Final Report

Grant to Support the
17th Annual Conference on the
Physics and Chemistry of Semiconductor Interfaces

U.S. Navy Office of Naval Research
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Prepared by
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October 12, 1992
Final Report

The seventeenth annual conference on the Physics and Chemistry of Semiconductor Interfaces (PCSI-17) was held at Clearwater Beach, FL on January 31-February 2, 1990. The organizing and program committee membership is shown in Appendix 1. In addition, the local arrangements committee is also shown in Appendix 1. The program and meeting was quite successful, with presentation of seventy three papers from the US and nine foreign countries, as shown in Appendix 2. The meeting was attended by 132 scientists as shown in Appendix 3. Finally the papers from the meeting were published in the Journal of Vacuum Science and Technology, Volume B4, July/August, 1990, as shown in Appendix 4.

In summary, the meeting was quite successful and served its intended purpose. The organizers are grateful for the support of the Office of Naval Research.

Dist A per telecon Dr. L. Cooper
ONR/Code 1114
Arlington, VA 22217-5000

10/27/92 CG
Appendix 1

Organizing and Program Committee
Local Arrangements Committee
SEVENTEENTH ANNUAL CONFERENCE
PHYSICS AND CHEMISTRY OF
SEMICONDUCTOR INTERFACES

January 31 - February 2, 1990
Sheraton Sand Key Hotel
Clearwater, Florida

ORGANIZING AND PROGRAM COMMITTEE

J. E. Rowe (AT&T Bell Labs.) - Chair
F. Grunthaner (JPL)
I. Lindau (Stanford)
T. McGill (Cal Tech.)
A. Pinczuk (AT&T Bell Labs.)
J. Woodall (IBM-Yorktown Hgts.)
P. Cohen (Minnesota)
L. Brillson (Xerox-Webster)
A. Zunger (SERI)

EX OFFICIO

R. Bauer (Xerox PARC)
R. Grant (Rockwell)
L. Cooper (ONR)
H. Wittmann (AFOSR)

LOCAL ARRANGEMENTS

Paul Holloway - Chair
Department of Materials Sci. & Engrg.

T. Anderson (UF)
A. Fuente (GE)
K. Jones (UF)
R. Park (UF)
L. Provo (GE)
H. Starling (GE)

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Appendix 2

PCSI-17 Program
PCSI - 17

Physics and Chemistry of Semiconductor Interfaces

Clearwater Beach (Tampa Area), Florida
January 31 - February 2, 1990
PCSI-17 PROGRAM

Sheraton Sand Key Hotel, Clearwater, Florida

Tuesday, January 30, 7:00 p.m. to 9:30 p.m Welcoming Reception

Wednesday, January 31, 1990

7:00 Breakfast buffet: Morning Session
8:20 WELCOMING REMARKS

SESSION I. Growth Ia: Hetero-Epitaxy Chair: T. C. McGill
Discussion Leader: G. J. Lapeyre

8:30 (1) (Invited) "Surface Morphology During Epitaxial Growth and Interface Formation," M. Lagally (Wisconsin)

9:00 (2) "In-Situ Diffraction Studies of Strained InGaAs Films Prepared by Molecular Beam Epitaxy," G. J. Whaley & P. I. Cohen, (University of Minnesota, Minneapolis, MN)

9:05 (3) "RHEED Intensity Oscillations During MBE Growth of GaAs/AlGaAs Interface Formation on (111)B GaAs Substrates," M. Y. Yen, D. H. Tomich, T. W. Haas* and W. V. Lampert*, (UDRI, Wright-Patterson*, OH)

9:10 (4) "Empirical Interatomic Potentials for Compound Semiconductors: Application to Superlattice Stability," K. E. Khor, Tomonori Ito and S. Das Sarma. (University of Maryland, College Pk, MD)

9:15 Discussions

SESSION I. (cont'd) Growth Ib: Strained Layers

9:30 (6) "Thermal Stability of Sb Overlayers on GaAs(110) and InP(110)," N. Esser, D. R. T. Zahn, C. Stephens*, M. Reckgügel and W. Richter (Institut Festkörperphysik, Germany, *Trinity College, Ireland)

9:35 (7) "Synchrotron Radiation Assisted Metalorganic Layer Epitaxy (SRMOLE)," H. Höchst and M. A. Engelhardt (University of Wisconsin, WI)


9:45 Discussions

10:00 Break

10:15 (9) "Growth of Antiphase Domain Free GaAs on Epitaxial Ge by Molecular Beam Epitaxy," S. Strite, K. Adomi, and H. Morkoc (University of Illinois, Urbana, IL)

10:20 (10) "In-situ Low Energy Ion Scattering Analysis of InP Surfaces During Molecular Beam Epitaxy," M. Kubo and T. Narusawa (Semiconductor Research Center, Osaka, Japan)

10:25 (11) "Influence of GaAs Surface Stoichiometry on the Electrical Properties of As-Grown Epitaxial ZnSe/Epitaxial GaAs Heterointerfaces," J. Qiu, Q.-D Qian, R. L. Gunshor, M. Kobayashi, D. R. Menke, D. Li, and N. Otsuka (Purdue University, W. Lafayette, IN)

10:30 (12) "Disruption, Local Order and Epitaxy at the Sn/III-V Semiconductor Interfaces," M. Tang, J. J. Joyce, Y. Meng, J. Anderson, and G. J. Lapeyre (Montana State University, Bozeman, MT)


10:40 Discussions
"Electronic and Geometric Structure of Epitaxially Grown CaF$_2$ and SrF$_2$ Passivation Layers on InP(001)," W. Weiβ, D. Schmeiβer and W. Göpel (Universitat Tubingen, FRG)

"Structure, Chemistry, and Fermi-level Movement at Interfaces of Epitaxial NiAl and GaAs(001)," S. A. Chambers and V. A. Loebs (BAEHT, Seattle, WA)

"Homogeneous Nucleation of Dislocations in In$_4$Ga$_6$As/CaAs Above the Critical Thickness," K. R. Breen, P. N. Uppal* and J. S. Ahearn*, (Dept. of Mat. Science, John Hopkins University, Baltimore, MD, *Martin Marietta Labs, Baltimore, MD)

Discussions

Poster Viewing

LUNCH

Wednesday Afternoon Session

SESSION III. Strained-layer Structures and Band Offsets - Chair: Rudy Ludeke

"In-situ Electron Microscope Observations of Relaxation Modes in GeSi/Si Strained Layers," R. Hull, J. C. Bean, S. D. Berger, and J. M. Bonar (AT&T Bell Laboratories, Murray Hill, NJ)


"Growth Kinetics in Heteroepitaxy and Growth of Monolayer Superlattices by Atomic Layer Epitaxy: GaAs/GaP SLS," M. Ozeki, K. Kodama, Y. Sakuma and N. Ohtsuka (Fujitsu Lab. Ltd., Atsugi, Japan)

"Dependence of Structural and Optical Properties of In\textsubscript{0.23}Ga\textsubscript{0.77}As/GaAs Quantum Wells on Misfit Dislocations: Different Critical Thickness for Dislocation Generation and Degradation of Optical Properties," M. Grundmann, U. Lienert, J. Christen, D. Bimberg, A. Fischer-Colbrie*, and J. N. Miller* (Institut für Festkörperphysik I, F. R. Germany, *Hewlett Packard Labs, Palo Alto, CA)

The Effect of Strain on the Valence Band Structure of InAs(100)," M. D. Williams and T.-H. Chiu (AT&T Bell Laboratories, Holmdel, NJ)

"Test of Band Offset Commutativity by Photoemission from an \textit{in situ} Grown ZnTe/CdS/ZnTe Quantum Well," W. G. Wilke, Ch. Maierhofer, and K. Horn (Fritz-Haber-Institut, West Germany)


"Device Interface Problems on an Atomic Scale," N. Moll (Hewlett Packard)

SESSION IV. Heterostructure & Superlattices - Chair: D. E. Aspnes

"Interface Strain at the Lattice Matched In\textsubscript{0.53}Ga\textsubscript{0.47}As/InP Heterointerface," Mark S. Hybertsen (AT&T Bell Laboratories, Murray Hill, NJ)

"Transport Properties and Applications of Unstrained In\textsubscript{0.75}Ga\textsubscript{0.25}As–Al\textsubscript{0.6}Ga\textsubscript{0.4}As Heterojunctions," D. V. Rossi, E. R. Fossum, P. D. Kirchner*, and J. M. Woodall* (Dept. of Elec. Eng., Columbia University, New York, NY, *IBM Research Div., Yorktown Heights, NY)


3:40 Discussions


4:00 (31) "Photoemission Study of the Ca_{1-x}Sr_xF_2/GaAs(100)," Kathleen Stair, J. Zajac, F. Chambers, M. A. Engelhardt* and H. Hochst* (AMOCO Corp. Res. Dept., Naperville, IL, Univ. of Wisconsin, Stoughton, WI)

4:05 Discussions

4:15 POSTER VIEWING

5:30 Dinner (Open) - Be back for evening session at 8:00 p.m.

Wednesday Evening Session

SESSION V. Tunneling, Electronic Structure and New Techniques - Chair: C. B. Duke

8:00 (32) (Invited) "Transport Across Coherent III-V Heterointerfaces," D. Z. Ting (Caltech)
8:30 (33) "Semiconductor Interface Electronic Structure Probing with Ballistic Electrons and Holes," L. D. Bell, M. H. Hecht, F. J. Grunthaner, and William J. Kaiser (CIT, Pasadena, CA)


8:45 Discussions

8:55 (36) "Electronic Structure of a Quasi-One-Dimensional Electron Gas at Finite Temperature," Hong Yu and J. C. Hermanson (Montana State University, Bozeman, MT)

9:00 (37) "Strain Relaxation During the Initial Stages of Growth in Ge/Si(001)," A. A. Williams*, J. E. Maedonald*, R. van Silfhout#, J. F. van der Veen#, M. S. Finney**, A. D. Johnson**, and C. Norris** (*Univ. of Wales College Cardiff, UK, #FOM Inst. Atomic Physics, The Netherlands, **Univ. of Leicester, UK)

9:05 (38) (Invited) "Structural and Vibrational Properties of Si(111)2x1 from ab-initio Molecular Dynamics," A. Selloni*, F. Ancilotto#, W. Andreoni#, R. Car*, and M. Parrinello**# (*Int. School Adv. Studies, Trieste, Italy, #IBM Zurich Lab, Switzerland)

9:20 Discussions

9:30 POSTER VIEWING
Thursday Morning Session

SESSION VI. Surface Chemistry: Oxide Growth and Passivation
Chair: Ingolf Lindau
Discussion Leader: Dale Ibbotson

8:00 (39) (Invited) "Plasma Enhanced Growth of Semiconductor-insulator Interfaces," G. Lucovsky (North Carolina State)

8:30 (40) "A Microscopic Structural Study of the Plasma Enhanced CVD (PECVD) Si–SiO₂ System," B. Robinson (T. J. Watson Res. Ctr., Yorktown Heights, NY)

8:35 (41) "Analysis of P₂S₆/NH₄OH Passivated GaAs Surface," Yun Wang and P. H. Holloway (Univ. of Florida, Gainesville, FL)


8:50 Discussions

9:00 (44) "Electronic Properties of NH₃ Adsorbed on InP(110) Surfaces at Room Temperature," S. Rossi Salmagne, H.-U. Baier, and W. Mönch (Lab. für Festkörperphysik, FRG)


SESSION Vila. Insulator - Semiconductor Interfaces

Chair: F. J. Grunthaner


9:50  (49) "Characterization and Optimization of Ultrathin Si Interface Control Layer for Surface Passivation of InGaAs," H. Hasegawa, M. Akazawa, H. Ishii, A. Uraie, H. Iwadate and E. Ohue (Hokkaido Univ., Sapporo, Japan)


SESSION VIlb. Surface Reconstruction

Chair: Jack Rowe

10:10 (51) (Invited) "The Role of Surface Reconstruction in Interface Morphology," E. D. Williams (University of Maryland, College Park, MD)

10:40 (52) "The Structure of the ZnSe(100)c(2x2) Surface," H. H. Farrell, M. C. Tamargo, S. Shibli, Y. Chang*, (Bellcore, Newman Springs Rd. NJ, *Univ. of Wisconsin, Madison, WI)

10:45 (53) "Atomic Structure of p(1x1)-Sb Overlayers on the (110) Surface of III-V Compound Semiconductors: A Question of Size?," John P. LaFemina*, C. B. Duke*, and C. Mailhiot** (*Pacific Northwest Lab., Richland, WA, **Xerox Webster Ctr., Webster, NY)

10:50 (54) "Surface Dielectric Functions of (2x1) and (1x2) Reconstructions of (001) GaAs," Yia-Chung Chang* and D. E. Aspnes (*Univ. of Illinois, Urbana, IL, Bellcore, Red Bank, NJ)
10:55  (55)  "Electronic and Structural Properties of Clusters on III-V Surfaces," M. Menon, J. Gryko, Z-H Huang, and R. E. Allen (Texas A&M Univ. College Station, TX)

11:00  (56)  "RHEED Characteristic Absences in GaAs(100) (2x4)-As: A Tool for Determining the Surface Stoichiometry," C. J. Palmstrom and H. H. Farrell (Bellcore, Red Bank, NJ)

11:05  Discussions

11:15  POSTER VIEWING

Thursday Evening Session

SESSION VIII. Heterostructures, Tunneling and Electron Localization
Chair: Jack Dow

7:30  (57)  (Invited) "Theory of Electron Transmission Through Epitaxial Interfaces*," M. D. Stiles (NIST, Gaithersburg, MD, *Work done in collaboration with D. R. Hamann, AT&T Bell Labs)

8:00  (58)  "Chemical and Electronic Structure of Pseudomorphic GaAs/InAs/GaAs Quantum Wells and InAs/GaAs Interfaces," F. J. Grunthaner, K. Delgadillo, B. R. Hancock, and J. K. Liu* (CIT, Pasadena, CA, *TRW, Los Angeles, CA)


8:10  (60)  "Band Offsets and Electron Localization in Semiconductor Superlattices and Interfaces," J. M. Bass, M. Oloumi and C. C. Matthai (University of Wales, Cardiff, UK)

8:15  Discussions

8:30 (62) "A Proposed Quantum Wire Structure: An 'Accumulation Wire' at Crossing Heterointerfaces," H. Harbury and W. Porod (Univ. of Notre Dame, IN)

8:35 (63) "Long-wavelength Infrared Detectors Based on Intersubband Absorption in Si$_{1-x}$Ge$_x$/Si Superlattices." Y. Rajakarunanayake and T. C. McGill (CIT, Pasadena, CA)

8:40 Discussions

8:50 POSTER VIEWING
SESSION IX. Atomic and Electronic Structure - Dynamical Effects  
Chair: Phil Cohen

8:30 (64) "Surface Dielectric Anisotropies and Phase Diagrams of (001) GaAs," D. E. Aspnes, L. T. Florez, A. A. Studna, and J. P. Harbison (Bellcore, Red Bank, NJ)


8:40 (66) "Substrate Orientation Dependence of Moving Emission and Ordering in Ga_{0.51}In_{0.49}P," M. C. DeLong and P. C. Taylor (Univ. of Utah, Salt Lake City, UT)

8:45 Discussions

9:00 (67) "Subpicosecond Photoelectron Spectroscopy of Laser-Excited Silicon (111) 7x7," Mark W. Rowe, H. Liu, G. P. Williams, Jr., and R. T. Williams (Wake Forest Univ., Winston-Salem, NC)


9:15 Discussions


9:55 Break

SESSION Xa. Fermi Level Pinning  
Chair: W. Mönch

10:45  (72) "Electronic Excitation Spectroscopy of the Cs/GaAs(110) Interface," T. Maeda-Wong, N. J. DiNardo*, and E. W. Plummer (Univ. of Penn., PA, *Drexel Univ., PA)

10:50  (73) "Morphology, Metalization, and Fermi Level Stabilization." W. E. Spicer, R. Cao, K. Miyano, T. Kendelevicz, and I. Lindau (Stanford Univ., Stanford, CA)

10:55  (74) "Schottky Barrier Heights and Interface Chemistry in Ag, In, and Al Overlayers on GaP(110)," M. Alonso, R. Cimino, Ch. Maierhofer, and K. Horn (Fritz-Haber-Institut, West Germany)

11:00  Discussions

11:15  POSTER VIEWING

12:15  Lunch

Friday Afternoon Session

SESSION Xb.  Fermi Level Pinning
Chair: Len Brillson

1:20   (75) "Metal-GaP(110) Interfaces: The Role of Metallicity and Other Issues," R. Ludeke, M. Prietsch, A. B. McLean and A. Santoni, (IBM Research Ctr., Yorktown Heights, NY)

1:25   (76) "Morphological Study of Ag, In, Sb, and Bi Overlayers on GaAs (100)," C. Spindt, R. Cao, K. Miyano, I. Lindau, and W. Spicer (Stanford Elec. Labs, Stanford Univ.)

1:30   (77) "Electronic Structure of Alkali Atoms and Aluminum Adsorbed on Semiconductor (110) Surfaces," G. Allan, M. Lannoo and C. Priester (Lab. de Physique de Solides, Lille Cedex, France)

1:35   Discussions

1:45   (78) "The Role of Ultrathin AlAs Interlayers in Determining the Interface Fermi Energy of the Epitaxial NiAl/AlAs/n-GaAs (001) System," S. A. Chambers, V. A. Loebs, and D. H. Doyle (Boeing Aerospace, Seattle, WA)
1:50 (79) "Effect of Discrete Dopants in Schottky Barriers," M. van Schilfgaarde (SRI Int., Menlo Pk, CA)

1:55 (80) "Low-Coverage Metal-Induce Unrelaxation of the Semiconductor Surface at Ag/InP(110) Interfaces: A Photoemission EXAFS Study," P. S. Mangat*, K. M. Choudhary*, D. Kilday and G. Margaritondo (*Univ. of Notre Dame, IN, Univ. of Wisconsin, Stoughton, WI)

2:00 Discussions

2:10 (81) (Invited) "Temperature Dependent Fermi-Level Pinning at Metal-Semiconductor Interfaces," J. Weaver (Univ. of Minnesota)

2:40 (82) "Microscopic Origin of the S-Factor for Schottky Barriers," Y. Chang, Y. Hwu, J. Hansen, F. Zanini and G. Margaritondo (Univ. of Wisconsin, Madison, WI)

2:45 Discussions

3:00 Break

SESSION XI. Interface States, Clusters and Adsorption
Chair: H. H. Wieder

3:20 (83) "Interface States, Electronic Barrier, and Chemistry at Metal/MBE-GaAs(100) Junctions: Metal and Orientation Dependence," S. Chang*, L. J. Brillson*, Y. J. Kime#, D. S. Rioux†, P. D. Kirchner** and J. M. Woodall** (*Xerox, Webster, NY, #Syracuse Univ., Syracuse, NY, †Univ. of Wisconsin, WI, **IBM, Yorktown Heights, NY)

3:25 (84) "Formation of In/GaP(111) Interface Studied by ELS, XPS and UPS," M. R. Yu, P. Q. Wang, X. F. Jin and X. Wang (Fudan Univ., Shanghai, China)

3:30 (85) "Photoemission Study of Li Adsorption on GaAs(110)," C. Laubschat, S. Brüderle, G. Remmers, M. Domke, S. Molodtsov, and G. Kaindl (Inst. für Exper. Berlin, Germany)

3:35 Discussions
3:50  "Dispersion of Band Gap States Near Metallic Clusters on GaAs(110)," P. N. First, J. A. Stroscio, R. A. Dragoset, D. T. Pierce, and R. J. Celotta (NIST, Gaithersbur, MD)

3:55  "XPS Investigation of the Ti/GaAs(100) and the Ti/AlGaAs(100) Interface," R. W. Bernstein and J. K. Grepstad (Univ. of Trondheim, Norway)

4:00  "Photovoltaic effects in photoemission studies of Schotty barrier formation," M. H. Hecht (California Institute of Technology, Pasadena, CA)

4:05  Discussions

4:15  POSTER VIEWING

5:45  Conference Banquet - Buses leave from Sheraton Sand Key Hotel
Appendix 3

List of Attendees to PCSI-17
LIST OF ATTENDEES

PCSI-17

January 31, February 1-2, 1990

Clearwater Beach, Florida
Dr. G. Allan
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Appendix 4

Publication of the Proceedings of PCSI-17
SUMMARY OF PCSI-17 CONFERENCE

The 17th Annual Conference on the Physics and Chemistry of Semiconductor Interfaces (PCSI-17) was held at the Sheraton Sand Key Hotel, Clearwater, Florida during the three days, January 31, February 1 and 2, 1990, and was attended by 129 people. The Conference format for all contributed papers was a four minute oral presentation and a poster presentation. There were 15 minute discussion sessions after every 4-5 contributed talks. All posters were up for the entire conference giving ample time for poster discussion with the posters being displayed in a large area adjacent to the lecture hall. In addition to the 78 contributed papers, there were ten invited papers representing a cross section of the most active areas in interface physics and chemistry. Most of the 88 papers are included in these proceedings. The topics include: characterization of surfaces and interfaces on an atomic scale; electronic states at heterostructure interfaces; epitaxial metal overlayers; STM: theory, characterization, and novel applications; nucleation of defects in growth including a video-tape of dynamic dislocation climb in epitaxial Si-Ge films; growth and characterization of non-lattice-matched systems; simulation of carrier dynamics of ballistic electron transport; sources of carrier scattering in nonideal interfaces, especially heterojunctions; and novel chemical aspects of activated oxide film growth emphasizing compound semiconductors. As in past years the conference made a contribution to the continuing endowment of the American Vacuum Society for the Annual Peter Mark Memorial Award. Peter was a founder of the PCSI series and a major force in the conference for its first six years until his untimely death. The award is given in honor each year to a young scientist or engineer for outstanding theoretical or experimental work. This year’s winner was Dr. Randy Feenstra of IBM T. J. Watson Research Center. He was selected “... for original applications of scanning tunneling microscopy to the study of atomic scale geometric and electronic structure of surfaces.” Randy was also one of the invited speakers at PCSI-17.

The overall success of PCSI was due to the efforts of many individuals. In particular, Professor Paul Holloway’s secretary, Mrs. Ludie Hampton did an outstanding job with local arrangements. The efforts of our colleagues at the University of Florida and members of the Florida Chapter of the AVS, Lyn Provo, Art Fuente, Tasker Beal, Hugh Starling, Professors Tim Anderson, Robert Park, and Kevin Jones were greatly appreciated. We would like to thank Hugh Starling for running the conference registration and information desk, and Mrs. Grace Pavlisko of AT&T Bell Laboratories who did the typing for the program booklet and helped with mailings from AT&T.

We would also like to acknowledge the generous financial support provided by the Air Force Office for Scientific Research (Horst R. Wittmann) and the Office of Naval Research (Larry R. Cooper). The Conference was held under the sponsorship of the American Physical Society as a topical conference, and the American Vacuum Society’s Electronics Materials and Processing Division.

Jack E. Rowe  
Chairman

Paul H. Holloway  
Local Arrangements Chair