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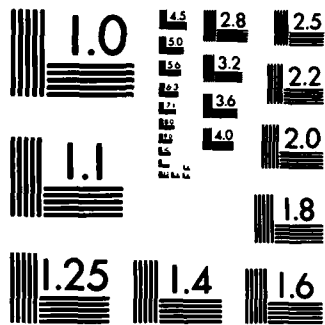
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Report No. UCB/ERL 85/1

JOINT SERVICES ELECTRONICS PROGRAM

ANNUAL PROGRESS REPORT
(Contract F49620-84-C-0057)
(1 May 1984 - 28 February 1985)

W. G. Oldham

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30 April 1985

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Prepared for:

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JOINT SERVICES ELECTRONICS PROGRAM
ANNUAL PROGRESS REPORT (Contract F49620-84-C-0057)
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by

W. G. Oldham

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) An annual report of the JSEP (Joint Services Electronics Program) in Electromagnetics, Solid State Electronics, Materials and Devices, Quantum Electronics and Information Sciences is presented. In addition, results of the research to date are summarized and significant accomplishments are indicated.		

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PART A: DIRECTORS OVERVIEW

The research sponsored by JSEP is presently divided into efforts in Quantum Electronics, Electromagnetics, Solid-State Electronics, and Information Systems. Some of the work crosses these boundaries. A large number of Research Assistants (presently under the title of "Postgraduate Researcher") and projects are supported, in fact more than can be continued into the second year. In general the work sponsored by JSEP is supported to completion, punctuated by a Thesis, publications, and graduation of the Research Assistant. The JSEP program is complemented by related programs under separate sponsorship. Complementary projects are common, but overlap of sponsorship is not permitted. (In some publications joint sponsorship is cited; generally this refers to sponsorship of the different individuals. In a few cases an individual is moved from one sponsor to another as one phase of a project ends and another begin.)

JSEP continues to be a significant factor in the ability of the laboratory to respond to important new research opportunities. The research results reported here are significant and gratifying. The list of accomplishments are given in part B, and Part C of this report contains some 14 published articles which have appeared during the period.

A special area of satisfaction is the successful operation of the MBE system for fabrication of GaAs devices. This equipment, originally purchased with JSEP funds, is now fully operational (after a long and difficult startup). The material produced is second to none in quality. The capability is key to further research both in the lightwave device technology research and in the microwave and millimeter wave device programs. Three separate projects within the JSEP program are using the equipment, and several projects under other sponsorship could not be performed without the MBE facility.

We recently held an internal review of the JSEP program at Berkeley (April 11 JSEP Internal Conference). This new get together was a huge success, and will be repeated annually. We had an opportunity to review each active project. More significantly, it was possible to see how the various projects complement each other to make up a more significant whole. This review forms the basis for selecting projects to emphasize in the second year.

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PART B: ACCOMPLISHMENTS

Three significant accomplishments which stand out this year are:

- 1) Several major milestones were reached in the work on combining integrated optical techniques with semiconductor lasers. First a ten-element semiconductor laser array using ridge-guide index guiding was successfully constructed. The device included the novel feature of a provision for partial pumping of the coupling region between the stripes. A single-lobe far-field pattern was achieved. (Y. Twu, A. Dienes, S. Wang, and J. R. Whinnery, *Appl. Phys. Lett.* 45, p. 709, October 1984.) A theoretical study led to a newer structure, now also fabricated. The latter is a five-element array with graded pumping, and it maintains single-lobe mode pattern up to the highest output power available.
- 2) The variables which control hot-carrier induced device degradation have been identified. The quality of the interface and the channel electric field play critical roles. A method has been developed to compare the interface quality of different devices (different fabrication technologies) so that the degradation rates of new devices may be predicted. (C. Hu et al., "Hot-Electron-Induced MOSFET Degradation—Model, Monitor, and Improvement," *IEEE Trans. on Electron Devices*, vol. ED-2, No. 2, February 1985.) The source of device degradation is hot-electron emission. A comprehensive model for channel hot-electron emission in MOSFETs has been developed. Geometrical effects from narrow and short channels are included so that scaling predictions may be made. A physical model for the degradation, related to the hot electrons, has been proposed. The very hottest electrons ($>4\text{eV}$) break Si-H bonds, freeing a proton to diffuse away. (S. Tam, P. K. Ko, and C. Hu, *IEEE Trans. Elec. Devices*, vol. ED-31, p. 116, September 1984)
- 3) The basic work on algorithms for automatic placement and routing has proven to be an important addition to CAD methodology. The "building block layout" system, or BBL, has been supported by JSEP for several years. A prototype of the automatic placement algorithm for two-level hierarchy with rectangular modules has been implemented. Recently several tests were performed which show a 10 -25% reduction of chip area for BBL layouts compared to other systems. [C. C. Chen and E. S. Kuh, Proc. ICCAD 84, pp. 90-92]

PART C: DESCRIPTION OF INDIVIDUAL WORK UNITS

RESEARCH PROJECTS

Project No.	Title and Faculty Investigator	Proposed Funding (\$Thousands)
I. ELECTROMAGNETICS		
EM-85-1	Conformal Time Domain Finite Difference Methods of Solving Scattering Problems— K. K. Mei and D. J. Angelakos	\$ 50.0K
EM-85-2	Millimeter Wavelength Electromagnetic Structures—S. E. Schwarz, K. K. Mei, and D. J. Angelakos	\$ 45.0K
EM-85-S(a) and -S(b)	Specialized Equipment for EM-85-2	(\$ 56.0K) (\$ 7.0K)
	ELECTROMAGNETICS	TOTAL
	Augmentation (a)	Total (\$ 56.0K)
	Augmentation (b)	Total (\$ 7.0K)
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II. QUANTUM ELECTRONICS J. R. Whinnery (Coordinator)		
QE-85-1	Analysis of Integrated-Optics Networks Applied to Semiconductor Lasers— J. R. Whinnery and S. Wang	\$ 40.0K
QE-85-2	Electro-Optical Interactions in Quantum-Well Structures: Applications to Detection and Millimeter Mixing— T. K. Gustafson, S. E. Schwarz, and R. M. White	\$ 44.0K
	QUANTUM ELECTRONICS	TOTAL
		\$ 84.0K
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III. SOLID STATE ELECTRONICS		
A. <i>Materials</i> S. Wang (Coordinator)		
SSM-85-1	Materials Issues in VLSI Interconnections— N. W. Cheung, C. M. Hu, and W. G. Oldham	\$ 40.0K
SSM-85-2	Studies of MBE Growth Kinetics and High-Energy Ion Implantation in Compound Semiconductors— N. W. Cheung and S. Wang	\$ 40.0K
SSM-85-S	Studies of Interface Problem of Compound Semiconductors—S. Wang	(\$ 57.5K)
	Materials	Subtotal
	Supplement	Subtotal
		\$ 80.0K
		(\$ 57.5K)

Project No.	Title and Faculty Investigator	Proposed Funding (\$Thousands)
B. <i>Devices</i> T. Van Duzer (Coordinator)		
SSD-85-1	Problems in E-Beam and Optical Lithography— A. R. Neureuther and W. G. Oldham	\$ 56.0K
SSD-85-2	Study of the Effects Limiting Realization of Far-Submicron Superconductive Electronic Structures— T. Van Duzer	\$ 30.0K
SSD-85-3	Studies in Room-Temperature and Cryogenic Heterodyne Detection—T. K. Gustafson and T. Van Duzer	\$ 42.0K
SSD-85-5	Wide-Dynamic-Range Signal Processing Using Monolithic Integrated Circuit Technology—R. G. Meyer, R. W. Brodersen, P. R. Gray	\$ 40.0K
SSD-85-6	High-Field Transport in MOS Devices— C. Hu and P. Ko	\$ 40.0K
SSD-85-S	Specialized Equipment for SSD-85-2	<u>(\$ 25.6K)</u>
	Devices	Subtotal \$208.0K
	Supplement	Subtotal (\$ 25.6K)
SOLID STATE ELECTRONICS		TOTAL \$288.0K
Supplements		(\$ 83.1K)
IV. <i>INFORMATION SYSTEMS</i> C. A. Desoer (Coordinator)		
ISS-85-1	Large-Scale and Nonlinear Circuits Study— L. O. Chua and E. S. Kuh	\$ 44.0K
ISS-85-2	Control in Distributed Systems—P. P. Varaiya J. Walrand	\$ 38.0K
ISS-85-3	Robust, Adaptive Control and Computer- Aided Design—C. A. Desoer, S. S. Sastry, and E. Polak	\$ 44.0K
ISS-85-4	Optimization Based Computer-Aided Design of Integrated Circuits—A. Sangiovanni- Vincentelli and R. G. Meyer	\$ 40.0K
INFORMATION SYSTEMS		TOTAL \$166.0K
PROPOSAL		TOTAL \$633.0K
Augmentation		(\$ 63.0K)
Supplements		(\$ 83.1K)

LIST OF PUBLICATIONS

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| L. O. Chua
A. C. Deng | 1984 | "Negative Resistance Devices: Part II." <i>International Journal of Circuit Theory and Applications</i> , vol. 12, 1984, pp. 337-373. |
| S. S. Sastry | 1984 | "Model-Reference Adaptive Control—Stability, Parameter Convergence, and Robustness." <i>IMA Journal of Mathematical Control & Information</i> , (1984)1, pp. 27-66. |
| S. Wang | 1984 | "Longitudinal-Mode Stability and Wavelength Tunability of Semiconductor Lasers with Composite Cavity Structures." <i>SPIE Processing of Guided Wave Optoelectronic Materials</i> , vol. 460, 1984, pp. 79-88. |
| H. K. Choi
K-L Chen
S. Wang | 4/84 | "Analysis of Two-Section Coupled-Cavity Semiconductor Lasers." <i>IEEE Journal of Quantum Electronics</i> , vol. QE-20, No. 4, April 1984, pp. 385-393. |
| D. Giandomenico
D-S Kuo
C. Hu
J. Choi | 4/84 | "Analysis and Prevention of Power MOSFET Anomalous Oscillations." <i>Proc. of the 11th Annual International Power Electronics Conference</i> , April 10-12, 1984, H-4, pp. 1-9. |
| C. A. Desoer
C. A. Lin | 5/84 | "Simultaneous Stabilization of Non-linear Systems." <i>IEEE Trans. on Automatic Control</i> , vol. AC-29, No. 5, May 1984, pp. 455-457. |
| M-J Chen
C. A. Desoer | 6/84 | "Algebraic Theory for Robust Stability of Interconnected Systems: Necessary and Sufficient Conditions." <i>IEEE Trans. on Automatic Control</i> , vol. AC-29, No. 6, June 1984, pp. 511-519. |
| S. Wang
Y. H. Wu
J. M. Hong
M. Werner | 6/84 | "Studies of MBE Growth Over Etched Channels for Fabrications of Index Guided Semiconductor Lasers," presented at Electric Materials Conference, Santa Barbara, CA, June 1984. |

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| A. C. Cangellaris
C. C. Lin
K. K. Mei | 6/84 | "Point-Matched Time Domain Finite Element Method." presented at URSI/USNC. June 1984, Boston, MA. <i>Symposium Digest</i> , p. 77. |
| E. Polak
Y. Y. Wardi | 7/84 | "A Study of Minimizing Sequences." <i>SIAM J. Control and Optimization</i> , vol. 22, No. 4, July 1984, pp. 599-609. |
| V. Visvanathan
A. Sangiovanni-Vincentelli | 7/84 | "A Computational Approach for the Diagnosability of Dynamical Circuits." <i>IEEE Trans. on Computer-Aided Design</i> , vol. CAD-3, No. 3, July 1984, pp. 165-171. |
| T. Nishi
L. O. Chua | 8/84 | "Topological Criteria for Nonlinear Resistive Circuits Containing Controlled Sources to Have a Unique Solution." <i>IEEE Trans. on Circuits and Systems</i> , vol. CAS-31, No. 8, August 1984, pp. 722-741. |
| S. Tam
P-K Ko
C. Hu | 9/84 | "Lucky-Electron Model of Channel Hot-Electron Injection in MOS-FETs." <i>IEEE Trans. on Electron Devices</i> , vol. ED-31, No. 9, September 1984, pp. 1116-1125. |
| Y-H Wu
M. Werner
S. Wang | 9/84 | "Channeled-Substrate GaAs/AlGaAs Multiple Quantum Well Lasers Grown by Molecular Beam Epitaxy." <i>Appl. Phys. Lett.</i> 45(6), 15 September 1984, pp. 606-608. |
| K. K. Mei
A. Cangellaris
D. J. Angelakos | 9-10/84 | "Conformal Time Domain Finite Difference Method." <i>Radio Science</i> , vol. 19, No. 5, September-October 1984, pp. 1145-1147. |
| D. Haas
J. Wurl
J. McLean
T. K. Gustafson | 10/84 | "On the Possible Production of Short Pulses in Semiconductor Lasers by External Laser Excitation Through X ³ ." <i>Optics Letters</i> , vol. 9, October 1984, p. 445. |
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| A. R. Newton
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Vincentelli | 10/84 | "Relaxation-Based Electrical Simila-
tion" <i>IEEE Trans. on Computer-
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October 1984, pp. 308-331. |
| P. P. Varaiya | 1985 | "Concensus in Distributed Estima-
tion" in <i>Control and Information
Sciences</i> , vol. 66. Springer-Verlag,
1985, pp. 182-192. |
| A. S. Chen
A. R. Neureuther
M. Pavkovich | 1-2/85 | "Proximity Effect Correction in
Variably Shaped Electron-Beam
Lithography," <i>Journal of Vacuum
Science and Technology B</i> , 3(1),
January/February 1985, pp. 148-
152. |
| C. Hu
S. C. Tam
F-C Hsu
P-K Ko
T-Y Chan
K. W. Terrill | 2/85 | "Hot-Electron-Induced MOSFET
Degradation—Model, Monitor, and
Improvement," <i>IEEE Trans. on Elec-
tron Devices</i> , vol. ED-32, No. 2,
February 1985, pp. 375-385 |

LIST OF MEMORANDUMS

D. J. Kim	M84/65 8/17/84	Characterization and Modeling of Positive Photoresist
T. Nishi L. O. Chua	M84/88 10/23/84	Uniqueness of Solution for Non- linear Resistive Containing CCCSs or VCVSs Whose Controlling Coef- ficients are Finite
T. Nishi L. O. Chua	M84/89 10/25/84	Topological Proof of the Nielsen- Willson Theorem
E. Polak S. Salcudean D. Q. Mayne	M85/15 2/28/85	A Sequential Optimal Redesign Pro- cedure for Linear Feedback Systems
E. Polak	M85/17 2/28/85	On the Mathematical Foundation of Nondifferentiable Optimization in Engineering Design

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