

CURRICULUM VITAE

SRINI RAGHAVAN, PhD

Professor of Materials Science and Engineering
Professor of Chemical and Environmental Engineering
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EDUCATION

1976	PhD	Materials Science and Mineral Engineering University of California, Berkeley
1973	MS	Materials Science and Mineral Engineering University of California, Berkeley
1971	BE	Metallurgy Indian Institute of Science, Bangalore
1968	BSc	Chemistry University of Madras

MAJOR FIELDS

Wet Processing in Semiconductor Manufacturing Including CMP
Corrosion and Electrochemistry
Surface and Colloidal Phenomena
Supercapacitors

EMPLOYMENT

Jan 2006-Aug 2007	Principal Scientist, Advanced Module Technical Development Intel Corporation, Santa Clara, CA (leave of absence from University of Arizona)
1988-Present	Professor, Materials Science and Engineering University of Arizona, Tucson
2006- Present	Professor, Chemical and Environmental Engineering University of Arizona, Tucson
2015-	Professor, Pharmacy Practice and Science University of Arizona, Tucson
1994-1996	Associate Department Head, Materials Science and Engineering University of Arizona, Tucson

1983-1988 Associate Professor, Materials Science and Engineering
University of Arizona, Tucson

1978-1983 Assistant Professor, Metallurgical Engineering
University of Arizona, Tucson

1976-1978 Lecturer, Materials Science and Mineral Engineering
University of California, Berkeley

OTHER WORK EXPERIENCE

6/15 -8/15 Visiting Faculty
R & D Fab of Micron Technology, Boise, ID
(Wet Processing Issues in DRAM and NAND Technologies)

8/03-12/03 Sabbatical Leave
Biomedical Engineering Department, Arizona Health Sciences Center
(Surface Coatings for Improving Micro Array Technology)

8/96-5/97 Sabbatical Leave
Sandia National Laboratories, Albuquerque, NM
(Anti-stiction Coatings for MEMS, Back End-of-Line Cleaning)

5/93-8/93 Summer Faculty Fellow
SEMATECH, Austin, TX
(Semiconductor Processing, Post-CMP Cleaning)

1/87-8/87 Sabbatical Leave
IBM (Tucson)
(Particulate Magnetic Recording Media)

7/85-8/85 Manufacturing Technical Rotator
Hughes Aircraft Co., Tucson, AZ
(Electroless Metal Plating and Anodizing)

6/83-7/83 Research Associate
SOHIO Research and Development, Cleveland, OH
(Particulate Processing)

CURRENT TEACHING ACTIVITIES

MSE 503: Applied Surface Chemistry
MSE/CHEE 435/535: Corrosion and Degradation of Materials
MSE/ECE 446/546: Semiconductor Processing
MSE 447L/547L: Semiconductor Processing Laboratory
MSE 502: Research Proposal Preparation

Short Courses Offered to Industries

Fundamentals of Chemical Mechanical Planarization
Advanced Wet Etching and Cleaning for Integrated Circuit Manufacturing
Science of Semiconductor Processing (CSP 201)-Intel College of Engineering

RECENT RESEARCH CONTRACTS

1. *Measurement of Reaction Products and Waste Treatment for Aqueous Etching of In-Bearing III-Vs*
Semiconductor Research Corporation (SRC) : January 2015 – December 2017
(A. Muscat, S. Raghavan and T. Corley)
2. *Electrochemical Probing of Causes for Variation in Life Time of Iridium Oxide –Tantalum Oxide Coated Anodes in Freeport-McMoran Electrowinning Baths*
Freeport-McMoran: May 1, 2015 to April 30, 2016
3. *ESH-Friendly Cleaning and Rinsing of Multi-Material Surfaces and Structures*
Semiconductor Research Corporation (SRC) : January 2012 – December 2014
(F. Shadman and S. Raghavan)
4. *Detection of radical and reactive species formed in wafer cleaning solutions irradiated with megasonic waves*
Semiconductor Research Corporation : July 2012 to June 2014
5. *Graphene Mediated Self-Assembled Fullerene Nanotubes based Ultracapacitors*
University of Arizona Renewable Energy Network, October 2013 –June 2014
(K. Muralidharan, T. Zega and S. Raghavan)
6. *Role of Ionic Contaminants in Packaging Reliability*
Intel (Chandler), July 2013 to July 2014

Recently Completed Projects

1. *Defect Reduction in Megasonic Cleaning, through In-Situ Characterization of Cavitation Processes using a Novel Electrochemistry based Device with Improved Time and Space Resolution*
National Science Foundation (NSF)
2. *Metallic Thin Films with Tunable Permittivity*
Canon

HONORS AND AWARDS

2015 Visiting Faculty, Micron Technology, Boise, ID
2012- 2014 Chevron Chair Professor, Indian Institute of Technology – Madras (3 year appointment)

2014- Honorary Professor, Hebei University of Technology, Tianjin, China
2015- Visiting Professor, International College of Semiconductor Technology,
National Chiao Tung University, Taiwan

CONSULTING EXPERIENCE

2013- present Member, Technical advisory Board, ProSys Inc., Campbell, Calif : *Megasonic Cleaning*

2012- 2013 ASM, Phoenix, AZ : *Wet Processing*

2012- 2013 Intel Corporation, New Mexico : *Wet Processing*

2011- 2013 Eastman Chemicals, Tennessee : *Electronic Chemicals*

2010 Tempronics, Tucson, AZ : *Thermoelectric Materials*

2007-2010 Howrey Law Firm, Chicago: *Expert Witness in a CMP Patent Litigation*

2008-2010 Sematech, Austin and Albany : *Surface Preparation*

2008-2009 Alta Devices, Santa Clara, CA : *Wet Processing in Solar Devices*

1999-2008 Member, Technical Advisory Board, *FSI International*, Chaska, MN (Surface Conditioning)

2003-2004 Perkins-Coie Law Firm, Portland: *Expert Witness in a Plating-Related Patent Litigation*

2001-2009 Air Products and Chemicals, Allentown, PA : *Surfactants, Specialty Chemicals*

1999-2010 Instructor, PTI Seminars, St. Louis, MO :
Fundamentals of CMP: One Day Short Course
Advanced Wet Etching and Cleaning: One Day Short Course

PROFESSIONAL SOCIETY MEMBERSHIPS

Member, Electrochemical Society
Member, National Association of Corrosion Engineers
Member, Materials Research Society

THESIS, DISSERTATIONS SUPERVISED TO-DATE

MS	37
PhD	37

PUBLICATIONS IN THE LAST FOUR YEARS

- R. Govindarajan, M. Keswani, S. Raghavan, and A. Sonogyi, Effect of Pretreatment of High Dose Implanted Resists by Activated Hydrogen Peroxide Chemical Systems for their Effective Removal by Conventional Sulfuric-Peroxide Mixtures, *IEEE Transactions on Semiconductor Manufacturing*, 25, 3, pp. 523-530 (2012).
- D. Thanu, S. Raghavan, and M. Keswani, Effect of Water Addition to Choline Chloride-Urea Deep Eutectic Solvent (DES) on the Removal of Post Etch Residues Formed on Copper, *IEEE Transactions on Semiconductor Manufacturing*, 25, 3, pp. 516-522 (2012).
- D. Zamani, M. Keswani, O. Mahdavi, J. Yan, S. Raghavan, and F. Shadman, Dynamics of Interactions between HF and Hafnium Oxide during Surface Preparation of High-K Dielectrics, *IEEE Transactions on Semiconductor Manufacturing*, 25, 3, pp. 511-515 (2012).
- S. Kumari, M. Keswani, S. K. Singh, M. Beck, E. Leibscher, P. Deymier, and S. Raghavan, Control of Sonoluminescence in Carbon Dioxide Containing DI Water at Near Neutral pH Conditions, *Solid State Phenomena*, 187, pp 177-180 (2012).
- V. Pandit, M. Keswani, S. Siddiqui and S. Raghavan, Comparison of Gold Particle Removal from Fused Silica and Thermal Oxide Surfaces in Dilute Ammonium Hydroxide Solutions, *Solid State Phenomena*, 187, pp 159-162 (2012).
- J. Taubert, M. Keswani and S. Raghavan, Post-etch residue Removal Using Choline Chloride–Malonic Acid Deep Eutectic Solvent (DES), *Microelectronic Engineering*, 102, pp 81-86 (2013).
- S. Siddiqui, M. Keswani, B. Brooks, A. Fuerst and S. Raghavan, A study of Hydrogen Peroxide Decomposition in Ammonia-Peroxide Mixtures (APM), *Microelectronic Engineering*, 102, pp 68-73 (2013).
- M. Keswani, S. Raghavan, and P. Deymier, Characterization of Transient Cavitation in Gas Sparged Solutions Exposed to Megasonic Field Using Cyclic Voltammetry, *Microelectronic Engineering*, 102, pp 91–97 (2013).
- M. Keswani, S. Raghavan and P. Deymier, Effect of Non-ionic Surfactants on Transient Cavitation in a Megasonic Field, *Ultrasonics Sonochemistry*, 20, pp 603–609 (2013).
- Z. Han, M. Keswani, and S. Raghavan, Megasonic Cleaning of Blanket and Patterned Samples in Carbonated Ammonia Solutions for Enhanced Particle Removal and Reduced Feature Damage, *IEEE Transactions of Semiconductor Manufacturing*, 26, 3, pp. 400-405 (2013).
- M. Keswani, S. Raghavan, and P. Deymier, A Novel Way of Detecting Transient Cavitation near a Solid Surface During Megasonic Cleaning using Electrochemical Impedance Spectroscopy, *Microelectronic Engineering*, 108, pp. 11-15 (2013).

- Z. Han, M. Keswani, E. Liebscher, M. Beck and S. Raghavan, Analysis of Sonoluminescence Signal from Megasonic Irradiated Gas-Containing Aqueous Solutions Using Replaceable Single-band Filters, *ECS Journal of Solid State Science and Technology*, 3 (1) N3101-N3105 (2014).
- M. Keswani, S. Raghavan, R. Govindarajan and I. Brown, Measurement of Hydroxyl Radicals in Wafer Cleaning Solutions Irradiated with Megasonic Waves, *Microelectronic Engineering*, 118, pp. 61–65 (2014).
- R. Balachandran, P. Deymier, S. Raghavan and M. Keswani, A Sono-electrochemical Technique for Enhanced Particle Removal from Tantalum Surfaces, *ECS Solid State Letters*, 3 (5), pp 49-52 (2014).
- R. Govindarajan, M. Keswani and S. Raghavan, Galvanic Corrosion Characteristics of Polysilicon – Tantalum Nitride Couple Immersed in Dilute HF Solutions, *Materials Science in Semiconductor Processing*, 27, pp 390-396 (2014).
- M. Keswani, S. Raghavan and P. Deymier, Electrochemical Investigations of Stable Cavitation from Bubbles Generated During Reduction of Water, *Ultrasonics Sonochemistry*, 21, 5, pp. 1893-1899 (2014).
- R. Balachandran, M. Zhao, B. Dong, I. Brown, S. Raghavan and M. Keswani, Role of Ammonia and Carbonates in Scavenging Hydroxyl Radicals Generated during Megasonic Irradiation of Wafer Cleaning Solutions, *Microelectronic Engineering*, 130, 25, pp.82-86 (2014)
- T. Gnanaprakasa, D. Sridhar, W. Beck, K. Runge, B. G. Potter, T. J. Zega, P. A. Deymier, S. Raghavan and K. Muralidharan, Graphene Mediated Self-Assembly of Fullerene Nanorods, *Chem. Commun.*, 51, pp. 1858-1861 (2015).
- T. Gnanaprakasa, Y. Gu, S. Eddy, Z. Han, W. Beck, K. Muralidharan and S. Raghavan, The Role of Copper Pretreatment on the Morphology of Graphene Grown by Chemical Vapor Deposition, *Microelectronic Engineering*, 131, pp. 1-7 (2015).
- D. Sridhar, K. Balakrishnan, T. Gnanaprakasa, S. Raghavan and K. Muralidharan, Self-assembled Fullerene Additives for Boosting the Capacity of Activated Carbon Electrodes in Supercapacitors, *RSC Adv.*, 5, 63834-63838 (2015).