Oliver M. R. Chyan

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EDUCATION

1989	Ph.D	Chemistry	Massachusetts Institute of Technology
1984	M.S.	Analytical Chemistry	University of Texas at Arlington
1982	M.S.	Analytical Chemistry	National Taiwan University
1980	B.S.	Chemistry	National Chung-Hsing University

PROFESSIONAL EXPERIENCE

2010	Visiting Professor	Institute of Atomic and Molecular Sciences, Taiwan Academia Sinica
2006-date	Professor	University of North Texas, Texas
2003-2004	Visiting Associate Research Fellow	Institute of Atomic and Molecular Sciences, Taiwan Academia Sinica
2002-date	Associate Faculty	Materials Science and Engineering Dept., UNT
1998-2006	Associate Professor	University of North Texas, Texas
1992-1998	Assistant Professor	University of North Texas, Texas
1990-1992	Research Associate	University of Cincinnati, Ohio
1984-1989	Research Assistant	MIT Massachusetts

PROFESSIONAL ACTIVITIES

Postdoctoral Fellow, University of Cincinnati	1990-92
Graduate Research Assistant, Massachusetts Institute of Technology	1986-89
Teaching Assistant, Massachusetts Institute of Technology	1984-85
Research Associate, Alcon laboratory, Fort Worth, Texas	1983-84

MEMBERSHIP IN PROFESSIONAL ORGANIZATIONS

American Chemical Society
Electrochemical Society
Material Research Society
Society of Environmental Toxicology and Chemistry

ACTIVITIES IN PROFESSIONAL ORGANIZATIONS

Referee, Analytical Chemistry
Referee, Journal of Electrochemical Society
Referee, Journal of Electroanalytical Chemistry and Interfacial Electrochemistry
Referee, Journal of Vacuum Science and Technology
Referee, for eight other professional journals
Vice Section Chairman for the ECS Symposium on "Electrodeposition of Bulk, Thin-film, and Surface Compounds" San Francisco, May 1994.

HONORS

Certificate of Honor Teacher named in the 1994, 1997, 2000, 2001, 2004 annual science talent search for the Siemens Westinghouse Science & Technology Competition for meritorious work with science students.

University of North Texas Developing Scholar Award 1997-1998

Certificate of Honor as the teacher for meritorious work with science students in the 57th annual Westinghouse Science Scholarship Competition 1994

Certificate of Honor as the teacher for meritorious work with science students in the 53th annual Westinghouse Science Scholarship Competition 1994

Alcon Laboratory Graduate Research Fellow, Fort Worth, Texas 1983-1984

Ministry of Education Chemistry Award, Taiwan 1980-1982

Dr. Lin Pen-Yen Memorial Undergraduate Scholar, Taiwan 1976-1980

AREAS OF EXPERTISE

Microelectronic Materials Characterization, Surface and Materials Chemistry, Corrosion and Prevention, Analytical Chemistry, Silicon Interfacial Characterization, Electrochemistry, Alternative Energy, Fuel Cell Catalyst, Environmental Chemistry, Photoelectrochemistry, Conducting Polymers, Molecular Electronics.

RESEARCH ACCOMPLISHMENT SUMMARY

Professor Chyan established, in 1992, *the Interfacial Electrochemistry and Materials Research laboratory* where he leads an interdisciplinary research team to investigate a multitude of fundamental issues and actively apply novel research technologies to semiconductor characterization, microelectronic fabrication and renewal energy. This research program, on the cutting edge of nanotechnology with close collaboration with industry including Intel, TI, Lam Research, TEL, ATMI and L-3, provides an ideal learning opportunity for graduate students to acquire hands on experience with materials chemistry and thin films, plasma processing, electrochemistry, spectroscopic and microscopic imaging techniques, device fabrication and characterization.

Grants: Professor Chyan has brought in over $ 3,276,920 external grant support into UNT since 1992. His ongoing research programs were supported by the Robert A. Welch Foundation, Texas Advanced Technology program, Intel, Texas Instruments, LAM Research Inc., Tokyo Electron Ltd.(TEL), Semiconductor Research Corporation, SEMATECH, Freescale/NXP, L3 and Eastman Kodak.

Publications and Professional Presentation: Professor Chyan has published 79 papers in peer-reviewed journals and conference proceedings. Professor Chyan has given more than 169 scientific lectures (including 78 invited talks) during his tenure at UNT.

Invention and Technology Transfer: Three United States Patents (*US Patent#* 6145372, 7247554 and 9366601) were awarded to professor Chyan's invention. One US Provisional Patent #62432115 was filed in December 2016.

- ***US Patent*# 6145372 (Detection of Trace Contamination on Silicon wafer)** has attracted >$523,000 external funding. The original invention results in 9 publications, 14 professional presentation and 15 invited talks.

- ***US Patent*# 7247554 (New Ru-based Cu Diffusion Barrier and Cu/Ru Bimetallic Corrosion)** has received >$1,340,000 external funding. The original invention contributed to 14 publications, 40 professional presentation and 12 invited talks.

- ***US Patent*# 9366601 (Novel Chemical Bonding Transformation Mapping Probe based on MIR-IR)** has received >$839,000 external funding. The original invention results in 15 publications, 11 professional presentation and 15 invited talks. Intel has formally initiated technical transfer negotiation and licensing request to UNT on Dec. 2016.

- ***US Provisional Patent*# 62432115 (New Monitoring Metrology for Precise Cu Etching Control).** Funding request of $375,000/3 years was under reviews by Intel. CHEMCUT Inc. has expressed interested in technical transfer negotiation and licensing request to UNT on Jan. 2017.

Some of current research projects include:

Semiconductor Materials Chemistry*:* Develop highly sensitive IR spectroscopic metrology to characterize trace post-etch residues (< 3 nm) on patterned ultra-low k nanostructure. Identify chemical, structural and bonding modification across ULK ILD interfaces to achieve integration success by optimizing plasma etching and post etch cleaning that minimize low-k dielectric damage. Develop an ultra-thin (< 5 nm), directly-plate-able Ru-based Cu diffusion barrier/liner for advanced interconnect application. Important interfacial phenomena including Cu electroplating, Cu diffusion, Cu post CMP clean and Cu/Ru bimetallic corrosion and inhibition were actively investigated. For front end processing, detection and monitoring of metal and organic contamination in various wet clean solutions to achieve ultraclean silicon surface. Optimize PECVD growth of amorphous silicon for ultra-sensitive night vision application.

Renewal Energy: Deposit metal nanoparticels on one dimensional carbon nanotubes and graphene supported by metallic and semiconducting substrates. Novel catalytic properties and energy storage/production are the focuses of this research effort. Develop cost-effective electrocatalysts for oxygen reduction reaction to achieve hydrogen and methanol fuel cells of high efficiency. Hydrogen fuel production via solar-assisted water splitting using high band gap nitride based semiconductors.

INSTRUCTIONAL ACTIVITIES

Professor Chyan's research program, operates in *the Interfacial Electrochemistry and Materials Research laboratory,* has an international reputation of successfully exploring critical underlying fundamental science to greatly facilitate microelectronic fabrication, functional nanostructure design and alternative energy development. With frequent

interactions with major microelectronic company like Intel, GlobalFoundries, TEL, and LAM, most of students received well-paid high tech job offers before graduation. As such, 19 (>75%) of past graduated students are currently working in the microelectronic industry. Many have risen to managerial positions and bring back sponsored projects to work with Chyan group at UNT.

Past Graduated Students (*Work in microelectronic industry)

Steve Chien*	graduate(M.S.94)	Conexant
Min Liu*	graduate(M.S. 95)	Steag Hama Tech USA
JunJun Wu*	graduate(M.S. 96)	Lucent
Fei Xu*	graduate(M.S. 97)	Steag Hama Tech USA
Haiqing Peng	graduate(M.S. 00)	Rice University
Thomas Ponnuswamy*	graduate(Ph.D. 02)	Novellus Inc.
Tana Arunagiri*	graduate(Ph.D. 03)	Lam Research Inc.
Raymond Chan*	graduate(Ph.D. 03)	TEL.
Oscar Ojeda*	graduate(M.S. 05)	Intel
Trace Q. Hurd*	graduate(Ph.D. 05)	Texas Instruments
Yibin Zhang*	graduate(Ph.D. 05)	GlobalFoundries
Sarah Flores*	graduate(M.S. 06)	Intel
Praveen Nalla*	graduate(Ph.D. 06)	Lam Research Inc.
Shyam Venkataraman*	graduate(M.S. 07)	BASF – Electronics
Fan Yang	graduate(M.S. 09)	UT Austin
Danny Taylor	graduate(M.S. 11)	E-chem Sale
Po-Fu Lin	graduate(M.S. 11)	Medical School
Kyle Kai-Hung Yu*	graduate(Ph.D. 11)	TEL
Karthik Pillai*	graduate(Ph.D. 11)	TEL
Jafar Abdelghani	graduate(Ph.D. 13)	Jordan University
Simon Koskey*	graduate(Ph.D. 14)	Intel
Tamal Mukherjee*	graduate(Ph.D. 15)	Lam Research Inc.
Arindom Goswami	graduate(Ph.D. 15)	UCF NanoScience Center
Sirish Rimal*	graduate(Ph.D. 15)	JSR-MICRO
Nick Ross*	graduate(Ph.D. 16)	Intel

Current Group Members

Muthappan Asokan	Ph.D. student
Issac Goutham	Ph.D. student
Alex Lambert	Master student

Former Undergraduate Research Students

William F. Ikerd	undergraduate (94)	Washington University
Soraksmey Chhim	undergraduate (98)	Texas A&M

Patrick W. Goodwill	undergraduate (98)	Stanford University
Abhi Prasad	undergraduate (98)	Nebraska Medical School
Ketul Parikh	undergraduate (00)	MIT
Vivian Liang	undergraduate (01)	Motorola
Christ Cheng	undergraduate (03)	Duke University
John Sarik	undergraduate (03)	UT-Austin
Jennifer Hanson	REU undergraduate	Michigan University
Davin Mcdow	REU undergraduate	Oklahoma Baptist University
Joe Chen	undergraduate (04)	Stanford University
Jason Snitker	REU undergrad (15)	
Nicklas Rydberg	undergraduate (15)	UT-Southwestern Med. School

Former Postdoc

Dr. Jin-song Gao	1998-1999
Dr. Tana Arunagiri	2004-2005

Undergraduate Theses

William F. Ikerd	"The Next Generation Ultra-sharp Tips for the Scanning Tunneling Microscope"
Patrick Goodwill	"Sensor for Trace Metallic Detection in Wafer Processing Chemicals"
Soraksmey Chhim	"Copper Metal Deposition on Silicon Wafer Substrate with Electrochemical Techniques"
Ketul Parikh	"Selective Deposition of Polyaniline on Modified Silicon Surfaces"
Vivian Liang	"Preparation and Characterization of Platinum and Palladium Nanoparticles on Pyrolyzed Photoresist Film"
Chris Chen	"Electrodeposition of Silver and Copper on a Ruthenium Substrate"
John Sarik	"The Exploration of Silver and a Copper/Silver Multilayer Electrodeposition for the Novel Metal Interconnects in Integrated Circuits"
Jennifer Hanson	"RuO_2/Ru Stack: a Potential Copper Diffusion Barrier in Sub-0.13 μm Generation Integrated Circuits"
Davin Mcdow	"Electrodeposition of Copper on a Iridium and Iridium Oxide Surfaces"
Natalli Sealover	“Interfacial Chemistry on Silicon(111) Surface.”

Joe Chen	"Underpotential Deposition of Cu on Nobel Metal Surfaces"

Graduate Theses

Steve Chien	"Investigation of Cu Outplating Mechanisms on Silicon Wafer Surfaces"
Min Liu	"Characterization and Applications of Pd/Sn Catalyst in Electroless Plating"
JunJun Wu	"Study on Etching and Charge Transfer Reaction at Silicon Surfaces"
Fei Xu	"Investigation of Ultra-trace Metallic and Organic Contaminants in Semiconductor Processing Environments"
Haiqing Peng	"The Performance of Silicon Based Sensor and Its Applications in Silver Toxicity Studies"
Thomas Ponnuswamy	"Hydrogen Terminated Silicon Surfaces: Development of Sensors to Detect Metallic Contaminants and Stability Studies Under Different Environments"
Raymond Chan	"Interfacial Electrochemistry and Surface Characterization: Hydrogen Terminated Silicon, Electrolessly Deposited Palladium & Platinum on Pyrolyzed Photoresist Films and Electrodeposited Copper on Iridium"
Tana N. Arunagiri	"Interfacial Electrochemistry of Metal Nanoparticles Formation on Diamond and Copper Electroplating on Ruthenium Surfaces"
Oscar Ojeda	"Electrochemical Surface Studies with the Electrochemical Quartz Nanobalance"
Trace Q. Hurd	"Chemistry, Detection, and Control of Metals During Silicon Processing"
Yibin Zhang	"Study of Ruthenium and Ruthenium Oxide's Electrochemical Properties and application as a Cu Diffusion Barrier"
Sarah Flores	"Electrochemical Study of Underpotential Deposition Processes on Transition Metal Surfaces"
Praveen Nalla	"Interfacial Studies of Bimetallic Corrosion in Copper/Ruthenium Systems and

	Silicon Surface Modification with Organic and Organometallic Chemistry"
Shyam Venkataraman	" Electrodeposition of Copper on Ruthenium Oxides and Bimetallic Corrosion of Copper/Ruthenium in Polyphenolic Antioxidants."
Fan Yang	" Preparation of Ag Metal Nanoparticle on Silicon by Solution Process"
Kyle Kai-Hung Yu	"Interfacial Electrochemistry of Copper and Spectro-electrochemical Characterization of Oxygen Reduction Reaction
Karthikeyan Pillai	"Copper Electrodeposition on Ru-Ta and Corrosion of Plasma Treated Cu in Post Etch Cleaning Solution"
Po-Fu Lin	"Electrochemical Quartz Crystal Microbalance Study of Bismuth Underpotential Deposition on Ruthenium and on Electrochemically Formed Ruthenium Oxide"
Danny Taylor	"Electrochemical Study of Bismuth UPD Process by Quartz Crystal Microbalance "
Simon Koskey	"Fundamental Studies of Copper Bimetallic Corrosion in Ultra Large Scale Interconnect Fabrication Process"
Jafar Abdelghani	"Interfacial Characterization of Chemical Vapor Deposition Growth Graphene and Electrodeposited Bismuth on Ruthenium Surface"
Arindom Goswami	"Fundamental Studies of Copper Corrosion in Interconnects Fabrication Process and Spectroscopic Investigation of Low-k Structures"
Tamal Mukherjee	"Investigation of Post-Plasma Etch Fluorocarbon Residue Characterization, Removal and Plasma-induced Low-k Damage for Advanced Interconnect Applications"
Sirish Rimal	"Characterization of Post-Plasma Etch Residues and Damage Evaluation on Patterned Porous Low-k Dielectrics using MIR-IR Spectroscopy"
Nick Ross	"Interfacial Electrochemistry of Cu/Al Alloys for IC Packaging and Chemical Bonding Characterization of B-doped Hydrogenated *a*-Si for Infrared Camera"

SERVICE TO DEPARTMENT, UNIVERSITY AND PUBLIC

Departmental:

Chair, Library committee for Chemistry	**1996-present**
Promotion and Tenure Committee	**1998 -present**
Departmental Photographer	**2007 -present**
Personnel Affairs Committee, Chair	**2015-present** 2003-2004 2008-2009
Personnel Affairs Committee	2007-2010, 2014-2016 1998-2000, 2002-2004
Surface Engineering and Science Cluster: Faculty Searches	2011- 2012
P&T subcommittee – Steve Cooke	2007- 2010
Chair, Chemistry Website Committee	2006-2009
Materials Chemistry Search Committee	1998 to 2000
Welch Chair Search Committee	2001 to 2003
Organic Search Committee	2000 to 2001
Physical/Organic Search Committee	2004 to 2005
Instrumentation Committee	1998 to 2003
Graduate recruiting Committee	1998 to 1999
Departmental Photographer	1996 to 1998
Undergraduate Affairs Committee Member	1993 to 1998
Graduate Affairs Committee	2000 to 2003

Analytical Faculty Search Committee	1996
Faculty Advisor for the Burleigh Instructional Scanning Tunneling Microscope	1996 to 1998

University:

UNT CART-Cleanroom Advisory Committee	**2016-present**
Surface Engineering Cluster Search Committee	2008-2010
UNT Clean Room Working Group	2008-2010
UNT Faculty Ambassador	**2007-present**
CAS Web Review Committee	2007-2013
Graduate Faculty Member (Category III)	**1996 -present**
Advisor: American Chemical Society Student Affiliates	2008-2010
TAMS Dean Evaluation Committee	2009-2010
Reviewer for Faculty Research Grant Program	1993 to 2008
Interviewer for the UNT Texas Academy of Mathematics and Science	1995 to 1998
Committee on Graduate Council Dissertation Award	2000, 2001

Public:

Chemistry Demo. for Denton Community School	1996
Science Demonstration for the Denton Boy Scouts	1996-1999

State:

Expert witness in chemistry graduate study for

the Office of Attorney General, State of Texas. 2001

PUBLICATIONS

1. "Heterojunction Photoelectrodes II. Electrochemistry at Tin-doped Indium Oxide /Aqueous Electrolyte Interfaces", Chyan, O. M. R.; Rajeshwar, K. *J. Electrochem. Soc.*, 1985, *132*, 2109.

2. "Heterojunction Photoelectrodes III. Cyclic Voltammetry at Indium Tin Oxide-coated Silicon / Aqueous Redox Electrolyte Interfaces", Chyan, O. M. R.; Ho, S. I.; Rajeshwar, K. *J. Electrochem. Soc.*, 1986, *133*, 531.

3. "Quantitation of Len Protein Mixed Disulfides by Ion-Exchange Chromatography", Lou, M. F.; Mckellar, R.; Chyan, O. M. R. *Exp. Eye Res.*, 1986, *42*, 607.

4. "New Conducting Polymers of Some Bithiophene- and Bis-N-Methylpyrrole Polyenes, Their Properties and Their Application in Microelectrochemical Devices", Baeuerle, P.;Wrighton, M. S.; Chyan, O. M. R.; Spangler C. W. *Ber. Bunsenges. Phys. Chem.,* 1987, *91*, 889.

5. "Chemically Modified Microelectrode Arrays: New Kinds of Electronic Devices", Wrighton, M. S.; Chao, S.; Chyan, O. M. R.; Jones, E. T.T.; Lofton, E. P.; Schloh, M. O.; Shu, C. F., in *Chemically Modified Surface in Science and Industry*, D. E. Leyden, W. T. Collins, ed., Gordon and Breach Science Publishes, N.Y., 1988, P. 337.

6. "Preparation and Characterization of Molecule-Based Transistors with a 50 Nanometer source-Drain Separation Using Shadow Deposition Techniques: Toward Faster, More Sensitive Molecule-Based Devices", Jones, E. T. T.; Chyan, O. M. R.; Wrighton, M. S. *J. Am. Chem. Soc.*,1987, *109*, 5526-5528.

7. "Potential Dependence of the Relative Conductivity of Poly (3-Methylthiophene): Electrochemical Reduction in Acetonitrile and Liquid Ammonia", Crooks, R. M.; Chyan, O. M. R.; Wrighton, M. S. *Chem. Mater.*, 1989, *1(1)*, 2.

8. "Imaging Surface Atomic Structure by Means of Auger Electrons", Hubbard, A. T.; Frank, D. G.; Chyan, O. M. R.; Golden, T. *J. Vac. Sci. Tech.*, 1990, *B8*, 1329.

9. "Imaging Surface Atomic Layers by Means of Auger Electrons", Batina, N.; Chyan, O. M. R.; Frank, D. G.; Golden, T.; Hubbard, A. T. *Naturwissenschaften*,

1990, *77*, 557.

10. "Direct Imaging of Monolayer and Surface Atomic Structure by Angular Distribution Auger Microscopy", Frank, D. G.; Golden, T.; Chyan, O. M. R.; Hubbard, A. T. *J. Vac. Sci. Tech.*, 1991, *A9*, 1254.

11. "Direct Imaging of Thin Film Atomic Structure by Angular Distribution Auger Microscopy", Frank, D. G.; Golden, T.; Chyan, O. M. R.; Hubbard, A. T. *Appl. Surf. Sci.*, 1991, *48-49* , 166.

12. "Imaging Monolayer Structure by Means of Auger Electrons", Frank, D. G.; Chyan, O.M.R.; Golden, T.; Hubbard, A. T. *J. Vac. Sci. Tech.*,1992, *A10*, 158.

13. "Probing Three Distinct Iodine Monolayer Structures at Pt(111) by Means of Angular Distribution Auger Microscopy: Results Agree with Scanning Tunneling Microscopy", Frank, D. G.; Chyan, O. M. R.; Golden, T.; Hubbard, A. T. *J. Phys. Chem.*, 1993, *97*, 3829.

14. "Auger Electron Angular Distributions from Al(100): Resolution of an Apparent Contradiction" Chyan, O. M. R.; Frank, D. G.; Doyle, C.A.; Hubbard, A. T. *J. Vac. Sci. Tech.*, 1993, *A11*, 2659.

15. "Auger Emission Angular Distributions from a Silver Monolayer in the presence and Absence of an Iodine Overlayer: Evidence for the Predominance of Inhomogeneous Inelastic Scattering of Auger Electrons by Atoms", Frank, D. G.; Chyan, O. M. R.; Golden, T.; Hubbard, A. T. *J. Phys. Chem.*, 1994, *98* , 1895.

16. "Measurement of Complete Auger Electron Emission Angular Distribution from SiC Films on Si(100)" Chyan, O. M. R.; Frank, D. G.; Hubbard, A. T; Li, J.P.; Steckl, A.T. *J. Vac. Sci. Tech. B*, 1994, *B12*, 457.

17. "Auger Emission Angular Distributions from Pt(111): the Effect of Adsorbed Iodine Monolayer", Doyle, Charles A.; Chyan, O. M. R.; Frank, D. G.; Golden, T.; Hubbard, A. T. *Surface and Interface Analysis*, 1994, *21(2), 123*.

*18. "Kinetics and Morphology of Copper Deposition on Hydrogen -Passivated Silicon Surfaces from Dilute HF Solutions", Sees, J.; Hall, L.; Chyan, O. M. R.; Chen, J.J.; Chien, H.Y., Proceedings of the Second International Symposium on Ultra-clean Silicon Surfaces, Brugge, Belgium, 1994, p 147.

*19. "Electrochemical Aspects of Noble Metals Related to Silicon Wafer Cleaning",

Chyan, O. M. R.; Chen, J.J.; Chien, H.Y.; Hall, L.; Sees, J., Proceedings of the Second International Symposium on Ultra-clean Silicon Surfaces, Brugge, Belgium, 1994, p 213.

*20. "High Surface Electrode Materials by Direct Metallization of Porous Substrates", Chyan, O. M. R.; Chen, J.J.; Liu, M.; Richmond, M.G.; Yang, K.; MRS Proceedings of Materials for Electrochemical Energy Storage and Conversion-Batteries, Capacitors and Fuel Cells, *Mater. Res. Soc. Symp. Proc.* 1995, 393, 265.

*21. "Copper Deposition on HF Etched Silicon Surfaces : Morphological and Kinetic Studies", Chyan, O. M. R.; Chen, J.J.; Chien, H.Y.; Sees, J.; Hall, L.; *J. Electrochem. Soc.*, 1996, *143*, 92.

*22. "Pulsed Plasma Polymerization of Tetramethyltin: Nanoscale Film Chemistry Composition Control", Chen, X.; Rajeshwar, K.; Timmons, R.B.; Chen, J.J. ; Chyan, O. M. R.; *Chem. Mater.*, 1996, *8*, 1067.

*23. "A New Potentiometric Sensor For the Detection of Trace Metallic Contaminants in Hydrofluoric Acid", Chyan, O. M. R.; Chen, J.J.; Chien, H.Y.; Wu, J.J.; Liu, M.; Sees, J.; Hall, L., *J. Electrochem. Soc.*, 1996, *143*, L235.

*24. "Porous Silicon Coated with Calixarene Carboxylic Acid Derivatives: Effects on Luminescence Quenching Selectivity", Zhang, L.; Coffer, J.L.; Wang, J.; Gutsche, C.D.; Chen,J.J.; Chyan, O. M. R., *J. Am. Chem. Soc.*, 1996, *118*, 12840.

*25. "Potentiometric Investigation of Silicon Electrode Immersed in Alkaline Hydrogen Peroxide Solution Containing Trace Level of Iron", Chyan, O. M. R.; Chen, J.J.; L. Chen; F. Xu, *J. Electrochem. Soc.*, 1997, *144*, L17.

*26. "Discrete Metal Deposition on Hydrogen Terminated Silicon Surfaces: Kinetics, Morphologies and Sensor Applications", Chyan, O. M. R.; Chen, J.J.; Wu, J.; Chien, H.Y., *Mater. Res. Soc. Symp. Proc.* 1997, *451*. 267.

*27. "Trace Level Organics in Hydrofluoric Acid Determined by Attenuated Total Internal Reflection Infrared Spectroscopy", Chyan, O. M. R.; Chen, J.J.; Xu, F.; Wu, J., *Anal. Chem.*, 1997, *69*, 2434.

*28. "Comparative Studies of Hydrogen Termination on Single Crystal Silicon Surfaces by FTIR and Contact Angle Measurements", Chyan, O. M. R.; Wu, J.; Chen, J.J., *Applied Spectroscopy* ,1997, *51*, 1905.

*29. "Study of Fluoride Induced Dissimilar Metal Corrosion in a Microelectromechanical System", Prasad, J.; Chyan, O.M.R.; Chen, J.J.; Liu, M.; Chen, L.; Xu, F., *J. Mater. Res.*, 1997, *12*, 3241.

*30. "An Apparatus and Method for Detecting Impurities in Wet Chemicals", Hall, L; Sees, J; Chyan, O. M. R. ; *U.S. Patent*, 6,145,372, 2000.

*31. "Ultrapure Water Quality Monitoring by a Silicon-based Potentiometric Sensor", Chyan, O. M. R. .; Chen, J.J.; Xu, F.; Wu, J.; Sees, J.; Hall, L , *The Analyst* , 2000, *125*, 175.

*32. "Qualitative and Quantitative Study of Silicon Wafer Surfaces Using ATR/FTIR Spectroscopy", Chen, J.J.; Xu, F.; Ponnuswamy, T.; Chan, R.; Wu, J.J.; Prasad, A.; Chyan, O. M. R. ; Sees, J. A.; Hall, L. H., *Recent Res. Devel. Applied Spectroscopy,* 2000, *3*, 81.

*33. "Preparation and Characterization of Metal Nanoparticles on a Diamond Surface", Gao, J.; Arunagiri, T.N.; Chen, J.J.; Goodwill, P.; Chyan, O. M. R. ; Perez, J.; Golden, D.,
Chem. Mater., 2000, *12*, 3495.

*34. "Deposition of Metal Nanoparticles on Diamond Surface Via a Solution Route", Arunagiri, T.N.; Chen, J.J.; Gao, J.; Goodwill, P.; Chyan, O. M. R. ; Proceeding for the Electrochemical Society National Meeting, Phoenix, Arizona, 2001.

*35. "Monitoring Metal Ion Contamination Onset in Hydrofluoric Acid Using Silicon/Diamond and Dual Silicon Sensing Electrode Assembly", Ponnuswamy, T.; Chen, J.J.; Xu, F., Chyan, O. M. R. , *Analyst*, 2001 ,*126*, 877.

*36. "Response of Ceriodaphnia Dubia to Ionic Silver: Discrepancies Among Model Predictions, Measured Concentrations and Mortality", Peng, H.; Brooks, B.W.; Chan, R.; Chyan, O. M. R. ; La Point, T.W., *Chemosphere*, 2002, *46*, 1141.

*37. "Preparation and Characterization of a Novel Infrared Sensor for Nickel Detection", Ponnuswamy, T.; Chyan, O. M. R. ; *Analytical Science*, 2002, *18*, 449.

*38. "Preparation and Characterization of Electrolessly Deposited Platinum and Palladium Nanoparticles on Pyrolyzed Photoresist Films on Silicon Substrates", Liang, V.L.; Chan, R.; Chyan, O. M. R. ; *J. Am. Undergrad. Res.*, 2002, *1*, 1.

*39. "Electrodeposition of Copper Thin Film on Ruthenium: a Potential Diffusion Barrier for Cu Interconnects", Chyan, O. M. R. ; Ponnuswamy, T.; and Arunagiri, T.N.; *J. Electrochem. Soc.*, 2003, *150*, 347.

*40. "Interfacial Characterization of Copper Thin Film on Ruthenium: a Potential Diffusion Barrier for Cu Interconnects", Chyan, O. M. R. ; Chan, R.; Arunagiri, T.N.; Zhang, Y.; Hurd, T. *Proceeding of 4th AVS International Conference on Microelectronics and Interface,* page 103, 2003.

*41. "Electrodeposition of Silver and Copper/Silver Multilayer on Ruthenium Substrate as a Potential New Metal Interconnects for Integrated Circuits", Cheng, C.; Arunagiri, T.N.; Chyan, O. M. R. ; *J. Am. Undergrad. Res.*, 2003, *2*, 11.

*42. "Diffusion Studies of Copper on Ruthenium Thin Film: a Plate-able Copper Diffusion Barrier", Chan, R.; Arunagiri, T.N.; Zhang, Y.; Chyan, O. M. R. ; Wallace, R.M.; Kim, M.J., *Electrochem. Solid-State Lett.*, 2004, 7, G154.

*43. "Underpotential Deposition of Copper on Electrochemically Prepared Conductive Ruthenium Oxide Surface", Zhang Y.; Long, L.; Arunagiri, T.N.; Ojeda, O.; Flores, S.; Chyan, O. M. R. ; Wallace, R.M, *Electrochem. Solid-State Lett.*, 2004, 7, C107.

*44. "Ruthenium-based Copper Diffusion Barrier :Studied by Electrochemistry, SIMS Depth Profiling and Sheet Resistance Measurements" Chyan, O. M. R. ; Chan, R.; Arunagiri, T.N.; Wallace, R. W.; Kim, M.J.; Hurd, T., *Proceeding of 204th International Meeting of the Electrochemical Society.*, page 118, 2004.

*45. "Method of Using Materials Based on Ruthenium and Iridium and Their Oxides, As a Cu Diffusion Barrier, and Integrated Circuits Incorporating Same" Chyan, O. M. R. and Ponnuswamy, T.; *U.S. Pat. Appl. Publ.* # 60/393,204, 2004, 11 pages.

*46. "Ruthenium: a Promisingly New Diffusion Barrier for Copper Interconnects for 65 and 45 nm Integrated Circuits Technology Nodes", Arunagiri, T.N.; Misra, A. ; Chyan, O. M. R. , *Indian Surface Finishing.* 2005, 2, 46.

*47. "Study of Palladium Metal Particle Deposition on the Conductive Diamond Surface by XRD, XPS and Electrochemistry", Arunagiri, T.N.; Golden, T. D.; Chyan, O. M. R. , *Mater. Chem. & Phys.*, 2005, *92*, 152.

*48. "Ultrafine Platinum Nanoparticles Uniformly Dispersed on Arrayed CNx Nanotubes with High Electrochemical Activity", Sun, C.L.; Chen, L.C. ; Su, M. C.; Hong, L. S.; Chyan, O. M. R. ; Hsu, C. Y.; Chen, K.H.; Chang, T.F.; Chang, L., *Chem. Mater.*, 2005, *17*, 3749.

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*67. " Electrochemical Investigation of Cu Corrosion in Cu-CMP and Post-CMP Solution Environments", Yu, K.; Chyan, O.M.R.; TECHCON 2008, University of Texas, Austin, Texas. (2008).

*68. " Photoelectrochemical Property Improvement of GaN Thin Film Through Etching ", A. Basilio, H. Yu-Kuei, T. Wen-Hsun, Y. Cheng-Hsuing, H. Geng-Ming, C. Oliver Chyan, Li-Chyong and C. Kuei-Hsie, the 216th ECS Meeting in Vienna, Austria. October (2009).

*69. "Study of Bimetallic Corrosion Related to Cu Interconnects by Using Micropattern Corrosion Screening and Tafel Plots" Yu, K.; Chyan, O.M.R.; ACS Miniature meeting, Denton, (2009).

*70. "Investigation of Cu Bimetallic Corrosion in CMP Chemical Environments using Micropattern Corrosion Screening", Nalla, P.; K. Pillai; Yu, K.; Venkataraman, S.; Chyan, O.M.R., *Advanced Metallization Conference*, Baltimore, (2009).

*71. "Study of Cu Corrosion in Polyphenols Anti-oxidants Solution", Yu, K.; Chyan, O.M.R., Semiconductor Research Corporation / Center for Advanced Interconnect Science and Technology program Review, Albany, New York. (Oct 2009)

*72. " Preparation and Characterization of Ru-Ta Alloys and Study of Electrochemical Cu Deposition", Pillai, K.S.; Chyan, O.M.R., Semiconductor Research Corporation / Center for Advanced Interconnect Science and Technology program Review, Albany, New York. (Oct 2009)

*73. " Effect of Plasma Etch Chemistry to the Cu Bimetallic Corrosion in Cu Interconnect Structure ", Yu, K.; Pillai, K.S.; Chyan, O.M.R., Semiconductor Research Corporation / Center for Electronic Material Processing and Integration program Review, UNT, Denton. (Nov 2010)

*74. " Synthesis of High Quality Graphene Monolayer by Thermal Chemical Vapor Deposition", Abdelghani, J.; Koskey, S.; Chyan, O.M.R.; ACS Southwest Regional Meeting, Austin. (2011)

*75. " Electrochemical quartz crystal microbalance and X-ray photoelectron spectroscopy study of bismuth underpotential deposition on ruthenium ", Lin, P.F.; Abdelghani, J.; Taylor, D.; Chyan, O.M.R.; ACS Southwest Regional Meeting, Austin. (2011)

*76. "Study of Cu bimetallic corrosion in CMP chemical environments using optical scanning and micropattern corrosion screening" Yu, K. K.; Thomas, N.; Venkataraman, . S.; Pillai, K. S. M.; Hurd, T. Q.; Boggs, K.; Chyan, O.M.R.; the 219th ECS Meeting in Montreal. (2011)

*77. "Cu Electrodeposition on Ru-Ta Alloy Thin Films" Pillai, K.S.M.; Yu, K.K.; Chyan, O.M.R..; the 219th ECS Meeting in Montreal. (2011)

*78. " EQCM Investigation of Metal Deposition on Ru and Ru Oxide Surfaces ", Yu, K.K. ; Lin, P. ; Abdelghani, J.; Venkataraman, S.S.; Chyan, O.M.R.; the 220th ECS Meeting in Boston. (2011)

*79. " Characterization of Post Etch Residues on Patterned Porous Low-k using Multiple Internal Reflection Infrared Spectroscopy " Rimal, S.; Ross, N.; Pillai, K. S.M.; Singh, K.J., Chyan, O.M.R.; the 220th ECS Meeting in Boston. (2011).

*80. " Visualization of Surface Energy Topography on Large-scaled Graphene by Electrochemical Approach" Lin, Y.K.; Chyan, O.M.R.; Chang, C.K.; Chen, Y.F.; Chen, L.C.; Chen, K.H.; New Diamond and Nano Carbons Conference, Singapore. (2013).

*81. "Towards a Faster Computer-How Chemistry Can Help", Mukherjee, T. and. Chyan, O.M.R., UNT Graduate Exhibition, Denton (2013).

*82. "Characterization of Boron Doped Amorphous Silicon Films by Multiple Internal Reflection Infrared Spectroscopy", N. Ross, K. Shrestha, O. Chyan, C. L. Littler, V. C. Lopes, and A. J. Syllaios, Mater. Res. Soc. International Meeting, San Francisco. (2013).

*83. "Bonding structure characterization and UV-assisted wet removal of fluorocarbon polymer film onlow-k dielectric trench structure", Mukherjee, T.; Berhe, S.A.; Arindom Goswami, A.; Chyan, O. M.R., ACS Southwest Regional Meeting, Dallas. (2014)

*84. "Probing Si-OH and Si-CH3 of Plasma Damaged Low-k Dielectric Nanostructures by MIR-IR Spectroscopy", Rimal, S.; Chyan, O. M.R., ACS Southwest Regional Meeting, Dallas. (2014)

*85. "Spectroscopic Study of the Chemical Bonding Structure in Amorphous Silicon for Microbolometer IR Imaging Application", Ross, N.; Chyan, O. M.R., ACS Southwest Regional Meeting, Dallas. (2014)

*86. "Study of Cu Bimetallic Corrosion and its Inhibition Strategy for Cu Interconnect Application using Micro-pattern Corrosion Screening " Goswami, A.; Koskey, S.; Yu, K.; Chyan, O.M.R.; the 227th ECS Meeting in Chicago. (2015).

*87. "Exploration of Chemical Bonding Transformation Mapping to Assist Low-k Dielectric Nanostructure Fabrication " Chyan, O.M.R.; Rimal, S.; Mukherjee, Goswami, A.; Ross, N.; the 227th ECS Meeting in Chicago. (2015)

*88. "Study of Bimetallic Corrosion and Its Inhibition Strategy for Cu Interconnect and IC Packaging Using Micro-Pattern Corrosion Screening" Ross N.; Goswami, A.; Berhe, S.A.; Lin, P. ; Snitker, J.; Chyan, O.M.R.; SRC *TECHCON 2015*, Austin, Texas.

*89. " Micro-pattern Corrosion Screening on Bimetallic Corrosion for Microelectronic Application" Chyan, O.M.R.; Yu, K.; Nalla, P.; Koskey, S.; the 66th ISE Annual Meeting in Taipei, Taiwan. (2015)

*90. " Aluminum Bonding Pad Corrosion of Wirebond Packages " Mathew, V.; Chopin, S.; Chyan, O.M.R.; Ross, N.; Lambert, A.; Asokan, M.; IMAPS-2016, Pasadena, CA. (2016)

*91. "Optimization of Cupric Chloride Chemical Equilibrium for Subtractive Etching of High Density Interconnects " Lambert, A.; Asokan, M.; Hix, M.; Casey, L.; Goutham, I.; Chyan, O.; Ojeda, O.; Ecton, J.; Roy, A.; Wang, H.; Arana, L., IPC-APEX 2017, San Diego, CA. (2017)

*92. "Mechanistic Investigation and Prevention of Al Bond Pad Corrosion in Cu Wire Bonded Device Assembly" A. Lambert, M. Asokan, N. Ross, S. Berhe, O.M.R., Chyan, M. Chowdhury, S. O'Connor, L. Nguyen, ECTC-2017, Lake Buena Vista, FL. (2017)

*Presentations originating from UNT.

INVITED TALKS (All Presentations originating from UNT)

*1. "Surface Electrochemistry", National Chung-Hsing University, Taichung, Taiwan, (June 1993).

*2. "Metal Deposition Induced Surface Roughening on Hydrogen Terminated Silicon Wafer Surfaces", the North Texas Section of the Electrochemical Society, Dallas, Texas, (1994).

*3. "Interfacial Studies of Metal Deposition on Hydrogen Passivated Silicon Surfaces", University of Texas at Arlington, Arlington, Texas. (March 1995)

*4. "Interfacial Characterization of Metal Deposited Silicon Wafer Surfaces", Texas Christian University, Forth Worth, Texas, (November 1995)

*5. "Scanning Probe Microscopy Techniques: Electrochemical and Microelectronic Applications" The South Texas Section of the Electrochemical Society, Houston, Texas. (December 1995)

*6. "Electrochemical Aspects in the Silicon Wafer Cleaning and Contamination Controls", The Second Joint Meeting of North and South Texas Section of the Electrochemical Society, Houston, Texas. (March 1996)

*7. "Interfacial Characterization of Hydrogen Terminated Silicon Wafer Surfaces: Kinetics, Morphologies and Sensor Applications.", Texas A&M University, (November 1996)

*8. "Nanoscale Chemistry on Silicon Surface and Its Applications in Integrated Circuits Fabrication", University of Missouri at Rolla. (March,1997)

*9. "Surface Chemistry of Silicon and Its Applications to Microelectronics Industry", Taiwan Academia Sinica, Taipei, Taiwan. (March 1997)

*10. "Sensitive Detection of Ultra-trace Metal and Organic Contaminants Using a Silicon-Based Sensor", Project Advisory Board Meeting, SEMATECH. (May 1997)

*11. "Trace Silver Measurement Utilizing a Silicon-based Sensing Electrode", the Fifth International Conference on Transport, Fate and Effects of Silver in the Environment, Hamilton, Ontario, Canada. (September 1997)

*12. "Characterization of Trace Impurities in Microelectronics Processing Chemicals Using a Silicon based Sensor", Utah State University, Logan, Utah. (October 1997)

*13. "Nanoscale Silicon Surface Chemistry and Its Applications to Integrated Circuit Fabrication", University of Utah, Salt Lake City, Utah. (October 1997)

*14. "Characterization of Trace Impurities in Microelectronics Processing Chemicals Using a Silicon based Sensor", University of Texas at Dallas, Dallas, Texas. (November 1997)

*15. "Monitoring Ultra-trace Impurities in IC processing Chemicals Using a Silicon -based Sensor", Georgia Institute of Technology, Atlanta, Georgia. (November 1997)

*16. "Nanoscale Silicon Surface Chemistry and Its Applications to Integrated Circuit Fabrication", University of Georgia, Athens, Georgia. (November 1997)

*17. "Interfacial Characterization of Discrete Metal Deposition on Silicon Surfaces: Morphologies, Kinetics, Catalysis and Sensor Applications", Massachusetts Institute of Technology. (July 1998)

*18. "Trace Silver Detection in Natural Waters Using Silicon-based Sensor and Matrix Isolation Technique", Eastman Kodak, Rochester, New York. (November 1999)

*19. "Development of a Solid State Chemical Sensor for Environmental Applications", Institute of Applied Science, University of North Texas, Denton. (March 2000)

*20. "Materials Chemistry of Silicon and Diamond in Hydrofluoric Acid Environment", Materials Science Department, University of North Texas, Denton. (April 2000)

*21. "Silicon Materials Chemistry and it's Applications in Microelectronics Industry", Chemistry Department, Texas A&M University, Commerce. (November 2000)

*22.. "Materials Chemistry of Silicon wafer and its Microelectronics Applications", College of Chemistry, Universidad Autonoma De Coahuila, Saltillo, Mexico, (November 2001)

*23. "Interfacial Characterization of Discrete Metal Deposition on Hydrogen Terminated Silicon and Diamond Surfaces", College of Chemistry, Peking University, China. (May 2002)

*24. "Electrochemistry on silicon wafer and it's Microelectronics Applications", Institute of Microelectronics, Peking University, China. (May 2002)

*25. "The Physical and Chemical Aspects of the Selected Interfaces that have both Academic Significance and Industrial Applications", College of Chemistry, Nankai University, China. (May 2002)

*26. "The Materials Aspects of Metal/Dielectrics/Silicon Wafer for IC Chip Production", Department of Materials Science, Nankai University, China. (May 2002)

*27. "Materials Research Based on Silicon Wafer and Metal Surfaces: Application to Advanced Integrated Circuit Fabrication", Chemistry Department of National Chung-Hsing University, Taiwan. (December 2002)

*28. "Interfacial Electrochemistry and its Application to the Cu Diffusion Barrier Integrated Circuit Fabrication", Applied Materials Inc., Santa Clara. (March 2003)

*29. "Recent Advances on Direct Plate-able Ruthenium Based Cu Diffusion Barrier Research at the UNT Interfacial Electrochemistry and Materials Research Laboratory", Texas Instruments Inc., Richardson, Texas. (April, 2003)

*30. "Interfacial Studies of Copper Thin Film on Ru and RuO_2: a New Cu Diffusion Barrier", SEMATECH, Austin. (May 2003)

*31. "Interfacial Chemistry on Silicon and Diamond Surfaces", University of Houston, Dr. Advincula's Polymer and Ultrathin Film Research Lab., Houston. (May 2003)

*32. "Recent Development of Metal Deposition on Ruthenium and Ruthenium Oxide Surfaces", Materials Science Division, Argonne National Laboratory, Argonne, Illinois. (July 2003)

*33. "Silicon Materials Chemistry and Its Applications to Integrated Circuit Fabrication", Texas Instruments, SiTD Interconnect Seminar, Richardson, Texas. (October 2003)

*35. "Silicon Materials Chemistry and Its Applications to Integrated Circuit Fabrication", Department of Chemical Engineering, National Cheng-Kong University, Taiwan. (October 2003)

*36. "Interfacial Diffusion study of Cu Across a 5 nm Ultra-thin Ru-based Cu Diffusion Barrier", Center of the Condensed Materials, National Taiwan University, Taipei, Taiwan. (November 2003).

*38. "Recent Progress in Anchoring Nanomaterials on Silicon and Metal Surfaces", Center of the Condensed Materials, National Taiwan University, Taipei, Taiwan. (July 2004)

*49. " Interfacial Engineering of Ultra-thin Ruthenium Diffusion Barriers for Advanced Interconnect Applications", National Taiwan University, Taiwan. (January 2007)

*50. "Materials Chemistry of Ruthenium and its Applications in Microelectronics and Alternative Energy Production", National Cheng-Kung University, Taiwan. (August 2007)

*51. " Interfacial Engineering of Ultra-thin Ruthenium Diffusion Barriers for Advanced Interconnect Applications", National Chung-Hsing University, Taiwan. (January 2008)

*52. "Investigation of Cu Corrosion in Cu-CMP and Post CMP Related Chemical Environments ", ATMI, Danbury, Connecticut. (May 2008)

*53. " Electrochemical Investigation of Cu Corrosion in Cu-CMP and Post-CMP Solution Environments", Semiconductor Research Corporation / Center for Advanced

Interconnect Science and Technology program Review, Albany, New York. (Oct 2008)

*54. " Electrochemical Investigation of Cu Corrosion in Cu-CMP and Post-CMP Solution Environments", Semiconductor Research Corporation / Center for Advanced Interconnect Science and Technology program Review, Albany, New York. (Oct 2009)

*55. "Recent advances in Interfacial Electrochemistry Applied to Microelectronics and Alternative Energy Production ", Center of the Condensed Materials, National Taiwan University, Taipei, Taiwan. (Oct 2010).

*56. "Recent advances in Interfacial Electrochemistry Applied to Microelectronics and Alternative Energy Production", Department of Materials Science and Engineering, National Donghua University, Taiwan. (Oct 2010).

*57. "Electrochemical Investigation of Cu Corrosion in Cu-CMP and Post-CMP Solution Environments", Semiconductor Research Corporation / Center for Electronic Material Processing and Integration program Review, UNT, Denton. (Nov 2010)

*58. "Characterization of Plasma-Etch-Polymers Using MIR-IR Spectroscopy", Semiconductor Research Corporation / Center for Electronic Material Processing and Integration program Review, UNT, Denton. (Nov 2011)

*59. "Electrochemical Investigation of Cu Corrosion in Cu-CMP and Post-CMP Solution Environments", Semiconductor Research Corporation / Center for Electronic Material Processing and Integration program Review, UNT, Denton. (Nov 2011)

*60. "Interfacial Engineering of Ultra-thin Ruthenium Diffusion Barriers for Advanced Interconnect Applications", Department of Materials Science and Engineering, National Chiao Tung University, Taiwan. (2012)

*61. "Development of an Effective Monitoring Metrology for Etching, Ashing and Cleaning on Patterned Porous Low-k ", Lam Research (2012)

*62. "Development of an Effective Monitoring Metrology for Etching, Ashing and Cleaning on Patterned Porous Low-k ", Novellus (2012)

*63. "Interfacial Characterization of Post Etch Polymer Residues and Plasma Treated Cu Surfaces related to Advanced Cu Interconnects", Intel (2012)

*64. "Electrochemical Investigation of Cu Corrosion in Cu-CMP and Post-CMP Solution Environments", Semiconductor Research Corporation / Center for Advanced Interconnect Science and Technology program Review, Albany, New York. (Oct 2012)

*65. "Interfacial Characterization of Post Etch Polymer Residues and Plasma Treated Cu Surfaces related to Advanced Cu Interconnects", SEMICON-Korea (2013)

*66. " Characterization of Hydrogenated Amorphous Silicon Thin Film by Multiple Internal Reflection Infrared Spectroscopy", L3 Communication, Plano (2013)

*67. "MIR-IR Characterization of Plasma Induced Low-k Damages and Post Etch Polymer Residues", ATMI Inc. (2014)

*68. "Develop a Novel Metrology to Characterize low-k Dielectric Nanostructure related to Advanced Cu Interconnects ", Chang Gung University, Taiwan. (2014)

*69. "Interfacial Characterization of low-k Dielectric Nanostructure related to Advanced Cu Interconnects", 20th Annual Taiwan Analytical Conference, Taiwan National Science Foundation, Taiwan. (2014)

*70. "Chemical Bonding Transformation Mapping to Optimize Low-k Dielectric Nanostructure Fabrication for Advanced Microelectronic Application ", National Chung-Hsing University, Taiwan. (January 2015)

*71. " Investigation of Al Pad Corrosion in the Cu Wire Bonded Semiconductor Device Assembly ", Semiconductor Research Corporation program Review, Georgia Institute of Technology, Atlanta, Georgia (June 2015)

*72. "Recent Development of Novel Characterization Metrology for Advanced Cu Interconnects", JSR Micro, Sunnyvale, CA. (April 2016)

*73. “Characterization of Microscopic Bimetallic Corrosion and Prevention Strategy for Microelectronic Fabrication” Advanced Coatings 2016, Houston, Texas. (May 2016)

*74. “Exploration of Chemical Bonding Transformation Mapping to Assist Low-k Dielectric Nanostructure Fabrication for Advanced Microelectronic Fabrication” IAMS at the Taiwan Academic Sinica, Taiwan (May 2016)

*75. "Mechanistic Investigation and Prevention of Al Bond Pad Corrosion in Cu Wire Bonded Device Assembly ", Semiconductor Research Corporation program Review, Georgia Institute of Technology, Atlanta, Georgia (June 2016)

*76. “Recent Development of Novel Characterization Metrology for Advanced Cu Interconnects” Taiwan Semiconductor Manufacturing Company, Taiwan (June 2016)

*77. “Exploration of Chemical Bonding Transformation Mapping to Assist Low-k Dielectric Nanostructure Fabrication for Advanced Microelectronic Fabrication” the National Sun Yet-Sen University, Taiwan (June 2016)

*78. “Chemical Bonding Transformation Mapping to Optimize Low-k Dielectric Nanostructure Fabrication and Post-etch Residue Clean”, The Surface Preparation and Cleaning Conference (SPCC) at Austin, TX (March 2017)

*Presentations originating from UNT.

PAST, CURRENT AND PENDING GRANTS SUPPORT

A. Awards from External Funding Sources

Professor Chyan has brought in over $ 3,248,300 external grant support into UNT since 1992.

Title: "Interfacial Characterization on HF/Silicon Wafer Systems"
Submitted to: Texas Instruments
Years: 1993 - 1994
Amount: $ 25,950

Title: "AFM, STM and Electrochemical Characterization of Silicon Surfaces"
Submitted to: Texas Instruments
Years: 1994
Amount: $ 25,000

Title: "Interfacial Characterization on HF/Silicon Wafer Systems"
Submitted to: Texas Instruments
Years: 1993 - 1994
Amount: $ 40,009.44

Title: "High Surface Area Electrode Materials for Advanced Battery and Fuel Cell Applications"
Submitted to: Gumbs Associates, Inc.
Years: 1994 - 95
Amount: $ 22,500

Title: "AFM Morphological Studies of Conducting Polymer Films"
Submitted to: Gumbs Associates, Inc.
Years: 1994 - 1995
Amount: $ 12,500

Title: "Interfacial Characterization on HF/Silicon Wafer Systems"

Submitted to: Texas Instruments
Years: 1995
Amount: $ 20,000

Title: "Sensor for Ultra -Trace Level Detection of Metallic Ions in Hydrofluoric Solutions"
Submitted to: Texas Instruments
Years: 1995 - 1996
Amount: $ 45,000

Title: "AFM, STM and Electrochemical Characterization of Silicon Surfaces"
Submitted to: Texas Instruments
Years: 1996 - 1997
Amount: $ 24,000

Title: "Characterization of Trace Organics Adsorbed on Silicon Surface by Multiple Internal Reflection FTIR"
Submitted to: Texas Instruments
Years: 1996 - 1997
Amount: $ 22,000

Title: "Potentiometric Determination of Part-Per-Trillion level of Ag^{+} in Environmental Water Sample"
Submitted to: Eastman Kodak
Years: 1996 - 1997
Amount: $ 5,000

Title: "Detecting Trace Level Organic Contaminations In Microelectronic Processing Chemicals Using ATR-FTIR Techniques"
Submitted to: SEMATECH
Years: 1997 - 1998
Amount: $ 5,000

Title: "Silicon-based Sensor Assembly for Trace Silver Detection"
Submitted to: Eastman Kodak
Years: 1995 - 1998
Amount: $ 75,000

Title: "Scanning Probe Microscopic Studies of Metal Depositions on Dissimilar Metallic Surfaces"
Submitted to: The Robert A.Welch Foundation
Years: 1997 - 1998
Amount: $ 103,200

Title: "Trace Silver Detection in Natural Waters Using Silicon-based Sensor and Matrix Isolation Technique"

Submitted to: Eastman Kodak
Years: 1998 - 1999
Amount: $ 50,000

Title: "Investigation of Discrete Metal Deposition on Semiconductor Surfaces"
Submitted to: The Robert A.Welch Foundation
Years: 1998- 2001
Amount: $ 126,000

Title: "Investigate the Cleaning Conditions for the Cooper Metallization in ULSI Applications"
Submitted to: Texas Instruments
Years: 1998 - 1999
Amount: $ 24,000

Title: " Trace Silver Detection in Natural Waters Using Silicon-based Sensor and Ion Exchange Membrane "
Submitted to: Eastman Kodak
Years: 2000-2001
Amount: $ 20,000

Title: " Metal Deposition on Early Group 14 Elements: Diamond, Silicon and Germanium "
Submitted to: The Robert A.Welch Foundation
Years: 2001- 2004
Amount: $ 150,000

Title: "Developing a new Ruthenium-based Diffusion Barrier for Copper Interconnects"
Co-PI: Dr. Michael Richmond
Funded by: Texas Advanced Technology Program
Years: Jan. 1, 2002- Dec. 31, 2003
Amount: $ 264,890

Matching Fund by: Texas Instruments
Years: Jan. 1, 2002- Dec. 31, 2003
Amount: $ 50,000
Matching Fund by: UNT
Years: Jan. 1, 2002- Dec. 31, 2003
Amount: $ 55,337 (Capital equipment match)

Title: " REU Site for Electronic Materials"
Submitted to: NSF, as a senior investigator with eight other UNT colleagues
Years: 2001- 2004
Amount: $ 264,494

Title: "Study of Bimetallic Corrosion at the Dissimilar Metal Interfaces with Nanometer Dimension"
Funded by: Semiconductor Research Corporation
Years: 2004- 2007
Amount: $ 150,000

Title: "Interfacial Study of Metal Deposition on Metallic Oxide Surfaces "
Funded by: The Robert A. Welch Foundation
Years: 2004- 2007
Amount: $ 150,000

Title: "Corrosion Investigation in a Dynamic Environments for the Next Generation Cu Interconnect Microstructure "
Funded by: Semiconductor Research Corporation
Years: 2004- 2007
Amount: $ 30,000

Title: "Study of Semiconductor Surface Chemistry and Its Applications to Advanced Interconnects"
Funded by: LAM research
Years: 2006- 2007
Amount: $ 40,000

Title: " Investigation of Cu Electrodeposition and Patination on Metallic Oxide "
Funded by: The Robert A. Welch Foundation
Years: 2007- 2010
Amount: $ 150,000

Title: " Electrochemical Investigation of Cu Corrosion in Cu-CMP and Post-CMP Solution Environments "
Funded by: Semiconductor Research Corporation
Years: 2008- 2010
Amount: $ 100,000

Title: "Study of Organometallic Chemistry and Its Applications to ALD TaN Barrier"
Co-PI: Dr. Michael Richmond
Funded by: LAM research
Years: 2007- 2008
Amount: $ 40,000

Title: " Electrochemical Investigation of Cu Corrosion in Cu-CMP and Post-CMP Solution Environments "
Funded by: Semiconductor Research Corporation
Years: 2010- 2013
Amount: $ 150,000

Title:	"Hybrid Nanocomposite High-k Dielectric Flexible Films for Semiconductor Applications "
Co-PI:	Dr. Richard B. Timmons, Dr. Rigoberto C. Advincula
Funded by:	Norman Hackerman Advanced Research Program (NHARP)
Years:	2010- 2012
Amount:	$ 196,461

Title:	"Interfacial Study of Cu Bimetallic Corrosion and Inhibition IC Cleaning Solution Environments"
Funded by:	ATMI
Years:	2010- 2012
Amount:	$ 123,000

Title:	"Characterization of Cu/W/Co Bimetallic Corrosion and Inhibition IC Cleaning Solution Environments"
Funded by:	ATMI
Years:	2011- 2012
Amount:	$ 48,000

Title:	"Characterization of Plasma-Etch-Polymers Using MIR-IR Spectroscopy"
Funded by:	SRC
Years:	2011-2012
Amount:	$ 135,000

Title:	"Characterization of Plasma-etched ULK Patterned wafers by MIR-IR Spectroscopy"
Funded by:	ATMI
Years:	2012- 2013
Amount:	$ 15,000

Title:	"Characterization of Plasma-etched SiC wafers by MIR-IR Spectroscopy"
Funded by:	Lam Research Inc.
Years:	2012
Amount:	$ 6,000

Title:	"Characterization of ULK Damages wafers by MIR-IR Spectroscopy"
Funded by:	TEL Inc.
Years:	2012
Amount:	$ 6,000

Title:	"Study of Chemical Bonding Structure of PECVD Amorphous Silicon Micobolometer "

Funded by: L3 Communication
Years: 2012
Amount: $ 35,000

Title: “Characterization of Plasma-etch-polymers using MIR-IR Spectroscopy”
Funded by: Semiconductor Research Corporation – Intel MSR grant
Years: 2012-2014
Amount: $ 252,000

Title: "Study of Chemical Bonding Structure of PECVD Amorphous Silicon Micobolometer "
Funded by: Army
Years: 2012-2013
Amount: $ 45,000

Title: " Investigation of Al Pad Corrosion in the Cu Wire Bonded Semiconductor Device Assembly "
Funded by: Semiconductor Research Corporation
Years: 2014- 2015
Amount: $ 85,000

Title: "Study of Chemical Bonding Structure of PECVD Amorphous Silicon Micobolometer "
Funded by: L3 Communication
Years: 2014
Amount: $ 10,000

Title: “Characterization of Plasma Processed Patterned Wafers by MIR-IR Spectroscopy”
Funded by: Intel.
Years: 2015
Amount: $ 14,193

Title: “Characterization of UV-radiated Post-etch Residue MIR-IR Spectroscopy”
Funded by: TEL Inc.
Years: 2015-2016
Amount: $ 60,000

Title: “Characterization of Carbon Nanotubes Coating on Wafers using MIR-IR Spectroscopy”
Funded by: Nantero Company
Years: 2015
Amount: $ 3,000

Title: "Characterization UV treatments for TTCA integrated wafer BEOL polymer removal using MIR-IR Spectroscopy"
Funded by: TEL Inc.
Years: 2015-2016
Amount: $ 60,000

Title: "Characterization of Plasma Processed Patterned Wafers by MIR-IR Spectroscopy"
Funded by: Lam Research Inc.
Years: 2015
Amount: $ 12,500

Title: "Mechanistic Investigation and Prevention of Al Bond Pad Corrosion in Cu Wire Bonded Device Assembly"
Funded by: Semiconductor Research Corporation
Years: 2015-2017
Amount: $163,333

Title: "Characterization of Chemical Equilibriums of Cu Etch Bath Samples"
Funded by: Intel.
Years: 2016
Amount: $7,200

Title: "Characterization of Plasma Processed Patterned Wafers by MIR-IR Spectroscopy"
Funded by: Intel.
Years: 2016-2017
Amount: $21,420

B. Awards from University of North Texas

Title: "Electrochemical and Scanning Probe Microscopic Studies of the Interfacial Processes"
Submitted to: UNT, Faculty Research Grant
Years: 1992-1993
Amount: $ 3,300

Title: "Electrochemical and Scanning Probe Microscopic Studies of the Interfacial Processes"
Submitted to: UNT, Summer Junior Faculty Research Fellowships
Years: 1993
Amount: $ 3,500

Title: "Characterization of the Self-assembled Monolayers on the Single Crystal Metal Substrate by Scanning Probe Microscopies"
Submitted to: UNT, Faculty Research Grant
Years: 1993-1994
Amount: $ 1,800

Title: "Innovative Approaches to the Formation of High Surface Area Electrode Materials for Advanced Battery and Fuel Cell Applications"
Submitted to: UNT, 1994 Summer Junior Faculty Research Fellowships
Amount: $ 3,500

Title: "High surface Electrode Materials Through Electroless Plating of Aerogels"
Submitted to: UNT, Faculty Research Grant
Years: 1994-1995
Amount: $ 1,800

Title: "Metallic Ions Interaction with HF-etched Silicon Surfaces"
Submitted to: UNT, Faculty Research Grant
Years: 1995-1996
Amount: $ 3,000

Title: "Novel Sensor for the Detection of Ultra-trace Metallic Contaminants in Microelectronic Processing Chemicals"
Submitted to: UNT, Faculty Research Grant
Years: 1996-1997
Amount: $ 3,800

Title: "Detecting Trace Organic Impurities in Microelectronic Processing Chemicals Using a Silicon Based Infrared Sensor"
Submitted to: UNT, Faculty Research Grant
Years: 1997-1998
Amount: $ 5,000

Title: "UNT Developing Scholar Award"
Years: 1997-1998
Amount: $ 2,500

Title: "Characterization of Organic Impurities Adsorbed on Silicon Wafer Surface by Attenuated Total Internal Reflection Infrared Spectroscopy"

Submitted to: UNT, Faculty Research Grant
Years: 1998-1999
Amount: $ 3,500

Title: " Probing the Heavy Metal Ions in Environmental Samples Using a Silicon Based Infrared Sensor "
Submitted to: UNT, Faculty Research Grant
Years: 1999-2000
Amount: $ 3,800

Title: "Investigation of Silver Speciation in Aquatic Systems "
Submitted to: UNT, Faculty Research Grant
Years: 2000-2001
Amount: $ 2,500

Title: "Comparative Study of Silver Speciation and Its Toxicity In Aquatic Systems"
Submitted to: Grant Proposal Preparation Program
Years: 2000-2001
Amount: $ 7,400

Title: "Investigation of Copper Deposition on Ruthenium Metal Surface "
Submitted to: UNT, Faculty Research Grant
Years: 2001-2002
Amount: $ 4,000

Title: "Development of a New Copper Diffusion Barrier Based on Ruthenium"
Submitted to: Grant Proposal Preparation Program
Years: 2001-2002
Amount: $ 3,579

Title: "Exploration of Fuel Cell Technology Based on Metal Nanoparticles Formation on Dimensional-Stable Diamond Electrode Surface "
Funded by: UNT, Faculty Research Grant
Years: 2003-2004
Amount: $ 3,500

C. Pending Proposals

Title: "Develop Chemical Sensitive Metrology for in-situ Monitoring and Control tools on Cu Etching"

Submitted to: Intel
Years: 2016- 2019
Amount: $ 375,000

D. Submitted Proposals (Unfunded)

Title : "Preparations and Characterizations of the Unique Substrates for the Atomic-scale Biological Imaging Studies"
Submitted to: The PG&G University Exploratory Research Program
Years: 1993 - 1996
Amount: $ 150,000

Title : "Studies of the Polydiacetylenic Self-assembled Monolayers by Scanning Tunneling Microscopy and Atomic Force Microscopy"
Submitted to: The Oak Ridge Associated University Junior Faculty Enhancement Award
Years: 1993
Amount: $ 10,000

Title : "Scanning Probe Microscopic Studies of the Polymerizable Diacetylenic Alkanethiolate Self-assembled Monolayers"
Submitted to: The Robert A.Welch Foundation
Years: 1993 - 1996
Amount: $ 91,500

Title : "High Surface Area Electrode materials"
Submitted to: IUCRC,UNT
Years: 1993 - 1996
Amount: $ 35,500

Title : "Scanning Probe Microscopic Studies of the Underpotential Deposition Processes on Solid Surfaces"
Submitted to: The Petroleum Research Fund
Years: 1993 - 1994
Amount: $ 20,000

Title : "Innovative Approaches to the Formation of High Surface Area Electrode Materials for Advanced Battery and Fuel Cell Applications"
Submitted to: Texas Advanced Technology Program
Years: 1994 - 1996
Amount: $ 136,423

Participation: Oliver Chyan, Principal Investigator
Michael. G. Richmond, Co-investigator

Title : "Innovative Approaches to the Formation of High Surface Area Electrode Materials for Advanced Battery and Fuel Cell Applications"
Submitted to: Technology Reinvestment Project, ARPA
Years: 1994 - 1996
Amount: $ 188,800
Participation: Oliver Chyan, Principal Investigator
Michael. G. Richmond, Co-investigator

Title : "Scanning Tunneling Microscopic Studies of the Diacetylene Alkanethiolate Monolayers"
Submitted to: The Petroleum Research Fund
Years: 1994 - 1995
Amount: $ 20,000

Title : "STM Imaging Mechanisms of the Ordered Organic Monolayers"
Submitted to: Robert A.Welch Foundation
Years: 1994 - 1997
Amount: $ 96,000

Title: "High Surface Area Electrode Materials by Direct Metallization of Aerogels"
Submitted to: The Petroleum Research Fund
Years: 1995 - 1996
Amount: $ 20,000

Title: "High Surface Area Electrode Materials by Direct Metallization of Aerogels"
Submitted to: The Petroleum Research Fund
Years: 1995 - 1996
Amount: $ 20,000

Title : "Purchase of Confocal Microscope System"
Submitted to: NSF
Years: 1995 - 1997
Amount: $ 146,315
Participation: Paul S. Braterman, Principal Investigator
Oliver Chyan was one of four co-investigators

Title : "Nanoscale Controlled Synthesis of New Organometallic Composite Films Via Pulsed Plasma Depositions"
Submitted to: Texas Advanced Research Program
Years: 1995 - 1997

Amount: $ 258,632
Participation: R.B. Timmons, Principal Investigator
Oliver Chyan , co-investigator

Title : "Sensor for In-line Monitoring Ultra-trace Metallic Contaminations in Microelectronic Processing Chemicals"
Submitted to: Texas Advanced Technology Program
Years: 1995 - 1997
Amount: $ 117,032

Title : "Novel Aerogel Based High Surface Area Electrode System"
Agency: NSF
Years: 1996 - 1999
Amount: $ 328,000

Title: "A Novel Silicon Based Sensor to Optimize Wet Chemical Processing and Reduce Waste in Semiconductor Manufacturing"
Submitted to: EPA/NSF
Years: 1997 - 2000
Amount: $ 313,552

Title: "Sensor for In-line Monitoring Ultra-trace Metallic Contaminants in Microelectronics Processing Chemicals"
Submitted to: Texas Advanced Technology Program
Years: 1997 - 1999
Amount: $ 130,419

Title: "Silicon-based Sensor Assembly for Microelectronics Applications"
Submitted to: MILLIPORE
Years: 1997 - 1999
Amount: $ 119,546

Title: "Center for Materials Synthesis and Development"
Submitted to: NSF
Years: 1997 - 2002
Amount: $ 4,692,070
Participation: Richard F. Reidy, Principal Investigator
Oliver Chyan was one of four co-investigators

Title: "Characterization and Monitoring the Organics Contamination in Ultrapure Water System"
Submitted to: SEMATECH
Years: 1998 - 1999
Amount: $ 40,000
Title: "Metal Depositionon Group 14 Elements: Diamond, Silicon and Germanium"

Submitted to: Texas Advanced Technology Program
Years: 1999-2001
Amount: $ 120,000

Title of the Grant: " Investigation of Static Etching in Tungdten/Silicon Wafer During Chemical Mechanical Polishing "
Granting Agency: AirLiquide Inc.
Period: 2001-2002
Total Amount: $ 33,000

Title of the Grant: " Bioavailability and Effects of Ingested Metals on Aquatic Organisms: A Comparative Study of Silver Speciation and its Toxicity in Aquatic Systems"
Granting Agency: Water Environmental Research Foundation .
Period: 2001-2003
Total Amount: $ 284,135
Participation: Thomas W. La Point, Principal Investigator
Oliver Chyan, Co-investigator

Title of the Grant: " REU in Chemistry at the University of North Texas"
Granting Agency: NSF, Senior Investigator
Period: 2002-2005
Total Amount: $ 210,316

Title: " GOALI: Study of Copper Electrodeposition on Ruthenium and Ruthenium Oxide: a New Approach of Cu Diffusion Barrier for Integrated Circuit Application "
Co-PI: Dr. Bob Wallace, Trace Hurd (TI)
Funded by: NSF
Years: September, 2002- August, 2005
Amount: $ 339,756

Title: "Atomic Layer Deposition of Ru and RuO_2 Ultra-thin Barrier for the Advanced Cu Interconnect Application"
Co-PI: Bob Wallace
Submitted to: Texas Advanced Technology Program
Years: Jan. 1, 2004- Dec. 31, 2005
Amount: $ 249,470

Title: " Solar energy conversion using semiconductor cells with "black absorbers"
Submitted to: Texas Advanced Technology Program
Participation: as Co-PI, Mohammad Omary, Principal Investigator
Years: 2004-2006
Amount: $ 248,000

Title: " GOALI: Study of Copper Electrodeposition on Ruthenium and Ruthenium

	Oxide: a New Approach of Cu Diffusion Barrier for Integrated Circuit Application "
Co-PI:	Bob Wallace, Trace Hurd (TI)
Submitted to:	NSF
Years:	2003- 2006
Amount:	$ 480,768
Title:	"Atomic Layer Deposition of Ru and RuO_2 Ultra-thin Barrier for the Advanced Cu Interconnect Application"
Co-PI:	Dr. Bob Wallace
Submitted to:	Texas Advanced Technology Program
Years:	Jan. 1, 2004- Dec. 31, 2005
Amount:	$ 249,470
Title:	"GOALI: Study of Copper Electrodeposition on Ruthenium and Ruthenium Oxide: a New Approach of Cu Diffusion Barrier for Integrated Circuit Application"
Co-PI:	Bob Wallace, Trace Hurd (TI)
Submitted to:	NSF
Years:	March, 2004- February, 2007
Amount:	$ 500,760
Title:	"Interface Reliability Study Between Low-k Dielectrics and Cu Plate-able Ruthenium-based Diffusion Barrier"
Submitted to:	SEMATECH
Years:	2004- 2006
Amount:	$ 160, 000
Title:	" Development of Ruthenium Barrier Films for Porous Low-k Integration "
Submitted to:	Semiconductor Research Corporation
Years:	2004- 2007
Amount:	$ 450, 000
Title:	"Interfacial Study of Cu/(5 nm Ru)/ILDs and Cu/5 nm (Ru/TaN)/ILDs Film Stacks Supported by Silicon Wafer "
Submitted to:	Texas Instruments
Years:	2005- 2008
Amount:	$ 160, 000
Title:	"Atomic Layer Deposition for the Construction of High-*k* Dielectrics and Copper Diffusion Barriers: a Global Materials Research Approach for Advanced Integrated Circuit Applications"
Co-PI:	Dr. Michael Richmond
Submitted to:	UNT Excellent Fund
Years:	2005- 2006
Amount:	$ 450, 000

Title:	"Interfacial Study on Cu/Ru film stack: a New Approach of Cu Diffusion Barrier for Integrated Circuit Application"
Co-PI:	Dr. Mohamed El Bouanani
Submitted to:	SEMATECH, Advanced Materials Research Center
Years:	2005 - 2008
Amount:	$ 393,986

Title:	"Portable Multi-functional Sensing Systems for Home Land Security "
Co-PI:	Dr. Indranath Dutta
Submitted to:	NPS Homeland Security Coordination Center
Years:	2005- 2008
Amount:	$ 250,000

Title:	"Atomic Layer Deposition for the Construction of High-*k* Dielectrics and Copper Diffusion Barriers: a Global Materials Research Approach for Advanced Integrated Circuit Applications"
Co-PI:	Dr. Michael Richmond
Submitted to:	NSF
Years:	2006- 2009
Amount:	$ 588,772

Title:	"Electrochemical Investigation of Cu/Noble Metal Barrier Interfaces"
Funded by:	Semiconductor Research Corporation
Years:	2007- 2010
Amount:	$ 150,000

Title:	" Elimination of Bimetallic Corrosion in Copper Interconnects and IC Packaging"
Submitted to:	Texas Advanced Research Program
Years:	2008-2010
Amount:	$ 150,000

Title:	" Development of a Novel High-k Dielectrics Nanocomposite Coating by Pulse-Plasma Deposition Process "
Submitted to:	UNT, Faculty Research Grant
Years:	2008-2009
Amount:	$ 5,000

Title:	" Flexible Inorganic/Organic Nanocomposite Films: High-k Dielectrics for Use in All-Polymeric FET's"
Submitted to:	Texas Advanced Research Program
Years:	2008-2010
Amount:	$ 150,000

Title:	" Acquisition of Dynamic Secondary Ion (DSIMS) Mass Spectrometers for Characterization of New Materials"
PI:	Guido Verbeck, Co-PI: Oliver Chyan, Rick Reidy, Thomas Scharf, Brain Gorman
Submitted to:	NSF-08-503 Major Research Instrumentation
Years:	2008-2009
Amount:	$1,332,320

Title:	" Interfacial Study of Cu Bimetallic Corrosion and Inhibition in Solution Environments containing Purine and its Derivatives "
Submitted to:	ATMI Inc.
Years:	2009-2012
Amount:	$ 240,000

Title:	" Novel Micropattern Corrosion Screening Technology for Microelectronics and MEMS Applications"
Submitted to:	Norman Hackerman Advanced Research Program (NHARP)
Years:	2009-2011
Amount:	$ 150,000

Title:	" Study of Copper Bimetallic Corrosion Mechanism in Polyphenols Solution "
Submitted to:	The Robert A. Welch Foundation
Years:	2010-2012
Amount:	$ 100,000

Title:	" Investigation of ULK ILD and its Film Stacks under RIE and Post RIE Conditions using Multiple Internal Reflection Infrared Spectroscopy"
Co-PI:	Guido Verbeck
Submitted to :	Semiconductor Research Corporation
Years:	2011- 2014
Amount:	$ 483,000

Title:	"Characterization of Patterned ULK Wafers Using Multiple Internal Reflection Infrared Spectroscopy"
Submitted to:	Applied Materials
Years:	2011-2012
Amount:	$ 15,000

Title:	"Characterization of Plasma-Etch-Polymers Using MIR-IR Spectroscopy"
Submitted to:	Intel
Years:	2012-2015
Amount:	$ 450,000

Title:	"Characterization of MICROPOSIT Remover Using Multiple Internal

	Reflection Infrared Spectroscopy"
Submitted to:	L3 Communication
Years:	2012-2013
Amount:	$ 10,818
Title:	" Characterization of Plasma-Etch-Polymers Using MIR-IR Spectroscopy"
Submitted to:	Semiconductor Research Corporation
Years:	2012- 2015
Amount:	$ 300,000
Title:	" MIR-IR Characterization of Plasma Induced ULK Damages
Submitted to:	TEL Inc.
Years:	2013- 2015
Amount:	$ 300,000
Title:	" In Situ Nanophase Impregnation of Natural Cellulosic Fibers for Functional Materials"
Submitted to:	NSF Scalable Nanomanufacturing (SNM) program (UNT Internal Submission)
CO-PI with:	**Sheldon Q. Shi; Nandika D'Souza; Zhenhai Xia; Brian Ayre**
Years:	2013- 2017
Amount:	$ 1, 500,000
Title:	" REU Site: Undergraduate Research Opportunities at the Interface of Computational and Experimental Chemistry at the University of North Texas "
Submitted to:	NSF, as a senior investigator with eight other UNT Chemistry colleagues
Years:	2014- 2016
Amount:	$ 243,742
Title:	" In Situ Nanophase Impregnation of Natural Cellulosic Fibers for Functional Materials"
Submitted to:	NIST Advanced Manufacturing Technology Consortia (AMTech) Program
CO-PI with:	**Sheldon Q. Shi**
Years:	2014- 2016
Amount:	$ 414,069
Title:	"Characterization of a-Silicon Thin Film Using Multiple Internal Reflection Infrared Spectroscopy"
Submitted to:	L3 Communication
Years:	2014-2015
Amount:	$ 50,000
Title:	"Doping and bandgap engineering on scalable two-dimensional MoS2"
Submitted to:	NSF, EPM

Participation: as Co-PI, Wonbong Choi, Principal Investigator
Years: 2015- 2018
Amount: $ 448,679