

REPORT DOCUMENTATION PAGE

AFRL-SR-BL-TR-01-

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1. AGENCY USE ONLY (Leave Blank)		2. REPORT DATE 08 Feb 2001	3. REPORT TYPE AND DATES COVERED Final Technical, 15 Apr 1999 through 14 Apr 2000	
4. TITLE AND SUBTITLE X-Ray Characterization of Quaternary Antimonide Materials for Mid-IR Lasers			5. FUNDING NUMBERS F49620-99-1-0239	
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7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) The University of New Mexico Center for High Technology Materials 1313 Goddard SE Albuquerque, NM 87106			8. PERFORMING ORGANIZATION REPORT NUMBER FT 313911	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES) AFOSR/NE 801 North Randolph Street, Room 732 Arlington, VA 22203-1977			10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Unlimited			<p>AIR FORCE OFFICE OF SCIENTIFIC RESEARCH (AFOSR) NOTICE OF TRANSMITTAL DTIC. THIS TECHNICAL REPORT HAS BEEN REVIEWED AND IS APPROVED FOR PUBLIC RELEASE LAW AFR 190-12. DISTRIBUTION IS UNLIMITED.</p>	
13. ABSTRACT (Maximum 200 words) <p>The new mid-IR PL/optical pumping setup has been invaluable in the study of GaInAsSb and AlInAsSb materials that are MBE grown on a GaSb substrate. A PL intensity plot vs. wavelength for GaInAsSb grown at the University of New Mexico is displayed on the last page of the report. This PL trace was generated using the equipment purchased with the grant money.</p> <p>We believe that new alloys constructed from AlInAsSb and GaInAsSb will be the backbone of future antimonide-based semiconductor lasers. UNM grows the AlInAsSb using the digital alloy method. This technique employs the growth of several phase-stable alloys (binaries, ternaries, quaternaries, etc.), each a fraction of a monolayer to several monolayers thick. The net composition of these thin layers yields the desired alloy. For our work, InAs, AlSb, and InSb binaries were used to build the AlInAsSb quaternary. Whereas the research community has found that bulk growth of optical quality AlInAsSb with large Al is impossible due to a miscibility gap, UNM has recently shown that high-quality digital alloy growth of non-phase-separated AlInAsSb is possible up to 40% Al composition. One of the next steps is to determine the energy bandgaps of these materials, which as of now are unknown.</p>				
14. SUBJECT TERMS X-Ray characterization, antimonides, Mid-IR lasers			15. NUMBER OF PAGES 3	
			16. PRICE CODE NSP	
17. SECURITY CLASSIFICATION OF REPORT UNCLASSIFIED	18. SECURITY CLASSIFICATION OF THIS PAGE UNCLASSIFIED	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT UNLIMITED	

20010430 093

X-Ray Characterization of Quaternary Antimonide Materials for Mid-IR Lasers

With the approval of the program manager, the equipment purchased on this grant was changed to a set of equipment suitable for photoluminescence experiments and optical pumping on mid-IR materials. This change was precipitated by the planned departure of the individual in the Principal Investigator's research group who requested the new x-ray source equipment. This individual was the only person with an intimate knowledge of high-resolution x-ray diffraction at the Center for High Technology Materials (CHTM) at the University of New Mexico (UNM). The following is a brief description of the equipment that was purchased. On the second page, photographs of the equipment in the laboratory are shown.

Liquid Nitrogen Optical Crostat: An evacuated dewar and shroud with three Calcium fluoride windows from Cryo Industries. This is a cryostasis chamber where samples are mounted for testing.

2 SDL, Inc. Laser Diode Drivers: High power current source from SDL to drive the pump laser.

Detector model J10D: An InSb detector from EG&G to detect infra-red emissions.

Power Meter model EPM1000: A power meter with PM3 thermopile from Molecron to determine total emitted power.

Gold Mirrors: Two spherical mirrors from CVI to focus and direct sample emissions into the monochromator. One ellipsoidal segmented mirror from Aero Research for collecting the sample's emissions.

Temperature Controller model 330: A temperature controller for cryostat from Lakeshore with heater and silicon diode.

Fiber Bundle: A fiber bundle to direct pump light into the cryostat

Water Cooler Model RTE100: A cooler for pump laser.

IR Camera model PV320: Mid-IR camera from Electrophysics for alignment of sample emission.

Lens: Plano-Convex lens from CVI for focusing pump onto sample.

The new mid-IR PL/optical pumping setup has been invaluable in the study of GaInAsSb and AlInAsSb materials that are MBE grown on a GaSb substrate. A PL intensity plot vs. wavelength for GaInAsSb grown at the University of New Mexico is displayed on the last page of the report. This PL trace was generated using the equipment purchased with the grant money.

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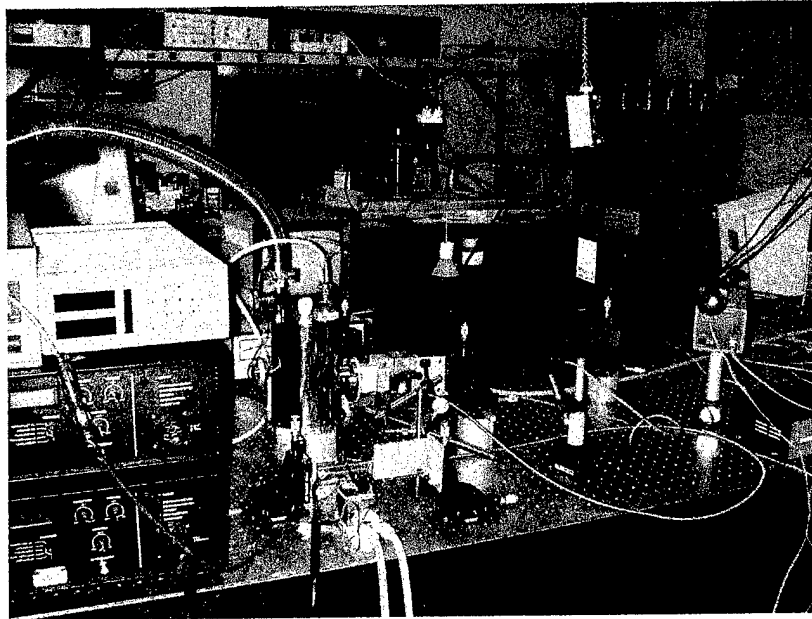


Fig. 1 The left foreground shows the black current drivers, cryostat temp. controller (white box), and the laser diode pump source assembly. The metal cylinder left of center is the cryostat, and the black box towards the back of the table is a monochromator. The IR camera for viewing and alignment is on the far right.

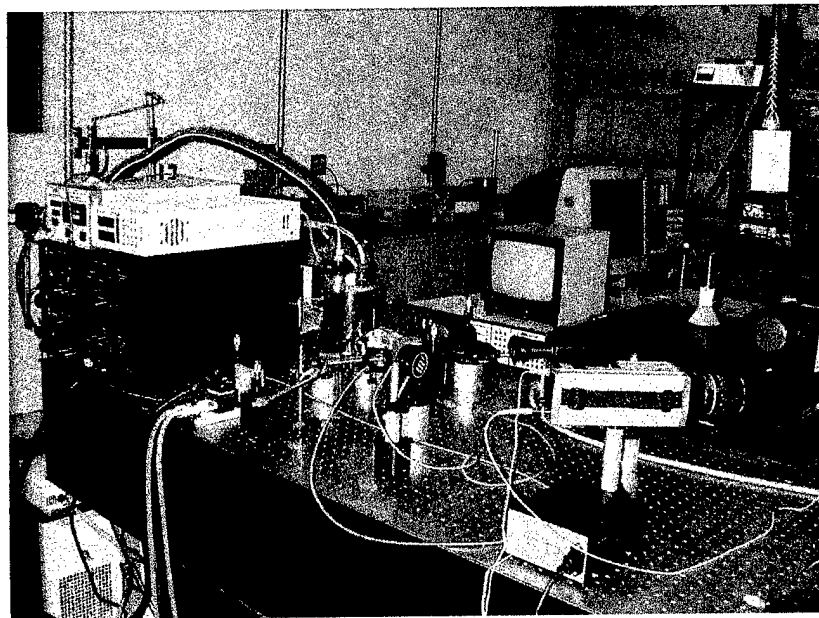


Fig. 2 Another view of the PL/optical pumping apparatus

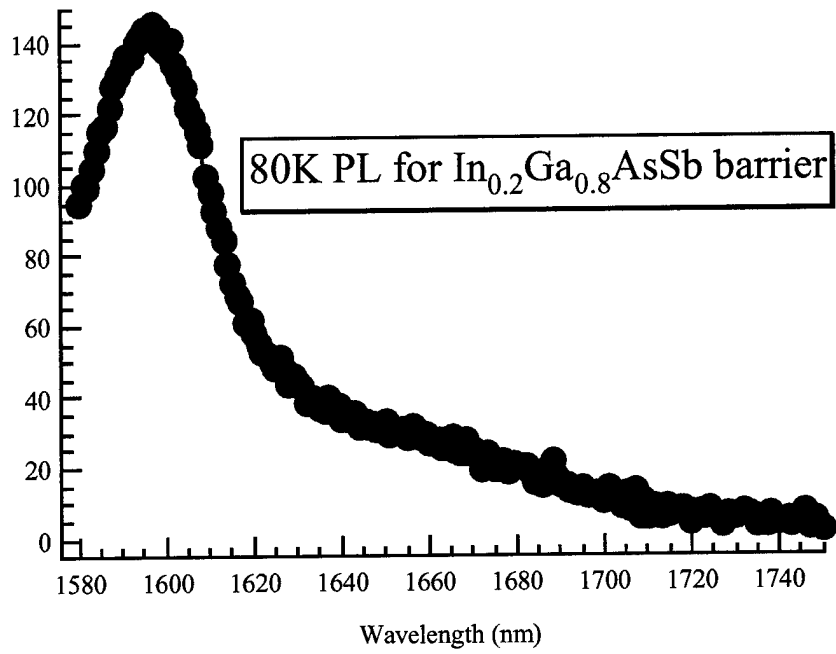


Fig. 3. PL data for a bulk GaInAsSb sample grown at UNM. Temperature is approximately that of liquid nitrogen.