE ONLY)*

6. BIBLIOGRAPHY

7. APPENDIXES

*TO BE INCLUDED ONLY IN FINAL PROGRESS REPORT