



NASA GRANTS - NAG3-2750 & NAG3-2930

IMPACT

(Publications, Invention Disclosures, Graduate Students)



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Report prepared by Canan Balaban, Manager, NASA Hydrogen Research Program, Department of Mechanical and Aerospace Engineering.

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Executive Summary

The University of Florida has developed a very strong hydrogen-technology base with four consecutive NASA grants totaling \$10M funding during the period of March 2002 and ending March 2008. The grant was managed by NASA Glenn Research center.

The NASA Hydrogen Research program at UF covered hydrogen technologies related to fuel cells, hydrogen production processes, cryogenic transport and storage, distributed sensors and laser instrumentation for hydrogen leak detection, and outreach. The fuel cell research was added during the last two grant periods. The fuel cell research included cross-cutting technologies for proton exchange membranes (PEM) and solid oxide fuel cells (SOFC).

Dr. Tim Anderson, Associate Dean of Research, was the Primary Investigator (PI) for the grant. The management structure of the program included 3 faculty coordinators and a program manager, as summarized in the program web site:

<http://www.mae.ufl.edu/NasaHydrogenResearch/index.php?src=Faculty&IDS=88|89|85>.

The research thrust areas and the faculty coordinators for the 4th grant were:

- Hydrogen Production, Storage, and Transport, Dr. Jim Klausner, Mechanical and Aerospace Engineering
- Sensors for Hydrogen Leak Detection, Dr. Jenshan Lin, Electrical and Computer Engineering
- Fuel Cells, Dr. Mark Orazem, Chemical Engineering

There were 40 task PI's, 4 post-docs, 99 graduate, and 12 undergraduate students under the grant. Some of the task PI's had more than one task. To date, researchers involved in this program have filed 6 patents/invention disclosures in all hydrogen technology areas and published more than 300 technical publications and made over 200 presentations acknowledging NASA support. The task PI's have submitted proposals totaling more than \$70M to external funding agencies. The total new funding received to date is \$9.98M.

The outreach activities included the development of a web site and a graduate course in hydrogen technology, as illustrated at the following web site:

(<http://www.mae.ufl.edu/NasaHydrogenResearch/index.php?src=h2webcourse>). In addition, two graduate students participated in summer internship at Glenn Research Center and one student at Kennedy Space Center.

The \$10M NASA hydrogen grant became an accelerator to establish an energy institute at UF. The Florida Institute for Sustainable Energy (FISE) became official on January 22, 2007 (<http://www.energy.ufl.edu/>). Dr. Eric Wachsman, FISE Director and also one of the Task PI's, received a \$4.5M Florida Center of Excellence award and established the Energy Technology Incubator for FISE to facilitate the commercialization of energy technologies.

Finally, it is noted that the State of Florida just announced the establishment of the Florida Energy Systems Consortium by statute. Funding in the amount of \$50M was provided by the State and included many of the participants in the NASA program.

The impact of the NASA grant is measured by:

- Number of Students
- Number of Publications
- Number of Invention Disclosures and Patent Applications
- Number of Collaborations
- Funding Received by Leveraging NASA Grant
- Dollar Amount of the Proposals Written

The list of students, publications, invention disclosures, patent application and collaborations are given in the report for each faculty member. The summary of this information is given in the table below:

The Impact of all 4 NASA Grants

Attributes	#
Number of Post Docs	4
Number of PhD Students	61
Number of MS Students	39
Number of Undergraduate Students	11
Number of High School Students	1
Number of Students Graduated	108
Students Interns Sent to GRC/KSC	3
Number of Publications (Journals/Books)	180
Number of Conference Papers	164
Number of Presentations	193
Number of Invited Presentations/Papers	29
Number of Invention Disclosures	3
Number of Patent Applications	3
Number of Collaborations (Outside of UF)	15
Funding Received by Leveraging NASA Grant	\$9.98M
Dollar Amount of the Proposals Submitted	>\$70M

Faculty Bio and Accomplishments



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NASA Funding

FY04 Grant

Task Title

Lithium Borohydride for Hydrogen Propellant Storage

Students

1. Anne Charneau, PhD – Graduation Date: 8/06
2. Michael Liesenfelt, Undergraduate – Graduation Date: 5/06



Dr. Jacob N. Chung, Mechanical & Aerospace Engineering
Andrew H. Hines, Jr. / Progress Energy Professor

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NASA Funding

FY02, FY03, FY04, FY05 grants

Task Titles

- *Zero Boil-Off (ZBO) Pressure Control*
- *Thermal-Fluid Transport Issues for High Power Density and Gravity Independent Aviation and Space Applications of PEM Fuel Cells*
- *Two Phase Flow Characteristics and Boiling Heat Transfer Rates During Cryogenic Chilldown and Transport in Reduced Gravity*

Students

Task: Zero Boil-Off (ZBO) Pressure Control

1. C. Carvalho, MS – Graduation Date: 5/04
2. Tailian Chen, Post Doctoral Fellow

Task: Two Phase Flow Characteristics and Boiling Heat Transfer Rates During Cryogenic Chilldown and Transport in Reduced Gravity

1. E. Uzgoren, PhD – Graduation Date: 5/06
2. K. Yuan, PhD – Graduation Date: 8/06, currently employed by Doty Scientific Inc. in South Carolina

Task: Thermal-Fluid Transport Issues for High Power Density and Gravity Independent Aviation and Space Applications of PEM Fuel Cells

1. Yan Ji, PhD – Graduation Date: 5/07
2. Yun Whan Na, PhD – Graduation Date: 5/07

Collaborations

InnovaTek Incorporated, Richland WA

Funding Received by Leveraging NASA Grant

\$200K, Office of Naval Research STTR Project entitled Dodecane Reforming for SOFCs, Phase II, August 2006 - March 2008, Funding through InnovaTek Inc. Richland, WA.

Publications

Task: Zero Boil-Off (ZBO) Pressure Control

1. Xiaoqin Yang and J. N. Chung, "Size Effects on Miniature Stirling Cycle Cryocoolers" *Cryogenics Journal*, Vol. 45, pp. 537-545, 2005
2. Chung, J.N., Shyy, W., Yuan, K., Chen, T. and Carvalho, C., "Microgravity Cryogenic Boiling Heat Transfer with Applications to ZBO and Pipe Chillover," *Advances in Cryogenics*, Vol. 49A, pp. 1179-1186, 2004.

Task: Cryogenic Two-Phase Flow & Heat Transfer in Reduced Gravity

Journal Publications

1. Kun Yuan, Yan, Ji, J. N. Chung and Wei Shyy, "Cryogenic Boiling and Two-Phase Flow During Pipe Chillover in Earth and Reduced Gravity", *J. Low Temperature Physics*, Vol. 150, pp. 101-122, (2008).
2. Yan Ji, Kun Yuan, J. N. Chung, "Numerical Modeling of Cryogenic Quenching Process in Terrestrial Gravity and microgravity", In revision for publication, *International Journal of Heat and Fluid Flow*, (2008).
3. Kun Yuan, Yan Ji and J. N. Chung, "Cryogenic Chillover Process under Low Flow Rates", *Int. J. Heat and Mass Transfer*, Vol. 50, pp. 4011-4022, (2007).
4. Chung, J.N., Shyy, W., Yuan, K., Chen, T. and Carvalho, C., "Microgravity Cryogenic Boiling Heat Transfer with Applications to ZBO and Pipe Chillover," *Advances in Cryogenics*, Vol. 49A, pp. 1179-1186, 2004.

Conference Papers

1. Kun Yuan, J. N. Chung, Yan Ji, Cryogenic Two-Phase Flow and Heat Transfer under Terrestrial and MicroGravity, ASME Int. Mech. Eng. Congress (IMECE) paper 82613, pp. 1-8, Orlando, Nov. 2005.
2. J. N. Chung, "Cryogenic Two-Phase Flow and Heat Transfer during Pipe Chillover" AIAA Paper 2004-2175, an Invited key-note paper at the 37th AIAA Thermophysics Conference, 12 pages, Portland, OR, June 28 - July 1, 2004.
3. Uzgoren, E., Shyy, W. and Garbey, M., "Parallelized Domain Decomposition Techniques for Multiphase Flows," *Proceedings of 2004 ASME Heat Transfer/Fluids Engineering Summer Conference*, July 11-15, Charlotte, North Carolina, HT-FED2004-56079

Invited Presentations

1. Chung, J.N., "Cryogenic Two-Phase Flow and Boiling Heat Transfer in ZBO System and during Pipe Chillover," *Invited Paper, 37th AIAA Thermophysics Conference* in Portland, OR, June 28 - July 1, 2004.



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NASA Funding

FY02, FY04, and FY05 grants

Task Title

Development of Nanocrystalline Complex Metal Hydrides for Hydrogen Storage

Students

1. Sankara Tatiparti, PhD – Graduation Date: 05/08

Funding Received by Leveraging NASA Grant

NSF funding of \$300K for three years in 2006: Nanocrystalline Al-Mg Alloys for hydrogen storage-
DMR 0605406.



**Dr. Z. Hugh Fan, Mechanical & Aerospace Engineering,
Biomedical Engineering**

Associate Professor

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NASA Funding

FY03, FY04, and FY05 grants

Task Title

Detecting Hydrogen by Enzyme-Catalyzed Electrochemistry

Students

1. Carl K. Fredrickson, MS – Graduation Date: 3/06; Employed by Spirit AeroSystems, Inc.
2. Brent Lutz, MS – Graduation Date: 4/06; Employed by Synkera Technologies Inc.
3. Jackie Viren, MS – Expected Graduation Date: 12/08
4. Zheng Xia, PhD – Expected Graduation Date: 12/08
5. Fernando Tavares, undergraduate student – Graduation Date: 12/04, now in the graduate school of University of Michigan
6. R. Ferguson, undergraduate student – Graduation Date: 5/05; Employed by Progress Energy Inc.
7. Corey Walker, undergraduate student – Graduation Date: 5/07, now in the graduate school of University of California at Irvine
8. Zachery Foster, high school student – Graduation Date: 5/07, now enrolled in UF

Collaborations

1. We collaborated with Dr. Friedrich at the Humboldt University in Berlin, Germany, who provided hydrogenase for the work. We have one co-authored publication.
2. We collaborated with Dr. Cattafesta at the University of Florida. We have one co-authored publication.

Funding Received by Leveraging NASA Grant

One related proposal was funded (\$70K) by National Science Foundation (NSF) with proposal No. CHE-0515711. It is entitled “Fluidic Sensors: Integrating Microfluidics with Biological Assays”, covering 8/15/2005-8/14/2006. The proposal was focusing on the enzyme stability.

Patents

One provisional patent application entitled “Hydrogen Sensor Using Enzyme-Catalyzed Reaction” was filed on March 16, 2005 with application No. 60/662,504. A follow-up international PCT was filed on March 16, 2006, with application No. PCT/US2006/009495.

Publications

Journal Publications

1. C. Walker, Z. Xia, Z. Foster, B. J. Lutz, and Z. H. Fan, "Investigation of Airbrushing for Fabricating Microelectrodes in Microfluidic Devices," *Electroanalysis*, in press (DOI: 10.1002/elan.200704118), 2008.
2. Z. Xia, L. Cattafesta, and Z. H. Fan, "Deconvolution Microscopy for Flow Visualization in Microchannels," *Analytical Chemistry*, vol. 79, pp. 2576-2582, 2007.
3. C. K. Fredrickson, Z. Xia, C. Das, R. Ferguson, F. T. Tavares, and Z. H. Fan, "Effects of Fabrication Process Parameters on the Properties of Cyclic Olefin Copolymer Microfluidic Devices," *Journal of Microelectromechanical Systems*, vol. 15, pp. 1060-1068, 2006.
4. Champak Das, Zheng Xia, Alexander Stoyanov, Z. Hugh Fan, "A Laser-Induced Fluorescence Imaging System for Isoelectric Focusing," *Instrume. Sci. Technol.*, 33, 2005.
5. B. J. Lutz, Z. H. Fan, T. Burgdorf, and B. Friedrich, "Hydrogen sensing by enzyme-catalyzed electrochemical detection," *Anal Chem*, vol. 77, pp. 4969-75, 2005.
6. A. V. Stoyanov, C. Das, C. K. Fredrickson, Z. H. Fan, "Conductivity Properties of Carrier Ampholyte pH Gradients in Isoelectric Focusing," *Electrophoresis*, 26, 2005, 473-479.
7. C. K. Fredrickson, Z. H. Fan, "Macro-to-Micro Interfaces for Microfluidic Devices", *Lab on a chip*, 4, 2004, 526-533.

Presentations

1. "Fluid mixing in channels with microridges", 2007 ASME International Mechanical Engineering Congress and Exposition, Seattle, WA, November 11-15, 2007.
2. "Incorporation of Screen Printed Microelectrodes on a Microfluidic Device", Undergraduate Research Symposium, Gainesville, FL, February 17, 2007.
3. "Biology-Inspired Analysis Systems for Sensing Space-Related Species", The 57th Pittsburgh Conference, Orlando, FL, March 12 - 17, 2006.
4. "A Miniaturized Protein Expression Array for Detecting Toxins in Space Missions", Habitation 2006, Orlando, Florida, February 5-8, 2006.



Dr. Yogi Goswami, Mechanical and Aerospace Engineering

Dr. Yogi Goswami

John and Naida Ramil Professor, and Director, Clean Energy Research Center, College of Engineering, University of South Florida, Tampa.

[Dr. Goswami was the PI for the 1st UF NASA Grant in 2002. At that time he was the Research Foundation Professor of the Dept. of Mechanical and Aerospace Engineering, College of Engineering, University of Florida, Gainesville.]

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<http://www.mae.ufl.edu/facultylist/ShowData.php?ID=19>

NASA Funding

FY02 grant

Task Title

1. Systems Study – Hydrogen Production
2. Indirect Solar Hydrogen Production

Students

1. Nitin Goel, Ph.D.; H₂ thermodynamic cycle – Graduation Date June 2005
2. Allyson Haskell, M.S.; H₂ education modules – Graduation Date December 2003
3. Man Su Lee, Ph.D.; H₂ production – Graduation Date August 2008
4. Madhukar Mahishi, Ph.D.; H₂ production and biomass – Graduation Date: December 2006
5. Christopher Martin, Ph.D.; H₂ thermodynamic cycle – Graduation Date: December 2004
6. Gunnar Tamm, Ph.D.; H₂ thermodynamic cycle – Graduation Date: December 2003
7. Bronislava Veltcheva, M.S.; H₂ education modules – Graduation Date: May 2004
8. Sanjay Vijayarajhavan, Ph.D.; H₂ thermodynamic cycle – Graduation Date: May 2004
9. Amit Vohra, Ph.D.; H₂ production facility – Graduation Date May 2006

Publications

Books

1. C.L. Martin and D.Y. Goswami, Solar Energy Pocket Reference, by James + James/Earthscan, London, UK (for the International Solar Energy Society), August 2005.
2. Goswami, D.Y., Vijayaraghavan, S., Campbell-Howe, B., Editors, Proceedings of the 2005 ISES Solar World Congress, Orlando, FL, August 2005.

Book Chapter

1. Goel, N., Mirabal, S.T., Ingley, H.A., and 3. Goswami, D.Y., 2003. "Hydrogen Production." In: Böer, K.W., and Goswami, D.Y. (Eds.), Advances in Solar Energy, vol. 15, ASES, pp. 405-458.

2. Vijayaraghavan, S., Goswami, D.Y., 2004. "Solar Thermal Energy, Industrial Heat Applications." In: Cleveland, C.J., (Ed.), Encyclopedia of Energy, vol. 5, Elsevier, Inc., pp. 661-667.

Journal Publications

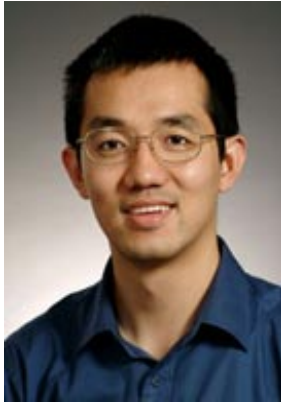
1. Goel, N., and Goswami, D.Y., 2007, "Experimental verification of a new heat and mass transfer enhancement concept in a microchannel falling film absorber" ASME Journal of Heat Transfer, vol. 129, pp. 154-161.
2. Goel, N., and Goswami, D. Y., 2005, "A Compact Falling Absorber," ASME Journal of Heat Transfer, vol. 127, no. 9, pp. 957-965.
3. Goel, N., and Goswami, D. Y., 2005, "Analysis of a Counter-Current Vapor Flow Absorber," International Journal of Heat and Mass Transfer, Vol. 48, No. 7, pp. 1283-1292.
4. Goswami, D.Y., Vijayaraghavan, S., Lu, S., and Tamm, G., 2004, "New and Emerging Developments in Solar Energy," Solar Energy Journal, vol. 76:1-3, pp. 33-43.
5. Mahishi, M.R., Sadrameli, M.S., Vijayaraghavan, S., and Goswami, D.Y., 2008, "A Novel Approach to Enhance the Hydrogen Yield of Biomass Gasification using CO₂ Sorbent," Journal of Engineering for Gas Turbines and Power (ASME), Jan. vol. 130, pp. 011501-8.
6. Mahishi, M.R., Sadrameli, S.M., Vijayaraghavan, S., Goswami, D.Y. (2008) "A novel approach to enhance the hydrogen yield of biomass gasification using CO₂ sorbent", ASME Journal of Engineering for Gas Turbines and Power, Vol. 130, January (011501-1).
7. Mahishi, M.R., Goswami, D.Y. 2007, "An experimental study of hydrogen production by gasification of biomass in the presence of a CO₂ sorbent", International Journal of Hydrogen Energy, 32: 2803-2808.
8. Mahishi, M.R., and Goswami, D.Y., 2007, Thermodynamic optimization of biomass gasifier for hydrogen production," International Journal of Hydrogen Energy, vol. 32, pp. 3931-3840.
9. Mahishi, M.R., Sadrameli, M.S., Vijayaraghavan, S., Goswami, D.Y., 2005, "Hydrogen Production from Ethanol: A Thermodynamic Analysis of a Novel Sorbent Enhanced Gasification Process. American Society of Mechanical Engineers, Advanced Energy Systems (publication) "AES" vol. 45, pp 455-463.
10. Martin, C., and Goswami, D.Y. 2006, "Effectiveness of Cooling Production with a Combined Power and Cooling Thermodynamic Cycle," Journal of Applied Thermal Engineering, Vol. 26, 5-6, 576-582.
11. Mirabel, S.T., Goel, N., and Ingley, H.A., Goswami, D.Y., 2004, "Utilization of Domestic Fuels for Hydrogen Production" International Journal of Power and Energy Systems, Vol. 24, No. 3, pp. 239-245.
12. Tamm, G., Goswami, D.Y., Lu, S., and Hasan, A.A., 2004, "Theoretical and Experimental Investigation of an Ammonia-Water Power and Refrigeration Thermodynamic Cycle," 2004, Solar Energy Journal, vol. 76:1-3, pp. 217-228.
13. Tamm, G., Goswami, D.Y., Lu, S., and Hasan, A., 2003, "A Novel Combined Power and Cooling Thermodynamic Cycle for Low Temperature Heat Sources – Part I: Theoretical Investigation," ASME Journal of Solar Energy Engineering, Vol. 125, No. 2, pp. 218-222.
14. Tamm, G., and Goswami, D.Y., 2003, "A Novel Combined Power and Cooling Thermodynamic Cycle for Low Temperature Heat Sources – Part II: Experimental Investigation," ASME Journal of Solar Energy Engineering, Vol. 125, No. 2, pp. 223-229.
15. Vijayaraghavan, S., and Goswami, D. Y., 2006, "A Combined Power and Cooling Cycle Modified to Improve Resource Utilization Efficiency Using a Distillation Stage." Energy: The International Journal, Volume 31, Issues 8-9, Pages 1177-1196.
16. Vijayaraghavan, S., and Goswami, D.Y., 2005, "Organic Working Fluids for a Combined Power and Cooling Cycle," ASME Journal of Energy Resources Technology, 127(2), pp. 125-130.

17. Vijayaraghavan, S., and Goswami, D.Y., 2003, "Organic Working Fluids for a Combined Power and Cooling Cycle," ASME Advanced Energy Systems Division Publication "AES" v. 43, pp. 77-85.
18. Vijayaraghavan, S., and Goswami, D. Y., 2003, "On Evaluating Efficiency of a Combined Power and Cooling Cycle," ASME Journal of Energy Resources Technology, Vol. 125, No.3, pp. 221-227.
19. Vijayaraghavan, S., and Goswami, D.Y., 2003, "Efficiency Definitions for a Combined Power and Cooling Cycle." ASME Journal of Energy Resources Technologies, Vol. 125, No. 3, pp. 221-227.

Conference Papers

1. Goel, N., and Goswami, D. Y., 2004, "A compact falling film absorber," Proceedings of IMEC 2004, ASME International Mechanical Engineering Congress and R&D Expo, Anaheim, CA, November 13-19, AES, pp. 309-320..
2. Goswami, D.Y., Mirabal, S.T., Goel, N., and Ingley, H.A., 2003, "A Review of Hydrogen Production Technologies," Proceedings of the First International Conference on Fuel Cell Science, Engineering and Technology, Rochester, NY, April 21-23, pp. 61-74.
3. Goswami, D.Y., Tamm, G., S. Lu, and Hasan, A.A., 2002, "A Novel Combined Power and Cooling Thermodynamic Cycle for Low Temperature Heat Sources, Part I: Theoretical Investigation." Solar Engineering 2002, Proceedings of the ASME International Solar Engineering Conference, pp. 31-38.
4. Goswami, D.Y., Tamm, G., S. Lu, and Hasan, A.A., 2002, "A Novel Combined Power and Cooling Thermodynamic Cycle for Low Temperature Heat Sources - Part II: Experimental Investigation." Solar Engineering 2002, Proceedings of the ASME International Solar Engineering Conference, pp. 39-46.
5. Goswami, D.Y., Vijayaraghavan, S., Lu, S., and Tamm, G., 2001, "New and Emerging Developments in Solar Energy," Proceedings of the World Solar Forum, International Solar Energy Society (ISES), Adelaide Australia, November.
6. Lee, Man Su, Goswami, D. Y., Kothurkar, N., and Stefanakos, E. K., "Fabrication of porous calcium oxide film for UT-3 thermochemical hydrogen production cycle," ASME Energy Sustainability 2007, June 27-30, Long Beach, California, 2007.
7. Lee, Man Su, Goswami, D.Y., Hettlinger, B. and Vijayaraghavan, S., 2006, "Preparation and Characteristics of Calcium Oxide Pellets for UT-3 Thermochemical Cycle," Proceedings of 2006 ASME International Mechanical Engineering Congress and Exposition, November 4-11, Chicago, Illinois.
8. Mahishi, M.R., Vijayaraghavan, S., Deshpande, D., Goswami, D.Y., 2005, "A Thermodynamic Analysis of Hydrogen Production by Gasification of Biomass", Proceedings of the ISES Solar World Congress, August 6-12, Orlando, FL.
9. Martin, C., Sadrameli, S.M., and Goswami, D.Y., 2005, "Comparison of Optimum Operating conditions for a Combined Power and Cooling Thermodynamic Cycle," Proceedings of the ISES Solar World Congress, August, Orlando, FL.
10. Martin, C.L., Goswami, D.Y., 2004. Experimental Verification of a Combined Power and Cooling Thermodynamic Cycle. In: Bingham, C., Agami Reddy, T. (Eds.), Proceedings of American Solar Energy Society's SOLAR 2004, "A Solar Harvest: Growing Opportunities," Portland, OR.
11. Martin, C.L., Goswami, D.Y., 2004. Analysis of Experimental Power and Cooling Production in a Combined Power and Cooling Cycle. In: Rivero, R., Monroy, L., Pulido, R., Tsatsaronis, G. (Eds.), Proceedings of ECOS 2004 conference: "Energy-Efficient, Cost-Effective and Environmentally-Sustainable Systems and Processes," Guanajuata, Mexico, vol. 3, pp. 1235-1244 (ISBN 968-489-027-3).

12. Mirabal, S. T., Ingley, H. A., Goel, N., and Goswami, D.Y., 2004, "Utilization of domestic fuels for hydrogen production," International conference on Co-Utilization of Domestic Fuels, Gainesville, FL, February 5 - 6.
13. Mirabal, S.T. and Goswami, D.Y., Goel, N., and Ingley, H.A., 2003, "Hydrogen Production," Proceedings of the ASES Solar 2003 Conference, Austin, TX, June 21-23.
14. Tamm, G.O., Goswami, D.Y., 2003. Experimental Investigation of an Improved Power and Cooling Thermodynamic Cycle for Low Temperature Heat Sources. In: Proceedings of the ISES 2003 Solar World Congress, Goteborg, Sweden.
15. Tamm, G., Vijayaraghavan, S., and Goswami, D.Y., 2003. "An Ammonia-Based Combined Power and Cooling Cycle for Low Temperature Heat Sources," International Joint Power Generation Conference, Atlanta, June, pp. 979-985.
16. Tamm, G., Goswami, D.Y., Lu, S., and Hasan, A.A., 2001, "Theoretical and Experimental Investigation of an Ammonia-Water Power and Refrigeration Thermodynamic Cycle," Proceedings of the ISES Solar World Congress, Adelaide, Australia, November.
17. Vijayaraghavan, S., and Goswami, D. Y., 2003, "Improved Configuration of a Novel Thermodynamic Power and Cooling Cycle," Proceedings of the ASES Solar 2003 Conference, June 21-26, Austin, TX.
18. Vijayaraghavan, S. and Goswami, D.Y., 2003, "Thermodynamic Studies on Alternate Binary Working Fluid Combinations for a Combined Power and Cooling Cycle," Proceedings of the 2003 (ISEC) International Solar Energy Conference, Hawaii Island, Hawaii, March 15-18.
19. Vijayaraghavan, S., and Goswami, D.Y., 2002, "Efficiency Definitions for a Combined Power and Cooling Cycle," Proceedings of the ASME Symposium on Thermodynamics and Design, Analysis and Improvement of Energy Systems, ASME International Mechanical Engineering Congress and Exposition, AES Vol. 42, November, New Orleans, LA.



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NASA Funding

FY05 grant

Task Title

Modeling of ZnO Nanorod Hydrogen Gas Sensors

Students

Youngki Yoon, Ph. D. candidate, degree expected, Dec. 2008.

James Fodor, M.S., May 2007.

Publications

1. Y. Yoon, J. Lin, S. Pearton, and J. Guo, "Role of Grain Boundaries in ZnO Nanowire Transistors," *Journal of Applied Physics*, Vol. 101, 024301, 2007.
2. S. Pearton, D. Norton, and J. Guo, "ZnO Nanowire Field-Effect Transistors," *IEEE Trans. on Electron Devices*, invited, under review, 2008.



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NASA Funding

FY02, FY03, FY04, and FY05 grants

Task Titles

Remote Sensing for Hydrogen Leak Detection

Raman and Rayleigh Scattering for Hydrogen Leak Detection

In Situ Investigation of Major and Minor Species to Support Detailed Model Development of Catalytic Chemistry in a Reformation Reactor

Students

1. Allen Ball, MS, – Graduation Date: 05/05
2. Vince Hohreiter, PhD, – Graduation Date: 12/05
3. Ben Dixon, BS, – Graduation Date: 05/05
4. Amy Twining, MS, – Graduation Date: 12/05

Publications

1. A. J. Ball, V. Hohreiter, D. W. Hahn. Hydrogen Leak Detection Using Laser-Induced Breakdown Spectroscopy, *Applied Spectroscopy*, 59:348-353 (2005). Note: This paper was featured on the cover of *Applied Spectroscopy*
2. D. W. Hahn, "Laser-induced breakdown spectroscopy for hydrogen leak detection," *International Congress on Applications of Lasers and Electro-Optics (ICALEO)*, Oct. 13-16, 2003, Jacksonville, FL. Conference presentation and paper.

Collaborations

Modest collaboration with Ocean Optics, Inc.



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NASA Funding

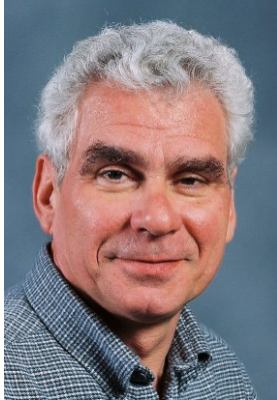
FY02, FY03, FY04, and FY05 grants

Students

1. Donald Myers, MS, Method for Measurement of residual Stress and Coefficient of Thermal Expansion of Laminated Composites – Graduation Date: 12/03
2. William Schulz, MS, Determination of residual stress and Thermal Behavior for Composite Laminates – Graduation Date: 4/05.
3. Lucian Speriatu, PhD, Experimental Characterization of mechanical Properties in Extreme Environments. Received 3rd Place in the Society for Experimental Mechanics National Student Paper Competition – Graduation Date: 07/05
4. Thomas Singer, MS, Received the AIAA, Abe Zarem Award for best Masters Student Paper – Graduation Date: 06/05

Publications

1. W. A. Schulz, L. Speriatu, B. P. Smarslok, P. G. Ifju, and R. T. Haftka, "Residual Stress Determination Using Temperature Dependent Material Properties," Society for Experimental Mechanics Annual Conference, paper #236, Seattle, June 2005.
2. L. Chen, B. V. Sankar and P. G. Ifju, "Application of Moire Interferometry for Mode II testing of stitched composites", *Journal of Composites, Technology and Research*, Vol. 1, Issue 3, March 2004.
3. W. A. Schulz, D. G. Myers, T. N. Singer, P. G. Ifju, and R. T. Haftka, "Determination of Residual stress and Thermal History of IM7/977-2 Composite Laminates," *Journal of Composites and Science Technology*, Sept. 2004.
4. P. G. Ifju, R. Haftka, D. Myers, W. Schulz and T. Singer, "Statistics Properties and Reliability Based Optimization of Laminates for Cryogenic Environments," AIAA-2003-1935, SDM Annual Conference, Norfolk VA, 10 pages, 7-9 April 2003.
5. P. G. Ifju., D. Myers, W. Schulz, "Residual Stress and Thermal Expansion of Graphite Epoxy Laminates Subjected to Cryogenic Temperatures," *American Society for Composites Annual Technical Meeting*, Gainesville, FL, Oct 20 – 22, 2003.
6. L. Chen, B. V. Sankar, P. G. Ifju, "Analysis of Mode I and Mode II tests for composites with translaminar reinforcements", *Journal of Composite Materials*.



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NASA Funding

FY02, and FY03 grants

Task Title

High Energy Densified Materials

Students

1. Andrew Browne, MS – Supported by Dept. Phys., – Graduation Date: 05/04
2. Kevin Larson, Undergraduate – Graduation Date: 05/04

Publications

Refereed Journal Publications

1. G. G. Ihas and J. Graham, "Infrared Spectra of Solid Hydrogen Isolated Carbon and Boron", Journ. Low Temp. Phys. **138**, no. 3/4. Note: This is the January 2005 issue, which is late in printing because of a change in ownership of the press.
2. G. G. Ihas, V. F. Mitin, and N. S. Sullivan, "Cryogenic Mass Gauging in a Free-falling Storage Tank", Journ. Low Temp. Phys. **134**, 437.
3. M. Matusiak, J. A. Hamida, G. G. Ihas and N. S. Sullivan, "Measurements of the nuclear spin relaxation times for small grains of solid hydrogen suspended in liquid helium, Journ. Low Temp. Phys. **134**, 775.
4. D. Zhou, G. G. Ihas and N. S. Sullivan, "Determination of the Ortho-Para Ratio in Gaseous Hydrogen Mixtures", Journ. Low Temp. Phys. **134**, 401.

Conference Papers

1. G. G. Ihas and J. Graham, "Rotating Stage Cryostat for Infrared Measurements", Quantum Fluids and Solids 2004, Trento, Italy, July, 2004.
2. "Design of "Zero Magneto-resistance" Ge Thin Film Thermometers", Gary Ihas, Chris McKenney, Vadim Mitin, and Vitali Dugaev, Bull. Am. Phys. Soc. **48**, 1277 (2003).
3. "Determination of the Ratio of Ortho Hydrogen and Para Hydrogen", D. Zhou, G.G. Ihas, N.S. Sullivan, Bull. Am. Phys. Soc. **48**, 1277 (2003).
4. "NMR measurements in a hydrogen/helium slush at 4.2 K", Marcin Matusiak, J. Hamida, G. G. Ihas, N. Sullivan, Bull. Am. Phys. Soc. **48**, 928 (2003).
5. "Giant Magnetic Field Effect on Germanium Film Electrical Conductance and its use for Low Magnetic Field Detection at Ultra-Low Temperatures", V.F. Mitin, V.K. Dugaev, G.G. Ihas, and C. McKenney, European MRS-2003.

6. "Characterization and Modeling of Ge Film Thermometers", for Low Temperature Measurements", G.G. Ihas, V.K. Dugaev, C. McKenney, V.V. Kholevchuk, V.F. Mitin, I.Yu. Nemish, E.A. Soloviev, M. Vieira, IEEE Sensors 2002, June 11-15 2002.
7. "Design of "Zero Magneto-resistance" Ge Thin Film Thermometers", Gary Ihas, Chris McKenney, Vadim Mitin, and Vitali Dugaev, Bull. Am. Phys. Soc. **48**, 1277 (2003).
8. "Determination of the Ratio of Ortho Hydrogen and Para Hydrogen", D. Zhou, G.G. Ihas, N.S. Sullivan, Bull. Am. Phys. Soc. **48**, 1277 (2003).
9. "NMR measurements in a hydrogen/helium slush at 4.2 K", Marcin Matusiak, J. Hamida, G. G. Ihas, N. Sullivan, Bull. Am. Phys. Soc. **48**, 928 (2003).
10. "Giant Magnetic Field Effect on Germanium Film Electrical Conductance and its use for Low Magnetic Field Detection at Ultra-Low Temperatures", V.F. Mitin, V.K. Dugaev, G.G. Ihas, and C. McKenney, European MRS-2003.
11. G. G. Ihas, V. F. Mitin, and N. S. Sullivan, "Cryogenic Mass Gauging in a Free-falling Storage Tank", QFS-2003, Albuquerque, June 2003.
12. M. Matusiak, J. A. Hamida, G. G. Ihas and N. S. Sullivan, "Measurements of the nuclear spin relaxation times for small grains of solid hydrogen suspended in liquid helium, QFS-2003, Albuquerque, June 2003.
13. D. Zhou, G. G. Ihas and N. S. Sullivan, "Determination of the Ortho-Para Ratio in Gaseous Hydrogen Mixtures", QFS-2003, Albuquerque, June 2003.
14. "Characterization of Ge Thin Film Thermometers" G.G. Ihas, C.M. McKenney, V.F. Mitin, V.K. Dugaev, M. Vieira, Bull. Am. Phys. Soc. **47**, Oct. 2002.

Invention Disclosures

Mass Gauging of Cryogenic Fluids in Tanks Experiencing Arbitrary Gravity or Acceleration

Collaboration

MicroSensor Research and Production Company, <http://www.microsensor.com.ua>



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NASA Funding

FY02 and FY03 grants

Task Title

The Ammonia -Water Combined Power and Refrigeration Cycle

Students

1. Neha Goswami, Undergraduate; Developed the hydrogen website/graphics for the mobile demonstration unit and hydrogen education modules – Graduation Date: 12/04
2. Samantha Mirabal, MS; Hydrogen production; co-authored book chapter and & several papers/presented at conferences – Graduation Date: 05/04
3. Paul Sathonpattanakij, PhD; Hydrogen production facility – Expected Graduation Date: 12/06
4. Karen Supan, PhD; Hydrogen education modules – Expected Graduation Date: 12/05

Publications

Book Chapter

1. Goswami, D.Y., Ingley, H.S., Goel, N., Mirabal, S.T., “Hydrogen Production,” Chapter 11, *Advances in Solar Energy*, Vol. 15, Goswami, Editor-in-Chief, pp. 405-458, April 2003.

Journal Publications

1. Mirabal, S.T., Goel, N., and Ingley, H.A., Goswami, D.Y., “Utilization of Domestic Fuels for Hydrogen Production” *International Journal of Power and Energy Systems*, Vol. 24, No. 3, pp. 239-245, 2004.

Conference Papers

1. Mirabal, S.T., Goel, N., and Ingley, H.A., Goswami, D.Y., “Utilization of Domestic Fuels for Hydrogen Production,” Presented at the International Conference on Co-utilization of Domestic Fuels, February 5, 2003.
2. Mirabal, S.T. and Goswami, D.Y., Goel, N., and Ingley, H.A. “Hydrogen Production,” Proceedings of the ASES Solar 2003 Conference, Austin, Texas, June 2003
3. Goswami, D.Y., Mirabal, S.T., Goel, N., and Ingley, H.A., “A Review of Hydrogen Production Technologies,” Proceedings of the ASME First International Conference on Fuel Cell Science, Engineering and Technology, Rochester, New York, April 21-23, 2003.



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NASA Funding

FY02, FY03, FY04, and FY05 grants

Task Titles

High Power Density Thermal Management of Proton Exchange Membrane Fuel Cells
Terrestrial Cryogenic Two-Phase Flow and Heat Transfer Nucleate Flow Boiling Heat Transfer
During Cryogenic Chilldown
Cryogenic Transport & Storage (CST)
In-Space Cryogenic Fluid Management Technology Elements

Students

1. Pat Garrity, PhD student. Expected Graduation Date: 07/08
2. Christopher Velat, MS – Graduation Date: 8/04
3. Yusen Qi, PhD – Graduation Date: 1/05
4. Jelliffe Jackson, PhD – Graduation Date: 5/06
5. Patrick Garrity, PhD – Graduation Date: 5/07

Publications

Journal Publications

1. Garrity, P., Klausner, J., Mei, R., A Flow Boiling Microchannel Evaporator Plate for Fuel Cell Thermal Management, *Heat Transfer Engineering*, 28(10):1–8, 2007.
2. Qi, Y., and Klausner, J.F., “Comparison of Gas Nucleation and Pool Boiling Site Densities,” *J. Heat Transfer*, in press, 2005.
3. Qi, Y. and Klausner, J.F., “Heterogeneous Nucleation with Artificial Cavities,” *J. Heat Transfer*, in press 2005.
4. Liao, J., Mei, R., and Klausner, J.F., “The Influence of the Bulk Liquid Thermal Boundary Layer on Saturated Nucleate Boiling,” *Int. J. Heat and Fluid Flow*, Vol. 25, pp. 196-208, 2004.
5. Qi, Y., Klausner, J.F., and Mei, R., “Role of Surface Structure in Heterogeneous Nucleation,” *Int. J. Heat Mass Transfer*, Vol. 47, pp. 3097-3107, 2004.

Conference Papers

1. Garrity, P., Klausner, J., Mei, R., Performance of Aluminum and Carbon Foams for Heat Transfer Augmentation, Proceedings of 2007 ASME-JSME Thermal Engineering Summer Heat Transfer Conference July 8-12, 2007, Vancouver, British Columbia, CANADA.

2. Garrity, P., Klausner, J.F., and Mei, R., "A Flow Boiling Microchannel Evaporator Plate for Fuel Cell Thermal Management," Proceedings of the Sixth International Conference on Boiling Heat Transfer," 2006.
3. Jackson, J., Liao, J., Klausner, J.F., Mei, R., "Transient Heat Transfer During Cryogenic Chillover," to appear in *Proceedings of the ASME HT2005 Conference*, HT2005-72145, 2005.
4. Liao, J., Mei, R., Klausner, J.F., "A Study on Numerical Instability of Inviscid Two-Fluid Model Near Ill-Posedness," to appear in *Proceedings of the ASME HT2005 Conference*, HT2005-72652, 2005.
5. Velat, C, Jackson, J., Klausner, J.F., and Mei, R., "Cryogenic Two-Phase Flow During Chillover," *Proceedings of the ASME HT-FED Conference*, HT-FED2004-56555 Charlotte, NC, 2004.
6. Liao, J., Mei, R., and Klausner, J.F., 2003, "The Influence of the Bulk Liquid Thermal Boundary Layer on Saturated Nucleate Boiling," *Proceedings of the 5th International Conference on Boiling Heat Transfer*, Montego Bay, May 4-8.



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NASA Funding

FY03 grant

Task Title

Modeling of a Hydrogen Gas Sensor

Students

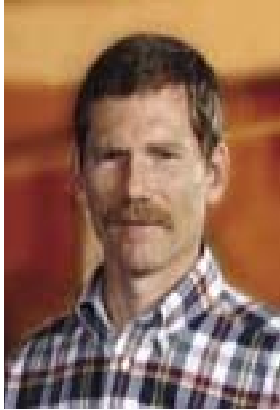
1. Scott Oetke, MS – Graduation Date: 05/04
2. Nicole Staszkiwicz, MS – Graduation Date: 05/06

Publications

1. El Kouche, J. Lin, M.E. Law, S. Kim, B.S. Kim, F. Ren, and S. Pearton, "Remote Sensing System for Hydrogen using GaN Schottky Diodes," *Sensors and Actuators B*, **105**(2), 2005, p. 329-333.

Conference Papers

1. "GaN-Based and ZnO Nanorod Sensors for Wireless Hydrogen Leak Detection", J. Lin, M. Law, F. Ren, S. Pearton, D. Norton, 207th meeting of ECS, Quebec City, Canada, May 2005.



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NASA Funding

FY02, and FY03 grants

Task Title

Fluid Distribution for In-Space Cryogenic Propulsion

Students

1. Sherif Kandil, PhD – Graduation Date: 12/05
2. Joseph Bray, MS – Graduation Date: 05/03
3. Brandon Osufsen, MS – left prior to graduation

Funding Received by Leveraging NASA Grant

Received a \$2.5M award from the FL State Grant Program to develop “Renewable Energy Fuels in a Micro-Grid Power Module”. The grant will be used to construct a small-scale demonstration plant using the University’s patented PoWER technology, including operation on a variety of liquid and gaseous biofuels. The system allows ultra-clean, efficient operation on a wide variety of biomass fuels, hydrogen or conventional fuels, and this project will be installed at the University of Florida Energy Research Park, connected to the grid by Progress Energy, to determine its performance using biofuels.

Invention Disclosures

Fluid Distribution for In-Space Cryogenic Propulsion

Publications

Journal Publications

1. Kandil, S.M., Lear, W.E., and Sherif, S.A., “Performance of a Jet-Pumped Cryogenic Refrigeration System.” *AIAA Journal of Propulsion and Power*, accepted for publication.
2. Kandil, S.M., Lear, W.E., and Sherif, S.A., “Mass Advantages in a Jet-Pumped Active Thermal Management System.” *SAE Transactions-Journal of Aerospace*, Vol. 111, No. 1, 2002, ISBN 0-7680-1285-6, pp. 765-773.
3. Freudenberg, K., Lear, W.E., Sherif, S.A., and Gollhofer, E.L., “Mass-Based Optimization of a Combined Thermal Management and Power Systems for Space Applications.” *AIAA Journal of Propulsion and Power*, Vol. 18, No. 6, November-December 2002, pp. 1161-1169.

Conference Papers

1. Bray, J.A., Lear, W.E., and Sherif, S.A., "Experimental Study of a Constant-Area Ejector with Two-Phase Fluids." *Proceedings of the Fourth ASME/JSME Joint Fluids Engineering Conference*, Vol. 1, Part B, Honolulu, Hawaii, July 6-11, 2003, ASME Paper No. FEDSM2003-45703, ASME, New York, Book No. I0666B, ISBN 0-7918-3696-7, pp. 773-779.
2. Kandil, S.M., Lear, W.E., and Sherif, S.A., "Regenerative Jet-Pumped Thermal Management Systems for Spacecraft Mass Reduction." *41st AIAA Aerospace Sciences Meeting and Exhibit*, Reno, Nevada, January 6-9, 2003, AIAA Paper 2003-0501.
3. Kandil, S.M., Lear, W.E., and Sherif, S.A., "Mass Advantages in a Jet-Pumped Active Thermal Management System." *Proceedings of the 2002 SAE Power Systems Conference*, Coral Springs, Florida, October 29-31, 2002, SAE Paper No. 2002-01-3200.
4. Kandil, S., Lear, W.E., and Sherif, S.A., "Performance of Jet-Pumped Cryogenic Refrigeration System." *40th AIAA Aerospace Sciences Meeting and Exhibit*, Reno, Nevada, January 14-17, 2002, AIAA Paper 2002-1031.



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NASA Funding

FY04, and FY05 grants

Task Title

Integration and Testing of Low Power Wireless Hydrogen Sensor Modules

Students

1. Changzhi Li, PhD – Expected Graduation Date: 08/09
2. Zhen Ning Low, PhD – Expected Graduation Date: 05/10
3. Xiaogang Yu, PhD – Expected Graduation Date: 05/11
4. Jerry Jun, MS – Graduation Date: 05/06
5. Bruce Chou, MS – Graduation Date: 05/06
6. Ahmad El. Kouche, BS – Graduation Date: 05/05

Collaborations

1. Dr. T. Nishida, Dr. K. Ngo (now with Virginia Tech), Dr. J. Guo – Department of Electrical and Computer Engineering
2. Dr. F. Ren – Department of Chemical Engineering
3. Dr. S. Pearton, Dr. D. Norton – Department of Material Science and Engineering
4. Mr. J. Painter – Ford Greenway in Orlando
5. University of Hawaii, Prof. Olga Boric-Lubecke and Prof. Victor Lubecke.

Funding Received by Leveraging NASA Grant

1. Hydrogen Sensing System, \$14,000, Florida Department of Environmental Protection, 8/15/2006-3/31/2007
2. Hydrogen Sensor System Prototype for Ford Motor Company, \$25,000 University of Florida Office of Technology Licensing, 8/15/2006-3/31/2007

Patents

1. USPTO Patent Cooperation Treaty Application: System for Hydrogen Sensing, UF Invention Disclosure #12267 (Aug. 3, 2006), filed on Oct. 5, 2006.

Publications

Journal Publications

1. T. Anderson, H.T. Wang, C. Li, Z. N. Low, B. S. Kang, J. Lin, S. J. Pearton, A. Osinsky, Amir Dabiran, P. Chow, J. Painter, F. Ren, "A New Advance in Hydrogen Sensors," (Invited) *Hydrogen and Fuel Cell Safety*, July 2007.
2. J. Jun, B. Chou, J. Lin, A. Phipps, S. Xu, K. Ngo, D. Johnson, A. Kasyap, T. Nishida, H. T. Wang, B. S. Kang, T. Anderson, F. Ren, L. C. Tien, P. W. Sadik, D. P. Norton, L. F. Voss, and S. J. Pearton, "A Hydrogen Leakage Detection System Using Self-Powered Wireless Hydrogen Sensor Nodes," *Solid State Electronics*, Vol. 51, Issue 7, pp. 1018-1022, July 2007.
3. H. T. Wang, T. J. Anderson, B. S. Kang, F. Ren, C. Li, Z. N. Low, J. Lin, B. P. Gila, S. J. Pearton, A. Osinsky, A. Dabiran, "Stable hydrogen sensors from AlGaIn/GaN heterostructure diodes with TiB₂-based Ohmic contacts," *Applied Physics Letters*, 90, 252109, June 2007.
4. Y. Yoon, J. Lin, S. J. Pearton, J. Guo, "Role of Grain Boundaries in ZnO Nanowire Field-Effect Transistors," *Journal of Applied Physics*, Vol. 101, Issue 2, 024301 (5 pages), January 15, 2007.
5. H. T. Wang, T. J. Anderson, F. Ren, C. Li, Z. N. Low, J. Lin, B. P. Gila, S. J. Pearton, A. Osinsky, A. Dabiran, "Robust Detection of Hydrogen Using Differential AlGaIn/GaN High Electron Mobility Transistor Sensing Diodes," *Applied Physics Letters*, 89, 242111, December 2006.
6. B. S. Kang, H. T. Wang, L.C. Tien, F. Ren, B. P. Gila, D. P. Norton, C. R. Abernathy, J. Lin, and S. J. Pearton, "Wide Bandgap Semiconductor Nanorod and Thin Film Gas Sensors," *Sensors*, Vol. 6, No. 6, pp. 643-666, June 2006.
7. L. C. Tien, P. W. Sadik, D. P. Norton, L. F. Voss, S. J. Pearton, H. T. Wang, B. S. Kang, F. Ren, J. Jun, and J. Lin, "Hydrogen sensing at room temperature with Pt-coated ZnO thin films and nanorods," *Applied Physics Letters*, 87, 222106, November 2005.
8. S.N.G. Chu, F. Ren, S.J. Pearton, B.S. Kang, S. Kim, B.P. Gila, C.R. Abernathy, J.-I. Chyi, W.J. Johnson and J. Lin, "Piezoelectric polarization-induced two dimensional electron gases in AlGaIn/GaN heteroepitaxial structures: Application for micro-pressure sensors," *Materials Science and Engineering: A*, Vol. 409/1-2, pp. 340-347, November 2005.
9. H. T. Wang, B. S. Kang, F. Ren, L. C. Tien, P. W. Sadik, D. P. Norton, S. J. Pearton, and J. Lin, "Detection of hydrogen at room temperature with catalyst-coated multiple ZnO nanorods," *Applied Physics A*, Vol. 81, No. 6, pp. 1117-1119, November 2005.
10. L. C. Tien, H. T. Wang, B. S. Kang, F. Ren, P. W. Sadik, D. P. Norton, S. J. Pearton, and J. Lin, "Room-Temperature Hydrogen-Selective Sensing Using Single Pt-Coated ZnO Nanowires at Microwatt Power Levels," *Electrochemical and Solid-State Letters*, 8 (9), G230-G232, July 2005.
11. H. T. Wang, B. S. Kang, F. Ren, L. C. Tien, P. W. Sadik, D. P. Norton, S. J. Pearton, and J. Lin, "Hydrogen-selective sensing at room temperature with ZnO nanorods," *Applied Physics Letters*, 86, 243503, June 2005.
12. A. EL Kouche, J. Lin, M. E. Law, S. Kim, B. S. Kim, F. Ren, S. J. Pearton, "Remote Sensing System for Hydrogen Using GaN Schottky Diodes," *Journal of Sensors and Actuators B: Chemical*, Vol. 105/2, pp. 329-333, 2005.
13. S. J. Pearton, B. S. Kang, Suku Kim, F. Ren, B. P. Gila, C. R. Abernathy, J. Lin, and S. N. G. Chu, "GaN-based diodes and transistors for chemical, gas, biological and pressure sensing," *J. Phys.: Condensed Matter*, vol. 16, issue 29, pp. R961-R994, July 2004.

Conference Papers

1. S. Pearton, F. Ren, B. Kang, H. Wang, B. Gila, D. Norton, L. Tien, T. Chancellor, T. Lele, Y. Tseng, J. Lin, "GaN and ZnO-Based Sensors for Gas, Nuclear Materials and Chemical Detection," accepted, *Proceedings of the E10 Symposium "Wide-Bandgap Semiconductor*

Materials & Devices 8," of the 212th Meeting of the Electrochemical Society, Washington, D.C., October 7-12, 2007.

2. L. Tien, D. Norton, B. Kang, H. Wang, F. Ren, J. Lin, S. Pearton, "ZnO Nanowires for Sensing and Device Applications," accepted, *Proceedings of the E6 Symposium "Nanoscale One-Dimensional Electronic and Photonic Devices," of the 212th Meeting of the Electrochemical Society, Washington, D.C., October 7-12, 2007.*
3. H. Wang, T. Anderson, F. Ren, C. Li, Z. Low, J. Lin, B. Gila, S. Pearton, A. Dabiran and A. Osinsky, "Robust Detection of Hydrogen Using Differential AlGaIn/GaN High Electron Mobility Transistor Sensing Diodes," *Proceedings of the STATE-OF-THE-ART PROGRAMS ON COMPOUND SEMICONDUCTOR at the 211th Meeting of the Electrochemical Society, May 2007.*
4. S. J. Pearton, L. C. Tien, H. S. Kim, D. P. Norton, J. J. Chen, H. T. Wang, B. S. Kang, F. Ren, W. T. Lim, J. Wright, R. Khanna, L. F. Voss, L. Stafford, J. Jun, J. Lin, "Development of Thin Film and Nanorod ZnO-Based LEDs and Sensors," in *Materials Research Society Symposium Proceedings Vol. 957, K-01-05, 12 pages, December 2006.*
5. T. Nishida, J. Lin, K. Ngo, F. Ren, D. Norton, S. Pearton, L. Cattafesta, M. Sheplak, J. Jun, A. Kasyap, D. Johnson, and A. Phipps, "Wireless Hydrogen Sensor Self-powered Using Ambient Vibration and Light," *Proceedings of 2006 ASME International Mechanical Engineering Congress and Exposition (IMECE), 6 pages, November 2006.*
6. K. Ngo, T. Nishida, J. Lin, S. Xu, and A. Phipps, "Power Converters for Piezoelectric Energy Extraction," *Proceedings of 2006 ASME International Mechanical Engineering Congress and Exposition (IMECE), 7 pages, November 2006.*
7. J. Jun, J. Lin, S. Xu, A. Phipps, K. Ngo, D. Johnson, A. Kasyap, T. Nishida, H. T. Wang, B. S. Kang, F. Ren, L. C. Tien, P. W. Sadik, D. P. Norton, L. F. Voss and S. J. Pearton, "Low-Power Detection of Hydrogen Leakage Using a Self-Powered Wireless Hydrogen Sensor Node," *Proceedings of the AIChE 2006 Spring National Meeting, 10 pages, April 2006.*
8. H. T. Wang, B. S. Kang, F. Ren, J. Jun, J. Lin, L. C. Tien, P. W. Sadik, D. P. Norton, L. F. Voss, S. J. Pearton, "Highly sensitive hydrogen sensor using Pt nanoparticles coated ZnO single and multiple nanowires," *Proceedings of 208th Meeting of the Electrochemical Society, pp. 238-247, 2005.*
9. H. T. Wang, B. S. Kang, F. Ren, R. C. Fitch, J. K. Gillespie, N. Moser, G. Jessen, T. Jenkins, R. Dettmer, D. Via, A. Crespo, J. Lin, B. P. Gila, C. R. Abernathy, L. C. Tien, D. P. Norton, S. J. Pearton, "Hydrogen-induced reversible changes in drain current of Pt-gated AlGaIn/GaN HEMTs," *Proceedings of 208th Meeting of the Electrochemical Society, pp. 274-283, 2005.*
10. A. EL Kouche, J. Lin, M. E. Law, S. Kim, B. S. Kim, F. Ren, S. J. Pearton, "Remote Sensing System for Hydrogen Detection Using GaN Schottky Diodes," *Proceedings of the 6th IEEE Wireless and Microwave Technology Conference, Tampa FL., p. 76, 2004.*

Presentations

1. Y. Wang, W. Lim, L. Covert, T. Anderson, J. Lin, S. Pearton, D. Norton and F. Ren, "Room Temperature Deposited Enhancement Mode and Depletion Mode Indium Zinc Oxide Thin Film Transistors," *E7 Symposium "ZnO, InZnO, and InGaO Related Materials and Devices for Electronic and Photonic Applications," of the 213th Meeting of the Electrochemical Society, Phoenix, AZ, May 20, 2008. (Refereed conference abstract)*
2. Y. Wang, F. Ren, L. Covert, J. Lin, W. Lim, S. Pearton, "Frequency Response and Devices Performance of the Indium Zinc Oxide Thin Film Transistors," *E8 Symposium "State-of-the-Art Program on Compound Semiconductors (SOTAPOCS 47)," of the 212th Meeting of the Electrochemical Society, Washington, D.C., October 7-12, 2007. (Refereed conference abstract)*
3. T. Anderson, H. T. Wang, B. S. Kang, C. Li, Z. N. Low, J. Lin, S. J. Pearton, J. Painter, C. Balaban, A. Osinsky, A. Dabiran, P. Chow, and F. Ren, "Advances in Wireless Hydrogen

Sensor Networks," NHA Annual Hydrogen Conference 2008, March 31-April 4, 2008.
(Refereed conference abstract)

4. T. Anderson, H. T. Wang, B. S. Kang, F. Ren, C. Li, Z. N. Low, J. Lin, and S. J. Pearton, "Wireless Hydrogen Sensor Networks Using GaN-based Devices," NHA Annual Hydrogen Conference 2007, San Antonio, TX, March 19-22, 2007. (Refereed conference abstract)

Invited Presentations

1. J. Lin, "Self-Powered Wireless Nano-Sensor for Hydrogen Leak Detection and Wireless Power Transmission," Radio Science Symposium for A Sustainable Humanosphere, Kyoto, Japan, March 20-21, 2006. (Invited)
2. J. Lin, A. EL Kouche, M. E. Law, F. Ren, B. S. Kang, S. J. Pearton, D. P. Norton, and C. R. Abernathy, "GaN-Based and ZnO Nanorod Sensors for Wireless Hydrogen Leak Detection," *Proceedings of the STATE-OF-THE-ART PROGRAMS ON COMPOUND SEMICONDUCTOR at the 207th Meeting of the Electrochemical Society*, Quebec City, Canada, May 15-20, 2005. – *Invited*
3. J. Lin, A. EL Kouche, M. E. Law, F. Ren, B. S. Kang, S. J. Pearton, D. P. Norton, and C. R. Abernathy, "Challenges of Building a Wireless Hydrogen Sensor Network," Florida Chapter of the AVS Science and Technology Society Annual Joint Symposium, Orlando, Florida, March 13-17, 2005. - *Invited*
4. J. Lin, A. EL Kouche, M. E. Law, F. Ren, B. S. Kang, S. J. Pearton, D. P. Norton, and C. R. Abernathy, "Challenges of Building a Wireless Hydrogen Sensor Network," Florida Chapter of the AVS Science and Technology Society Annual Joint Symposium, Orlando, Florida, March 13-17, 2005. (Invited)
5. J. Lin, "Wireless Sensor System" in Energy Colloquium, University of Florida, November 1, 2004. (Invited)



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NASA Funding

FY03 and FY04 grants

Task Title

Hydrogen Leak Detection Sensors - Communications and Networking

Students

1. Yuan Guo, PhD – Expected Graduation Date: 05/06
2. Hetal Patel, PhD – Expected Graduation Date: 05/07

Funding Received by Leveraging NASA Grant

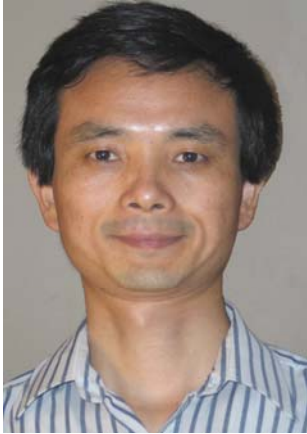
1. National Science Foundation, "Distributed Intersystem Authentication for Multi-Network Environments" (\$298K).
2. Motorola, "Rapid Authentication for Wireless Sensor Networks" (\$18K).
3. US Department of Defense "A Novel Approach to Wireless Network Management" (\$100K).
4. National Science Foundation, "I/UCRC (Industry/University Cooperative Research Center). The center is called: Advanced Space Technologies Research & Engineering Center (ASTREC), and it's objective is to transform the culture of the space industry from risk-averse to smartly risk-tolerant. By distributing risk across multiple satellites, ASTREC aims to retain multi-sensor functionality while ensuring that overall capability remains robust (Submitted in Spring 2008.)

Collaborations

- Motorola, Inc.

Publications

1. J. McNair and Y. Guo, "Adaptive Network Coordination for Wireless Sensor Environment Monitoring Applications," journal paper in preparation.
2. Y. Guo, M. Perkins, and J. McNair, "Reliability Enhancements for Environment Monitoring Using ZigBee Sensor Networks," submitted to IEEE Milcom Conference, April 2005.
3. Y. Guo and J. McNair, "An Adaptive Sleep Protocol for Environment Monitoring Using Wireless Sensor Networks," submitted to IEEE Globecom Conference, March 2005.
4. Y. Guo and J. McNair, "Cost-Efficient Cluster Formation for Wireless Sensor Networks," to appear in Proceedings of the International Conference on Cybernetics and Information Technologies, Systems and Applications (CITSA), Orlando, Florida, July 2004.



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NASA Funding

FY02, FY03, FY04, and FY05 grants

Task Titles

Simulation and Modeling for the Improvement on the Thermal Fluid Management of PEM Fuel Cell
Numerical Investigation of Cryogenic Fluid Transport in Pipelines During Chilldown Process
Chill Down Process of Hydrogen Transport Pipelines
In-Space Cryogenic Fluid Management Technology Elements

Students

1. Yanxia Zhao, PhD; Recived MS. Moved to Nevada. Switched major to statistics.
2. Jun Liao, Ph.D – Graduation Date: 06/06
3. Jianghui Chao: Received PhD. Post-doc at the University of Florida
4. Jun Liao: Recived PhD. Employed with Westinghouse Electric Company, Monroeville, PA.
5. Hieu H. Tran: Received MS.

Publications

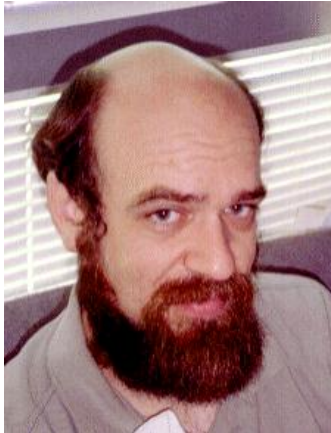
Journal Publications

1. Jianghui Chao, Renwei Mei, Rajkeshar Singh, Wei Shyy, 2007, "A Filter-Based, Mass-Conserving Lattice Boltzmann Method for Immiscible Multiphase Flows", International Journal of Numerical Method for Fluid Flow.
2. Liao, J., Yuan, K., Mei, R., Klausner, J.F., Chung, J., 2005, "Cryogenic Chill-Down Model Inside Transportation Pipelines," Proceedings of the ASME Summer Heat Transfer Conference, San Francisco, CA.
3. Liao, J., Mei, R., and Klausner, J.F., "The Influence of the Bulk Liquid Thermal Boundary Layer on Saturated Nucleate Boiling," Int. J. of Heat and Fluid Flow, vol. 25, pp. 196–208, 2004.
4. Qi, Y., Klausner, J.F., and Mei, R., "Role of Surface Structure in Heterogeneous Nucleation," Int. J. Heat Mass Transfer, vol. 47, pp. 3097-3107, 2004.

Conference Papers

1. Multi-Scale Computational Fluid Dynamics with Interfaces, Jianghui Chao, Renwei Mei, and Wei Shyy, 59TH ANNUAL MEETING OF THE DIVISION OF FLUID DYNAMICS, Marriott Tampa Waterside, November 19-21, 2006, Tampa, Florida
2. Yanxia Zhao, Renwei Mei, James F. Klausner, Effects of Geometrical Parameters on Improving the Transversal Mass Transport in PEM Fuel Cells, Proceedings of FEDSM2006, 2006 ASME Joint U.S. - European Fluids Engineering Summer Meeting, July 17-20, Miami, FL

3. Jun Liao, Kun Yuan, Renwei Mei, James F. Klausner, and Jacob Chung, 2005, "Cryogenic Chill-Down Model inside Transportation Pipeline" ASME Summer Heat Transfer Conference July 17-22, 2005, San Francisco, California, USA
4. Liao, J., Mei, R., Klausner, J.F. 2005, "A Study on Numerical Instability of Inviscid Two-Fluid Model Near Ill-Posedness Condition", Proceedings of the ASME Summer Heat Transfer Conference, San Francisco, CA.
5. Jun Liao, Renwei Mei, James F. Klausner, 2005, "A Study on Numerical Instability of Inviscid Two-Fluid Model near Ill-posedness Condition" ASME Summer Heat Transfer Conference July 17-22, 2005, San Francisco, California, USA
6. Velat, C., Jackson, J., Klausner, J.F., and Mei, R., 2004, "Cryogenic Two-Phase Flow during Chillover," in Proceedings of the ASME HT-FED Conference, Charlotte, NC.
7. Qi, Y., Klausner, J.F., and Mei, R., 2003, "Role of Surface Structure in Heterogeneous Nucleation," Proceedings of the 5th International Conference on Boiling Heat Transfer, Montego Bay, May 4-8.



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NASA Funding

FY04, and FY05 grants

Task Title

Detailed Modeling of Methanol and Ethanol Catalytic Reaction

Students

1. Patrick D. Griffin, MS, Graduation Date: 06/06
2. Weizhong Zhang, PhD – Have not received degree.
3. Hector Leiva – Have not received degree

Publications

1. "Two-Dimensional Modeling of a Chemically Reacting Boundary Layer Flow in a Catalytic Reformer", Patrick D. Griffin, Master of Science Thesis, Department of Mechanical and Aerospace Engineering, University of Florida, 2006
2. David Mikolaitis and Patrick Griffin, "Reacting Flow in the Entrance to a Channel with Surface and Gas-Phase Kinetics", 2006 58th Annual Meeting of the APS Division of Fluid Dynamics, November 19-21, 2006, Tampa Bay, Florida
3. "Gas Phase Ignition and Extinction of Syngas over a Hot Platinum Surface", (In preparation)



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NASA Funding

FY04 grant

Task Title

Power for Wireless Hydrogen Sensor Network—Energy Harvesters

Students

1. Shengwen Xu, PhD – Graduation Date: 4/07
2. Bharath Kannan, PhD – Graduation Date: 4/07



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NASA Funding

FY04, and FY05 grants

Task Title

Co-PI for: Rational Design of Higher Conductivity Solid Oxide Electrolytes

Students

1. Shobit Omar, PhD – Expected Graduation Date: 05/09

Publications

Journal Publications

1. "Development of Higher Ionic Conductivity Ceria Based Electrolyte," S. Omar, E. D. Wachsman, and J. C. Nino, *Solid State Ionic Devices IV, ECS Transactions*, E.D. Wachsman, F.H. Garzon, E. Traversa, R. Mukundan, and V. Birss, Ed., Vol.1 [7] pp. 73-82 (2004).
2. "A Co-Doping Approach towards Enhanced Ionic Conductivity in Fluorite-Based Electrolytes," S. Omar, E. D. Wachsman, and J. C. Nino, *Solid State Ionics*, 177 [35-36] pp. 3199-3202 (2006).

Conference Papers

1. "Microstructural Effects on the Grain Ionic Conductivity of $Gd_{0.10}Ce_{0.90}O_{2-x}$ ", S. Omar, H. El-Shall, E. D. Wachsman, and J. C. Nino, 31st International Conference & Exhibition on Advanced Ceramic & Composites, Daytona Beach, Florida, USA, January 21-26, 2007.
2. "Effect of Microstructure on the Grain Ionic Conductivity of Ceria based Electrolytes", S. Omar, H. El-Shall E. D. Wachsman, and J. C. Nino, 2006 MRS Fall Meeting, Boston, Massachusetts, USA, November 27-December 1, 2006.
3. "A Co-Doping Approach towards Enhanced Ionic Conductivity in Fluorite-Based Electrolytes", S. Omar, E. D. Wachsman, and J. C. Nino, European Materials Research Society Spring Meeting, Nice, FRANCE, June 1st , 2006.
4. "Effect of Co-Doping on the Electrical Properties of Ceria Electrolyte", S. Omar, E. D. Wachsman, and J. C. Nino, 30th International Conference & Exhibition on Advanced Ceramic & Composites, Cocoa Beach, Florida, USA, January 24, 2006.
5. "Development of Higher Ionic Conductivity Ceria Based Electrolyte," S. Omar, E. D. Wachsman, and J. C. Nino, 208th Electrochemical Society Meeting, Los Angeles, California, USA, October 19, 2005.



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NASA Funding

FY04, and FY05 grants

Task Title

Environmentally - Driven Power Source, Power for Wireless Hydrogen Sensor Network - Energy Harvesters

Students

1. Anurag Kasyap, PhD – Graduation Date: 05/07; PhD Mechanical and Aerospace Engineering, Employed at AdaptivEnergy.
2. Shengwen Xu, PhD, Employed at Intel
3. Alex Phipps, PhD student
4. David Johnson, MS – Graduation Date: 05/06

Collaborations

1. Dr. Rich Waters, Naval Warfare (SPAWAR) Systems Center, San Diego
2. Dr. Donald Blake, Air Vehicles Directorate, Aeronautical Sciences Division, Wright-Patterson AFB/AFRL

Patents

1. Nishida, T., Cattafesta, L., Sheplak, M., and Khai D.T. Ngo, “Resonant Energy MEMS Array Processor,” U.S. Patent No. 6,954,025, filed 5/13/03, issued October 11, 2005.

Publications

1. J. Jun, B. Chou, J. Lin, A. Phipps, X. Shengwen, K. Ngo, D. Johnson, A. Kasyap, T. Nishida, H.T. Wang, B.S. Kang, F. Ren, L.C. Tien, P.W. Sadik, D.P. Norton, L.F. Voss, and S.J. Pearton, “A Hydrogen Leakage Detection System Using Self-Powered Wireless Hydrogen Sensor Nodes,” *Solid-State Electron.* 51, pp. 1018-1022, July 2007.
2. Shengwen Xu, Khai D. T. Ngo, Toshikazu Nishida, Gyo-Bum Chung, and Attma Sharma, “Low Frequency Pulsed Resonant Converter for Energy Harvesting,” *IEEE Trans. Power Electronics*, Vol. 22, pp. 63 – 68, January 2007.
3. K. Ngo, A. Phipps, T. Nishida, J. Lin, S. Xu, “Power Converters for Piezoelectric Energy Extraction,” presented at ASME International Mechanical Engineering Congress and Exposition, Chicago, IL, November 5-10, 2006.
4. Kasyap, A. Phipps, M. Sheplak, K. Ngo, T. Nishida, L. Cattafesta, “Lumped Element Modeling of Piezoelectric Cantilever Beams for Vibrational Energy Reclamation,” presented at ASME International Mechanical Engineering Congress and Exposition, Chicago, IL, November 5-10, 2006.

5. T. Nishida, J. Lin, K. Ngo, F. Ren, D. Norton, S. Pearton, L. Cattafesta, M. Sheplak, J. Jun, A. Kasyap, D. Johnson, A Phipps, "Wireless Hydrogen Sensor Self-Powered Using Ambient Vibration and Light," presented at ASME International Mechanical Engineering Congress and Exposition, Chicago, IL, November 5-10, 2006.
6. J. Jun, B. Chou, J. Lin, A. Phipps, X. Shengwen, K. Ngo, D. Johnson, A. Kasyap, T. Nishida, H. T. Wang, B. S. Kang, F. Ren, L. C. Tien, P. W. Sadik, D. P. Norton, L. F. Voss, and S. J. Pearton, "Low-Power Detection of Hydrogen Leakage Using a Self-Powered Wireless Hydrogen Sensor Node," 2006 Spring Meeting of American Inst. Chem. Engineers, Orlando, FL, April 23-27, 2006.
7. Shengwen Xu, Khai D. T. Ngo, Toshikazu Nishida, Gyo-Bum Chung, and Attma Sharma, "Converter and Controller for Micro-Power Energy Harvesting," Proceedings of IEEE Applied Power Electronics Conference, 2005, pp. 226-230.



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NASA Funding

FY04, and FY05 grants

Task Title

Co-PI for: Novel ZnO Nanorod Hydrogen Gas Sensors

Co-PI for: Remote Power Transmission Using High Power GaN HEMTs and Diodes for Regenerative Fuel Cells

Students

1. Patrick Sadik – PhD – Graduation Date: 05/08
2. Li Chia Tien – PhD – Graduation Date: 05/07

Collaborations

1. SVT Associates, Eden Prairie, MN, contact Dr. Andrei Osinsky.

Publications

1. S. Pearton, D. Norton, and J. Guo, "ZnO Nanowire Field-Effect Transistors," *IEEE Trans. on Electron Devices*, invited, under review, 2008.
2. J. Jun, B. Chou, J. Lin, A. Phipps, S. Xu, K. Ngo, D. Johnson, A. Kasyap, T. Nishida, H. T. Wang, B. S. Kang, T. Anderson, F. Ren, L. C. Tien, P. W. Sadik, D. P. Norton, L. F. Voss, and S. J. Pearton, "A Hydrogen Leakage Detection System Using Self-Powered Wireless Hydrogen Sensor Nodes," *Solid State Electronics*, Vol. 51, Issue 7, pp. 1018-1022, July 2007.
3. L.C. Tien, D.P. Norton, B.P. Gila, S.J. Pearton, Hung-Ta Wang, B.S. Kang and F. Ren, "Detection of hydrogen with SnO₂-coated ZnO nanorods", *Appl. Surf. Sci.* 253, 4748 (2007).
4. L.C. Tien, D.P. Norton, S.J. Pearton, Hung-Ta Wang and F. Ren, "Nucleation control for ZnO nanorods grown by catalyst-driven molecular beam epitaxy", *Appl. Surf. Sci.* 253, 4620 (2007).
5. B. S. Kang, H. T. Wang, L.C. Tien, F. Ren, B. P. Gila, D. P. Norton, C. R. Abernathy, J. Lin, and S. J. Pearton, "Wide Bandgap Semiconductor Nanorod and Thin Film Gas Sensors," *Sensors*, Vol. 6, No. 6, pp. 643-666, June 2006.
6. L. Tien, P. Sadik, D.P. Norton, L. Voss, S.J. Pearton, H.T. Wang, B. S. Kang, F. Ren, J. Jun and J. Lin, "Hydrogen sensing at room temperature with Pt-coated ZnO thin films and nanorods", *Appl. Phys. Lett.* 87, 222106 (2005).
7. L. Tien, H.T. Wang, B.S. Kang, F. Ren, P.W. Sadik, D.P. Norton, S.J. Pearton and J. Lin, "Room temperature hydrogen selective sensing using single Pt-coated ZnO nanowires at microwatt power levels", *Electrochem. Solid-State Lett.* 8 G239 (2005).

8. H. T. Wang, B. S. Kang, F. Ren, L. C. Tien, P. W. Sadik, D. P. Norton, S. J. Pearton, and Jenshan Lin, "Hydrogen-selective sensing at room temperature with ZnO nanorods", *Appl. Phys. Lett.* **86**, 243503 (2005).
9. J.R. LaRoche, Y.W. Heo, B.S. Kang, L. Tien, Y. Kwon, D.P. Norton, B.P. Gila, F. Ren and S.J. Pearton, "Fabrication approaches to ZnO nanowire devices", *J. Electron. Mater.* **34** 404 (2005).
10. B.S. Kang, Y.W. Heo, L.C. Tien, D.P. Norton, F. Ren, B.P. Gila and S.J. Pearton, "Hydrogen and ozone gas sensing using multiple ZnO nanorods," *Appl. Phys.A* **80** 1029 (2005).
11. H. T. Wang, B. S. Kang, F. Ren, L. C. Tien, P. W. Sadik, D. P. Norton, S. J. Pearton, and J. Lin, "Detection of hydrogen at room temperature with catalyst-coated multiple ZnO nanorods," *Applied Physics A*, Vol. 81, No. 6, pp. 1117-1119, November 2005.
12. L. C. Tien, H. T. Wang, B. S. Kang, F. Ren, P. W. Sadik, D. P. Norton, S. J. Pearton, and J. Lin, "Room-Temperature Hydrogen-Selective Sensing Using Single Pt-Coated ZnO Nanowires at Microwatt Power Levels," *Electrochemical and Solid-State Letters*, **8** (9), G230-G232, July 2005.
13. H. T. Wang, B. S. Kang, F. Ren, L. C. Tien, P. W. Sadik, D. P. Norton, S. J. Pearton, and J. Lin, "Hydrogen-selective sensing at room temperature with ZnO nanorods," *Applied Physics Letters*, **86**, 243503, June 2005.

Conference Papers

1. Y. Wang, W. Lim, L. Covert, T. Anderson, J. Lin, S. Pearton, D. Norton and F. Ren, "Room Temperature Deposited Enhancement Mode and Depletion Mode Indium Zinc Oxide Thin Film Transistors," *E7 Symposium "ZnO, InZnO, and InGaO Related Materials and Devices for Electronic and Photonic Applications," of the 213th Meeting of the Electrochemical Society*, Phoenix, AZ, May 20, 2008. (Refereed conference abstract)
2. S. Pearton, F. Ren, B. Kang, H. Wang, B. Gila, D. Norton, L. Tien, T. Chancellor, T. Lele, Y. Tseng, J. Lin, "GaN and ZnO-Based Sensors for Gas, Nuclear Materials and Chemical Detection," accepted, *Proceedings of the E10 Symposium "Wide-Bandgap Semiconductor Materials & Devices 8," of the 212th Meeting of the Electrochemical Society*, Washington, D.C., October 7-12, 2007.
3. L. Tien, D. Norton, B. Kang, H. Wang, F. Ren, J. Lin, S. Pearton, "ZnO Nanowires for Sensing and Device Applications," accepted, *Proceedings of the E6 Symposium "Nanoscale One-Dimensional Electronic and Photonic Devices," of the 212th Meeting of the Electrochemical Society*, Washington, D.C., October 7-12, 2007.
4. S. Pearton, D. Norton, F. Ren, L. Tien, B. Kang and G. Chi, "Wide Bandgap Semiconductor Nanowires for Sensing Applications", 211th Meeting of the Electrochemical Society, Chicago, Illinois May 2007.
5. S. J. Pearton, D. Norton, F. Ren, B. Gila, B. Kang and L.C. Tien, "GaN, ZnO and InN Nanowires for Gas Sensing Systems", TMS Annual Meeting and Exhibition, Orlando, FL, Feb 2007.
6. D. P. Norton, L. C. Tien, H. T. Wang, P. W. Sadik, B. S. Kang, F. Ren and S. J. Pearton, "Chemical Sensing with ZnO Nanorods", TMS Annual Meeting and Exhibition, Orlando, FL, Feb 2007.
7. S. J. Pearton, L. C. Tien, H. S. Kim, D. P. Norton, J. J. Chen, H. T. Wang, B. S. Kang, F. Ren, W. T. Lim, J. Wright, R. Khanna, L. F. Voss, L. Stafford, J. Jun, J. Lin, "Development of Thin Film and Nanorod ZnO-Based LEDs and Sensors," in *Materials Research Society Symposium Proceedings Vol. 957*, K-01-05, 12 pages, December 2006.
8. T. Nishida, J. Lin, K. Ngo, F. Ren, D. Norton, S. Pearton, L. Cattafesta, M. Sheplak, J. Jun, A. Kasyap, D. Johnson, and A. Phipps, "Wireless Hydrogen Sensor Self-powered Using Ambient Vibration and Light," *Proceedings of 2006 ASME International Mechanical Engineering Congress and Exposition (IMECE)*, 6 pages, November 2006.

9. J. Jun, J. Lin, S. Xu, A. Phipps, K. Ngo, D. Johnson, A. Kasyap, T. Nishida, H. T. Wang, B. S. Kang, F. Ren, L. C. Tien, P. W. Sadik, D. P. Norton, L. F. Voss and S. J. Pearton, "Low-Power Detection of Hydrogen Leakage Using a Self-Powered Wireless Hydrogen Sensor Node," *Proceedings of the AIChE 2006 Spring National Meeting*, 10 pages, April 2006.
10. S.J. Pearton, W. T Lim, J. S Wright, R. Khanna, L. Voss, L. Stafford, L. Tien, H. S Kim, D. P Norton, J. J Chen, H. T Wang, B. S Kang, F. Ren, J. Jun and Jenshan Lin, "Development of Thin Film and Nanorod ZnO-Based LEDs and Sensors", MRS Fall Meeting, Boston, Nov 2006.
11. Li-Chia Tien, Hung-Ta Wang, Byoung-Sam Kang, David Norton, Fan Ren and S.J. Pearton, "Highly Selective Hydrogen Sensing with Pt-functionalized ZnO Thin Films and Nanorods", MRS Fall Meeting, Boston, Nov 2006.
12. J. Lin, J. Jun, A. Phipps, X. Shengwen, K. Ngo, D. Johnson, A. Kasyap, T. Nishida, H. T. Wang, B. S. Kang, and F. Ren, L. C. Tien, P. W. Sadik, D. P. Norton, L. F. Voss, and S. J. Pearton, "Self-Powered Wireless Nano-Sensor for Hydrogen Leak Detection and Wireless Power Transmission", Radio Science Symposium for A Sustainable Humanosphere, Kyoto, Japan, March 20-21, 2006.
13. T. Nishida, J. Lin, K. Ngo, F. Ren, D. Norton, S. Pearton, L. Cattafesta, M. Sheplak, J. Jun, A. Kasyap, D. Johnson, and A. Phipps, "Wireless Hydrogen Sensor Self-powered Using Ambient Vibration and Light", 2006 ASME International Mechanical Engineering Congress November 5-10, 2006 - Chicago, Illinois.
14. L.C. Tien, P.W. Sadik, D.P. Norton, L.F. Voss and S.J. Pearton, "Highly Selective Hydrogen Sensing at Room Temperature with Pt-Functionalized ZnO Thin Films and Nanorods", Florida AVS Meeting, Orlando, FL March 2006.
15. Hung-Ta Wang, Byoung Sam Kang, Fan Ren, Li-Chia Tien, Patrick Sadik, David Norton, S.J. Pearton, Jenshan Lin, "Hydrogen-Selective Sensing at Room Temperature with Pt-Coated ZnO Nanorods", 72nd Southeast Section of the APS, Gainesville, FL, Nov 2005.
16. H. T. Wang, B. S. Kang, F. Ren, J. Jun, J. Lin, L. C. Tien, P. W. Sadik, D. P. Norton, L. F. Voss, and S. J. Pearton, "Highly sensitive hydrogen sensor using Pt nanoparticles coated ZnO single and multiple nanowires", 208th ECS Meeting, Los Angeles, CA Oct 2005.
17. H.- T. Wang, B. S. Kang, L. Tien, P. Sadik, D. Norton, S.J. Pearton and Fan Ren, "Highly Sensitive Hydrogen Sensor Using Pd Nanoparticles Coated ZnO Nanorods" 2005 EMC Conference, Santa Barbara, July 2005.
18. H. T. Wang, B. S. Kang, F. Ren, J. Jun, J. Lin, L. C. Tien, P. W. Sadik, D. P. Norton, L. F. Voss, S. J. Pearton, "Highly sensitive hydrogen sensor using Pt nanoparticles coated ZnO single and multiple nanowires," *Proceedings of 208th Meeting of the Electrochemical Society*, pp. 238-247, 2005.
19. H. T. Wang, B. S. Kang, F. Ren, R. C. Fitch, J. K. Gillespie, N. Moser, G. Jessen, T. Jenkins, R. Dettmer, D. Via, A. Crespo, J. Lin, B. P. Gila, C. R. Abernathy, L. C. Tien, D. P. Norton, S. J. Pearton, "Hydrogen-induced reversible changes in drain current of Pt-gated AlGaIn/GaN HEMTs," *Proceedings of 208th Meeting of the Electrochemical Society*, pp. 274-283, 2005.
20. J. Lin, A. EL Kouche, M. E. Law, F. Ren, B. S. Kang, S. J. Pearton, D. P. Norton, and C. R. Abernathy, "GaIn-Based and ZnO Nanorod Sensors for Wireless Hydrogen Leak Detection," *Proceedings of the STATE-OF-THE-ART PROGRAMS ON COMPOUND SEMICONDUCTOR at the 207th Meeting of the Electrochemical Society*, 12 pages, 2005. (Invited).
21. "High Thermal Stability W₂B Ohmic Contacts to ZnO Ozone and pH Sensors", L. Voss, Kelly Ip, Rohit Khanna, C. J. Kao, I. Kravchenko, B. S. Kang, F. Ren, Y. W. Heo, D. P. Norton, G. C. Chi and S. J. Pearton, 2005 Spring MRS, San Francisco, March 2005.
22. "GaIn-Based and ZnO Nanorod Sensors for Wireless Hydrogen Leak Detection", J. Lin, M. Law, F. Ren, S. Pearton, D. Norton, 207th meeting of ECS, Quebec City, Canada, May 2005.
23. "ZnO Nanowire Devices", S.J. Pearton, Y.W.Heo, D.P. Norton, F. Ren, B.S.Kang and J.R.LaRoche, 2005 TMS Annual meeting, San Francisco, Feb 2005.

24. J. Lin, A. EL. Kouche, M. E. Law, F. Ren, B. S. Kang, S. J. Pearton, D. P. Norton, and C. R. Abernathy, "Challenges of Building a Wireless Hydrogen Sensor Network," Florida Chapter of the AVS Science and Technology Society Annual Joint Symposium, Orlando, Florida, March 13-17, 2005. (Invited)



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Task Title

Ultra-wideband Communication for Tiny Low Power Radios

Students

1. Swami Sankaran, PhD – Expected Graduation Date:12/06

Publications

1. S. Sankaran, and K. K. O, "Schottky Barrier Diodes for Millimeter Wave and Detection in a Foundry CMOS Process," IEEE Electron Device Letters, vol. 26, no. 7, pp. 492-494, July, 2005.
2. S. Sankaran, and K. K. O, "A Schottky Diode with Cut-off Frequency of 400 GHz Fabricated in 0.18- μ m CMOS," Electronics Letters vol. 41, no. 8, pp. 506-508, Apr. 2005.
3. K. K. O, K. Kim, B. A. Floyd, J. Mehta, H. Yoon, C.-M. Hung, D. Bravo, T. Dickson, X. Guo, R. Li, N. Trichy, J. Caserta, W. Bomstad, J. Branch, D.-J. Yang, J. Bohorquez, E. Seok, L. Gao, A. Sugavanam, J.-J. Lin, J. Chen, and J. Brewer, "On-chip Antennas in Silicon Integrated Circuits and Their Applications," (**Invited**) IEEE Trans. on Electron Devices, vol. 52, no. 7, pp. 1312-1323, July 2005
4. K. K. O, K. Kim, B. Floyd, J. Mehta, H. Yoon, C.-M. Hung, D. Bravo, T. Dickson, X. Guo, R. Li, N. Trichy, J. Caserta, W. Bomstad, J. Branch, D.-J. Yang, J. Bohorquez, J. Chen, E.-Y. Seok, L. Gao, A. Sugavanam, J.-J. Lin, S. Yu, C. Cao, M.-H. Hwang, Y.-P. Ding, S.-H. Hwang, H. Wu, N. Zhang, and J. E. Brewer, "The Feasibility of On-Chip Interconnection using Antennas," IEEE/ACM International Conference on Computer Aided Design, pp. 979-984, San Jose, CA, Nov. 2005.
5. J.-J. Lin, H.-T. Wu, and K. K. O, "Compact On-Chip Monopole Antennas on 20- μ -cm Silicon Substrates for Operation in the 5.8-GHz ISM Band," 2005 IEDM, pp. 967-970, Washington, DC, Dec. 2005.
6. S. Sankaran and K. K. O, "A Schottky Barrier Diode Ultra-Wideband Amplitude Modulation (AM) Detector in Foundry CMOS Technology," 2006 IEEE RFIC Symposium, pp. 309-312, June 2006, San Francisco, CA.
7. E. Seok, C. Cao, S. Sankaran, and K. K. O, "A Millimeter-Wave Schottky Diode Detector in 130-nm CMOS Technology," 2006 Symposium on VLSI Circuits, pp.178-179, June 2006, Honolulu, HI.

8. K. K. O, K. Kim, B. Floyd, J. Mehta, H. Yoon, C.-M. Hung, D. Bravo, T. Dickson, X. Guo, R. Li, N. Trichy, J. Caserta, W. Bomstad, J. Branch, D.-J. Yang, J. Bohorquez, J. Chen, E.-Y. Seok, J. E. Brewer, L. Gao, A. Sugavanam, J.-J. Lin*, Y. Su, C. Cao*, M.-H. Hwang, Y.-P. Ding, Z. Li, S.-H. Hwang, H. Wu, S. Sankaran, and N. Zhang, "Silicon Integrated Circuits Incorporating Antennas," **(Invited)** 2006 IEEE Custom Integrated Circuits Conference, pp. 473-480, Sep. 2006, San Jose, CA.
9. S. Sankaran and K. K. O, "A Ultra-Wideband Amplitude Modulation (AM) Detector using Schottky Barrier Diodes Fabricated in Foundry CMOS Technology," IEEE J. of Solid-State Circuits, vol. 42, no. 5, pp. 1058-1064, May, 2007.
10. J.-J. Lin, H.-T. Wu, S. Yu, L. Gao, A. Sugavanam, J. E. Brewer, and K. K. O, "Communication Using Antennas Fabricated in Silicon Integrated Circuits," Accepted to IEEE J. of Solid-State Circuits.



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NASA Funding

FY04, and FY05 grants

Task Title

A Test Bed for Impedance Measurements on PEM Fuel Cells
Interpretation Models for Impedance Response of PEM Fuel Cells

Students

1. Sunil Roy, PhD – Graduation Date: 05/08
2. Michael Matlock, MS. – Graduation date: 05/06

Publications

Journal Publications

1. S. K. Roy and M. E. Orazem, "Error Analysis of the Impedance Response of PEM Fuel Cells," *Journal of the Electrochemical Society*, **154** (2007), B883-B891.
2. S. K. Roy, M. E. Orazem, and B. Tribollet, "Interpretation of Low-Frequency Inductive Loops in PEM Fuel Cells," *Journal of the Electrochemical Society*, **154** (2007), B1378-B1388.

Manuscripts in preparation

1. S. K. Roy and M. E. Orazem, "Analysis of Flooding as a Stochastic Process in PEM Fuel Cells by Impedance Techniques," manuscript in preparation with submission expected in April 2008.
2. S. K. Roy and M. E. Orazem, "Application of Impedance Techniques to Estimate Interfacial Capacitance of PEM Fuel Cells," manuscript in preparation with submission expected in May 2008.

Refereed Conference Proceedings

1. S. K. Roy and M. E. Orazem, "Deterministic Impedance Models for Interpretation of Low-Frequency Inductive Loops in PEM Fuel Cells," in *Proton Exchange Membrane Fuel Cells 6*, T. Fuller, C. Bock, S. Cleghorn, H. Gasteiger, T. Jarvi, M. Mathias, M. Murthy, T. Nguyen, V. Ramani, E. Stuve, T. Zawodzinski, editors, *ECS Transactions*, **3:1**, (2006), 1031-1040.
2. S. K. Roy and M. E. Orazem, "Stochastic Analysis of Flooding in PEM Fuel Cells by Electrochemical Impedance Spectroscopy," in *Proton Exchange Membrane Fuel Cells 7*, T. Fuller, H. Gasteiger, S. Cleghorn, V. Ramani, T. Zhao, T. Nguyen, A. Haug, C. Bock, C. Lamy, and K. Ota, editors, *Electrochemical Society Transactions*, **11:1**, (2007), 485-495.

Non-Refereed Conference Proceedings

1. S. K. Roy and M. E. Orazem, "Interpretation of Low-Frequency Inductive Loops in PEM Fuel Cell Impedance Data in Terms of Reactions Influencing the Life-Time of Fuel Cell Performance," Proceedings of the 2007 NHA Annual Hydrogen Conference, the National Hydrogen Association, Washington, DC, 2007.

Presentations

1. S. K. Roy and M. E. Orazem, "Application of Measurement Models to Impedance Data of PEMFC," presented at the 209th Meeting of The Electrochemical Society, Denver, Colorado, May 7-12, 2006.
2. S. K. Roy and M. E. Orazem, "Interpretation of Low-Frequency Inductive Loops in PEM Fuel Cell Impedance Data," presented at the 210th meeting of the Electrochemical Society, Cancun, Mexico, October 29 - November 3, 2006.
3. S. K. Roy and M. E. Orazem, "Interpretation of Low-Frequency Inductive Loops in PEM Fuel Cell Impedance Data in Terms of Reactions Influencing the Life-Time of Fuel Cell Performance," NHA Annual Hydrogen Conference, March 19-22, 2007.
4. M. E. Orazem, "An Integrated Approach to Impedance Spectroscopy," **invited** plenary lecture presented at the Seventh International Symposium on Electrochemical Impedance Spectroscopy, Argelès sur Mer, France, June 3-8, 2007.
5. M. E. Orazem and S. K. Roy, "On Modeling the Impedance Response of PEM Fuel Cells," Invited lecture, presented at the International Conference "Polymer Batteries Fuel Cells-PABFC-2007" on the occasion of Professor Scrosati's 70th birthday, Rome, Italy, June 11-15, 2007.
6. S. Roy and M. Orazem, "Stochastic Analysis of Flooding in PEM Fuel Cells by Electrochemical Impedance Spectroscopy," presented at the 212th Meeting of the Electrochemical Society, Washington DC, October 7-12, 2007.
7. S. K. Roy and M. E. Orazem, "Guidelines for Evaluation of Error Structure for Impedance Response of PEM Fuel Cells," to be presented at the 213th Meeting of the Electrochemical Society, Phoenix, Arizona, May 18-23, 2008.



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NASA Funding

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Task Title

Innovative Design of a Compact Reformer for PEM FC

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Patent

A provisional US Patent (Serial No. 60/722,469) was filed the reformer design features in year 2006.



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NASA Funding

FY03, FY04, and FY05 grants

Task Titles

Remote Power Transmission Using High Power GaN HEMTs and Diodes for Regenerative Fuel Cells

Co-PI for: Novel ZnO Nanorod Hydrogen Gas Sensors

Co-PI for: Remote Wireless Power Transmission for Regenerative Fuel Cells

Students

1. Jon Wright, PhD, Summer intern at NASA Glenn in summer 2007. Graduation Date:8/ 2009
2. Travis Anderson, Interning at Sandia National Labs during summer of 2008. Graduation Date:5/ 2008
3. Kelly Ip, PhD – Graduation Date: 7/05
4. Kwang Baik, Ph.D – Graduation Date: 5/04

Funding Received by Leveraging NASA Grant

The PI's have completed a Phase I SBIR award with Nitronex, Inc. on developing AlGaIn/GaN HEMTs on Si substrates and that team has been invited to submit a Phase II proposal. In addition funding from US DOE (\$90K), NSF (\$82K), US Army (\$102K) were received.

Publications

1. "Analysis and Design of AlGaIn/GaN HEMT Resistive Mixers", T. Chang, W. Wu, J. Lin, S. Jang, F. Ren, S.J Pearton, R. Fitch and J. Gillespie, *Microwave and Optical Techn. Lett.* 49,1152 (2007).
2. "AlGaIn/GaN high electron mobility transistors on Si/SiO₂/poly-SiC substrates", T. J. Anderson, F. Ren, L. Voss, M. Hlad, B. P. Gila, L. Covert, J. Lin, S. J. Pearton, P. Bove, H. Lahreche, and J. Thuret, *J. Vac. Sci. Technol. B* 24, 2302 (2006).
3. "Laser ablation of via holes in GaN and AlGaIn/GaN high electron mobility transistor structures", Travis Anderson, Fan Ren, S. J. Pearton, Michael A. Mastro, Ron T. Holm, Rich L. Henry, Charles R. Eddy, Jr., Joon Yeob Lee, Kwan-Young Lee, and Jihyun Kim, *J. Vac. Sci. Technol. B* 24, 2246 (2006).
4. "A high efficiency class-F power amplifier using AlGaIn/GaN HEMT", Sangwon Ko, Wenhsing Wu, Jenshan Lin, Soohwan Jang, Fan Ren, S.J. Pearton, Robert Fitch and James Gillespie, *Microwave and Optical Technology Letters*, 48, 1955(2006).
5. "Thermal Considerations in Design of Vertically Integrated Si/GaN/SiC Multichip Modules", T.J. Anderson, F. Ren, L. Covert, J. Lin and S.J. Pearton, *J. Electrochem. Soc.* 153 G906 (2006).

6. "Electrical Performance of GaN Schottky Rectifiers on Si Substrates", L. Voss, S.J. Pearton, F. Ren, P. Bove, H. Lareche and J.Thuret, J. Electrochem. Soc. 153, G681(2006).
7. "Si diffused GaN for enhancement mode GaN MOSFET on Si applications", S.Jang, F.Ren, S.J.Pearton, B.P.Gila, M.Hlad, C.R.Abernathy, H.S.Yang, C.J.Pan, J.I.Chyi, P.Bove, H. Lareche and J. Thuret, J. Electron. Mater. 35,685(2006).
8. "Comparison of laser wavelength operation for drilling of via holes in AlGaIn/GaN HEMTs on SiC substrates", T.Anderson, F. Ren, L.Covert, J.Lin, S.J.Pearton, T.Dalrymple, C.Bozada, R.Fitch, N.Moser, R .Bedford and M. Schimpf", J.Electron. Mater. 35,675(2006).
9. "Thermal Simulations of three-dimensional Integrated Multichip Module with GaN power amplifier and Si modulator", T.J. Anderson, F. Ren, L.Covert, J.Lin and S.J. Pearton, J. Vac .Sci. Technol. 24,284(2006).

Presentations

1. "AlGaIn/GaN High Electron Mobility Transistors and Diodes Fabricated on Large Area Silicon on Poly-SiC (SopSiC) Substrates for Lower Cost and Higher Yield" T.J. Anderson, F. Ren, L. Voss, M. Hlad, B.P. Gila, S.J. Pearton, J.Kim, J. Lin, P. Bove, H. Lahreche, J. Thuret, and R. Langer, 2007 Mantech Conference,Austin,TX, May 2007.
2. "Microwave Performance of AlGaIn/GaN High Electron Mobility Transistors on Si/SiO₂/Poly-SiC Substrates", T. Anderson, F. Ren, L. Covert, J. Lin, S. J. Pearton, J. Thuret, P. Bove and H. Lahreche, TMS Annual Meeting and Exhibition, Orlando, FL, Feb 2007.
3. "AlGaIn/GaN High Electron Mobility Transistors on Si/SiO₂/poly-SiC Substrates", Travis Anderson, Fan Ren, Lars Voss, Mark Hlad, Brent Gila, S.J. Pearton, Lance Covert, Jenshan Lin, Julien Thuret, P. Bove and H. Lahreche, MRS Fall Meeting, Boston, Nov 2006.
4. "SiC Via Fabrication and Integration for Wide Bandgap HEMT/MMIC Devices", by R. Shul, M. Overberg, A. Baca, C. Sanchez, J. Stevens, L. Voss, K. Ip, S. Pearton, M. Martinez, M. Armendariz and G. Wouters, 210th Meeting of ECS, Cancun, Mexico, Nov 2006
5. "Hydrogen sensitive Schottky diodes on free-standing GaN Rectifiers", L.Voss, B.P. Gila and S.J. Pearton, Hung-Ta Wang and F. Ren, 208th ECS Meeting, Los Angeles, CA Oct 2005.



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NASA Funding

FY03 grant

Task Title

Rayleigh Scattering for Hydrogen Leak Detection

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2. Sameer Paranjpe, MS – Graduation Date: 05/04
3. Philip Jackson, MS – Expected Graduation Date: 06/05



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NASA Funding

FY04, and FY05 grants

Task Title

Co-PI for: Rational Design of Higher Conductivity Solid Oxide Electrolytes

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NASA Funding

FY03, FY04, and FY05 grants

Task Title

Novel ZnO Nanorod Hydrogen Gas Sensors

Co-PI for: Remote Wireless Power Transmission for Regenerative Fuel Cells

Students

1. Jon Wright, Summer intern at NASA Glenn in summer 2007 and will graduate with a Ph.D in summer 2009
2. Travis Anderson, Interning at Sandia National Labs during summer of 2008 and will graduate with a Ph.D in 5/2008.
3. Hung Ta Wang, PhD – Expected Graduation Date: 05/08
4. Sam Kang, PhD – Expected Graduation Date: 12/05

Collaborations

1. SVT Associates, Eden Prairie, MN, contact Dr. Andrei Osinsky.

Publications

1. Low temperature (<100°C) patterned growth of ZnO nanorods arrays on Si", B.S. Kang, S.J.Pearton and F.Ren, Appl.Phys.Lett.90, 083104 (2007).
2. "Detection of hydrogen with SnO₂-coated ZnO nanorods", L.C. Tien, D.P. Norton, B.P. Gila, S.J. Pearton, Hung-Ta Wang, B.S. Kang and F. Ren, Appl. Surf. Sci. 253, 4748 (2007).
3. "Nucleation control for ZnO nanorods grown by catalyst-driven molecular beam epitaxy", L.C. Tien, D.P. Norton, S.J. Pearton, Hung-Ta Wang and F. Ren, Appl. Surf. Sci. 253, 4620 (2007).
4. "Wide Bandgap Semiconductor Nanorod and Thin Film Gas Sensors", B.S. Kang, H.-T. Wang, L.- C. Tien, F. Ren, B. P. Gila, D. P. Norton, C. R. Abernathy, J. Lin and S.J. Pearton, Sensors 6,643(2006).
5. "Hydrogen sensing at room temperature with Pt-coated ZnO thin films and nanorods",L. Tien, P. Sadik, D.P. Norton, L. Voss, S.J. Pearton, H.T. Wang, B. S. Kang, F. Ren, J.Jun and J.Lin, Appl. Phys. Lett.87,222106 (2005).
6. "Room temperature hydrogen selective sensing using single Pt-coated ZnO nanowires at microwatt power levels", L. Tien, H.T. Wang, B.S. Kang, F. Ren, P.W. Sadik, D.P. Norton, S.J. Pearton and J.Lin, Electrochem. Solid-State Lett.8 G239 (2005).
7. "Hydrogen-selective sensing at room temperature with ZnO nanorods", H. T. Wang, B. S. Kang, F. Ren, L. C. Tien, P. W. Sadik, D. P. Norton, S. J. Pearton, and Jenshan Lin, Appl. Phys. Lett. 86, 243503 (2005).

8. "Fabrication approaches to ZnO nanowire devices", J.R. LaRoche, Y.W. Heo, B.S. Kang, L. Tien, Y. Kwon, D.P. Norton, B.P. Gila, F. Ren and S.J. Pearton, *J. Electron. Mater.* 34 404 (2005).
9. "Hydrogen and ozone gas sensing using multiple ZnO nanorods," B.S. Kang, Y.W. Heo, L.C. Tien, D.P. Norton, F. Ren, B.P. Gila and S.J. Pearton, *Appl. Phys.A* 80 1029 (2005).
10. "Remote sensing system for hydrogen using GaN Schottky diodes", A. El. Kouche, J.Lin, M. E. Law, S. Kim, B. S. Kim, F. Ren and S. J. Pearton, *Sensors and Actuators B:Chemical*, 105,329 (2005).
11. "Comparison of MOS and Schottky W/Pt -GaN diodes for hydrogen detection", B.S.Kang, S.Kim, F. Ren B.P.Gila, C.R.Abernathy and S.J. Pearton, *Sensors and Actuators B* 104, 232 (2005).
12. "Hydrogen sensors based on Sc_2O_3 /AlGaIn/GaN HEMTs", B.S.Kang, R.Mehandru, S.Kim, F. Ren, R.C.Fitch, J.K.Gillespie, N.Moser, G.Jessen, T.Jenkins, R.Dettmer, D.Via, A.Crespo, K.H.Baik, B.P.Gila, C.R. Abernathy and S.J. Pearton, *Phys. Stat. Solidi*, C 1-4 274 (2005).
13. "AlGaIn/GaN HEMT structures for pressure and pH sensing", B.S.Kang, S.Kim, J.Kim, R.Mehandru, F. Ren, K.Baik, S.J. Pearton, B.P.Gila, C.R.Abernathy, C.C.Pan, G.T.Chen, J.I.Chyi, M.Sheplak, T.Nishida and S.N.G.Chu, *Phys. Stat. Solidi*, C 1- 4 375 (2005).
14. "ZnO nanowire growth and devices", Y.W.Heo, D.P.Norton, L.C.Tien, Y.Kwon, B.S.Kang, F. Ren, S.J. Pearton and J.R.LaRoche, *Mat.Sci.Eng.R* 47,1(2004).
15. "Detection of CO using bulk ZnO rectifiers", B.S. Kang, S.Kim, F. Ren, K. Ip, Y.W. Heo, B.P.Gila, C.R.Abernathy, D.P.Norton and S.J. Pearton, *Appl.Phys.A.* 80,259 (2004).
16. "GaN-based diodes and transistors for chemical, gas, biological and pressure sensing", S.J. Pearton, B.S. Kang, S. Kim, F. Ren, B.P. Gila, C.R.Abernathy, J.Lin and S.N.G.Chu, *J. Phys:Condensed Matter* 16 R961(2004).
17. "Enhanced functionality in GaN and SiC devices by using novel processing", S.J. Pearton, C.R.Abernathy, F. Ren and Y.D.Park, *Solid-State Electron.*48 1965(2004).
18. "Detection of C_2H_4 using wide bandgap semiconductor sensors: AlGaIn/GaN MOS diodes and bulk ZnO rectifiers, *J.Electrochem.Soc.*151 G468(2004).
19. Hydrogen-induced reversible changes in drain current in Sc_2O_3 /AlGaIn/GaN HEMTs", B.S. Kang, R. Mehandru, S. Kim, F. Ren, R. Fitch, J. Gillespie, N. Moser, G. Jessen, T. Jenkins, R. Dettmer, D. Via, A.Crespo, B.P.Gila, C.R. Abernathy and S.J. Pearton, *Appl. Phys. Lett.* 84 4635(2004)
20. "Sensitivity of Pt/ZnO Schottky Diode Characteristics to Hydrogen," S. Kim, B. Kang, F. Ren, K. Ip, Y. Heo, D. Norton and S.J. Pearton, *Appl. Phys. Lett.* 84, 1698 (2004).

Conference Papers

1. "Low Temperature (< 100°C) Patterned Growth of ZnO Nanorod Arrays on Si," by B. Kang, S. Pearton and F. Ren, 211th Meeting of the Electrochemical Society, Chicago, Illinois May 2007.
2. "Wide Bandgap Semiconductor Nanowires for Sensing Applications," by S. Pearton, D. Norton, F. Ren, L. Tien, B. Kang and G. Chi, 211th Meeting of the Electrochemical Society, Chicago, Illinois May 2007.
3. "GaN, ZnO and InN Nanowires for Gas Sensing Systems", S. J. Pearton, D. Norton, F. Ren, B. Gila, B. Kang and L.C. Tien, TMS Annual Meeting and Exhibition, Orlando, FL, Feb 2007.
4. "Chemical Sensing with ZnO Nanorods", D. P. Norton, L. C. Tien, H. T. Wang, P. W. Sadik, B. S. Kang, F. Ren and S. J. Pearton, TMS Annual Meeting and Exhibition, Orlando, FL, Feb 2007.
5. "Development of Thin Film and Nanorod ZnO-Based LEDs and Sensors", S.J. Pearton, W. T Lim, J. S Wright, R. Khanna, L. Voss, L. Stafford, L. Tien, H. S Kim, D. P Norton, J. J Chen, H. T Wang, B. S Kang, F. Ren, J. Jun and Jenshan Lin, MRS Fall Meeting, Boston, Nov 2006.

6. "Highly Selective Hydrogen Sensing with Pt-functionalized ZnO Thin Films and Nanorods", Li-Chia Tien, Hung-Ta Wang, Byoung-Sam Kang, David Norton, Fan Ren and S.J. Pearton, MRS Fall Meeting, Boston, Nov 2006.
7. "Self-Powered Wireless Nano-Sensor for Hydrogen Leak Detection and Wireless Power Transmission", J. Lin, J. Jun, A. Phipps, X. Shengwen, K. Ngo, D. Johnson, A. Kasyap, T. Nishida, H. T. Wang, B. S. Kang, and F. Ren, L. C. Tien, P. W. Sadik, D. P. Norton, L. F. Voss, and S. J. Pearton, Radio Science Symposium for A Sustainable Humanosphere, Kyoto, Japan, March 20-21, 2006.
8. "Wireless Hydrogen Sensor Self-powered Using Ambient Vibration and Light", T. Nishida, J. Lin, K. Ngo, F. Ren, D. Norton, S. Pearton, L. Cattafesta, M. Sheplak, J. Jun, A. Kasyap, D. Johnson, and A. Phipps, 2006 ASME International Mechanical Engineering Congress November 5-10, 2006 - Chicago, Illinois.
9. "Highly Selective Hydrogen Sensing at Room Temperature with Pt-Functionalized ZnO Thin Films and Nanorods", L.C. Tien, P.W. Sadik, D.P. Norton, L.F. Voss and S.J. Pearton, Florida AVS Meeting, Orlando, FL March 2006.
10. "Hydrogen-Selective Sensing at Room Temperature with Pt-Coated ZnO Nanorods", Hung-Ta Wang, Byoung Sam Kang, Fan Ren, Li-Chia Tien, Patrick Sadik, David Norton, S.J. Pearton, Jenshan Lin, 72nd Southeast Section of the APS, Gainesville, FL, Nov 2005.
11. "Highly sensitive hydrogen sensor using Pt nanoparticles coated ZnO single and multiple nanowires", H. T. Wang, B. S. Kang, F. Ren, J. Jun, J. Lin, L. C. Tien, P. W. Sadik, D. P. Norton, L. F. Voss, and S. J. Pearton, 208th ECS Meeting, Los Angeles, CA Oct 2005.
12. "Highly Sensitive Hydrogen Sensor Using Pd Nanoparticles Coated ZnO Nanorods", H.- T. Wang, B. S. Kang, L. Tien, P. Sadik, D. Norton, S.J. Pearton and Fan Ren, 2005 EMC Conference, Santa Barbara, July 2005.
13. "Effect of Hydrogen on Palladium Coated Carbon Nanotube Conductance", H. T. Wang, B. S. Kang, F. Ren, J. Sippel, A. G. Rinzler and S. J. Pearton, 2005 Annual Joint Symposium of Florida, Chapter of the AVS and Florida Society for Microscopy, March, 2005, Orlando, FL
14. "High Thermal Stability W₂B Ohmic Contacts to ZnO Ozone and pH Sensors", L. Voss, Kelly Ip, Rohit Khanna, C. J. Kao, I. Kravchenko, B. S. Kang, F. Ren, Y. W. Heo, D. P. Norton, G. C. Chi and S. J. Pearton, 2005 Spring MRS, San Francisco, March 2005.
15. "GaN-Based and ZnO Nanorod Sensors for Wireless Hydrogen Leak Detection", J. Lin, M. Law, F. Ren, S. Pearton, D. Norton, 207th meeting of ECS, Quebec City, Canada, May 2005.
16. "ZnO Nanowire Devices", S.J. Pearton, Y.W.Heo, D.P.Norton, F. Ren, B.S.Kang and J.R.LaRoche, 2005 TMS Annual meeting, San Francisco, Feb 2005.
17. "Hydrogen and ozone gas sensing using multiple ZnO nanorods", B.S. Kang, F. Ren, Y.W.Heo, B.P.Gila, D.Norton and S.J. Pearton, Fall MRS meeting, Boston, Nov 2004.
18. "ZnO spintronics and nanowire devices, D.P. Norton, Y.W.Heo, L.Tien, M.Ivill, Y.Li, B.S.Kang, F. Ren, J.Kelly, A.F. Hebard and S.J. Pearton, Fall MRS meeting, Boston, Nov 2004.
19. "Nanodevices using single ZnO nanowires" Y.W.Heo, B.S.Kang, L.Tien, Y.Kwon, J.LaRoche, B.P.Gila, F. Ren, S.J. Pearton and D.P.Norton, Fall MRS meeting, Boston, Nov 2004.
20. "Hydrogen and ethylene sensors based on Sc₂O₃/AlGaIn/GaN HEMTs", B. Kang, R. Mehandru, S.Kim, F. Ren, R. Fitch, J. Gillespie, N. Moser, G.Jessen, T.Jenkins, R.Dettmer, D. Via, A.Crespo, K.Baik, B.P.Gila, C.R.Abernathy and S.J. Pearton, MRS Intl.Workshop on GaN, Pittsburgh, PA, July 2004.
21. "Sensitivity of Pt/ZnO Schottky Diode Characteristics to Hydrogen," S. Kim, B. Kang, K. Ip, Y.W. Heo, D.P. Norton, S.J. Pearton and F. Ren, 203rd Meeting of ECS, San Antonio, TX, May 2004.
22. "AlGaIn/GaN-Based MOS-Diode Based H₂ Gas Sensors," B. Kang, F. Ren, B. Gila, C.R. Abernathy and S.J. Pearton, 203rd Meeting of ECS, San Antonio, TX, May 2004.

23. "Remote Sensing System for H₂ Detection Using GaN Schottky Diodes," A. Elkouche, J. Lin, M.E. Law, S. Kim, B.S. Kang, F. Ren and S.J. Pearton, Wireless and Microwave Technol. Conf. 2004, Clearwater, FL, April 2004.
24. "GaN and SiC Schottky Diode Gas Sensors," F. Ren, J. Kim, B. Gila, C.R. Abernathy, S.J. Pearton, A. Bacca, R.D. Briggs and G.Y. Chung, 2003 Intl. Symp. Comp. Semicond., La Jolla, CA, August 2003.



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NASA Funding

FY02, FY03, FY04, and FY05 grants

Task Title

Lightweight Composite Tanks for Liquid Hydrogen Storage

Students

1. Wonjong Noh, MS – Graduation Date: 8/04
2. Sujith Kalarikkal, MS – Graduation Date: 8/04
3. Van Pelt III, James, MS – Graduation Date: 12/06
4. Choi, Sukjoo, PhD – Graduation Date: 5/05
5. Nicole Apetre, PhD – Graduation Date: 5/05
6. Jianlong Xu, PhD – Graduation Date: 8/07

Funding Received by Leveraging NASA Grant

1. A stress gradient failure theory for textile structural composites, US Army, \$63,833
2. A stress gradient failure theory for textile structural composites, US Army, \$27,479
3. Multi-continuum theory for linerless composite tank design, CTD, Inc., \$30,000
4. Uncertainty propagation in the analysis and design of integrated thermal protection system, NASA, \$82,853

Publications

Journal Publications

1. Choi, S., B.V. Sankar. "Gas Permeability of Graphite/Epoxy Composite Laminates for Cryogenic Storage Systems", *Composites Part B* (under review)
2. Choi, S., B.V. Sankar. "Gas Permeability of Various Graphite/Epoxy Composite Laminates for Cryogenic Storage Systems". *Composites Part B: Engineering* (submitted for publication)
3. Xu, J., B.V. Sankar, S.K. Bapanapalli. "Finite Element Based Method to Predict Gas Permeability in Cross-ply Laminate", *Journal of Composite Materials*. (submitted for publication)
4. Xu, J., B.V. Sankar. Parametric investigation of gas permeability in cross-ply composite laminates using three-dimensional finite elements. *AIAA Journal* 45(4) 2007 934-941.
5. Choi, S, B.V. Sankar. Fracture toughness of transverse cracks in graphite/epoxy laminates at cryogenic conditions. *Composites: Part B* 38 (2007) 193-200.

6. Kalarikkal, S., B.V. Sankar, P.G. Ifju. Effect of Cryogenic Temperature on the Fracture Toughness of Graphite/Epoxy Composites. *ASME Journal of Engineering Materials and Technology* 128(2) 2006 151-157.
7. Choi, S., B.V. Sankar. Micromechanical Analysis of Composite Laminates at Cryogenic Temperatures. *J. Composite Materials*, 40(12) 2006 1077-1091.
8. Choi, S. and B.V. Sankar, 2005, "A Micromechanical method to predict the fracture toughness of cellular materials", *International Journal of Solids & Structures*, 42/5-6, pp. 1797-1817.
9. Choi, S., B.V. Sankar. "Fracture toughness of carbon foam", *Journal of Composite Materials*, 37(23):2101-2116, 2003.

Conference Papers

1. Van Pelt, J., B. V. Sankar, P. G. Ifju. "Gas Permeability of Composite Laminates for Cryogenic Storage Systems", *21st Annual Technical Conference of the American Society for Composites*, CD ROM Proceedings, University of Michigan, Dearborn, MI, September 2006, Paper #212, 17 pages.
2. Xu, J., B.V. Sankar. "Prediction of Gas Permeability in Cross-ply Laminates using Finite Elements", *21st Annual Technical Conference of the American Society for Composites*, CD ROM Proceedings, University of Michigan, Dearborn, MI, September 2006, Paper #207, 9 pages.
3. J. Xu and B.V. Sankar. "Parametric investigation of gas permeability in cross-ply composite laminates using three-dimensional finite elements", AIAA Paper 2006-2093, 47th AIAA/ASME/ASCE/AHS/ASC Structures, Structural Dynamics, and Materials Conference, 1 - 4 May 2006, Newport, Rhode Island (12 pages).
4. Lee, S., S. Choi and B.V. Sankar. "A micromechanical model for predicting the fracture toughness of functionally graded foams", *Proceedings of the 22nd Southeastern Conference in Theoretical and Applied Mechanics (SECTAM)*, August 15-17, 2004, Center for Advanced Materials, Tuskegee University, Tuskegee, Alabama, pp. 613-622.
5. Choi, S., B.V. Sankar. "Thermal stresses in a composite pressure vessel at cryogenic temperatures", *Developments in Theoretical and Applied Mechanics*, *Proceedings of the 22nd Southeastern Conference in Theoretical and Applied Mechanics (SECTAM)*, August 15-17, 2004, Center for Advanced Materials, Tuskegee University, Tuskegee, Alabama, pp. 587-596.
6. Choi, S. and B.V. Sankar, "A micromechanics method to predict the fracture toughness of carbon foam", *Fourteenth International Conference on Composite Materials*, CD ROM proceedings, San Diego, California, July 2003, Paper # 1355, 11 pages.
7. Choi, S. and B.V. Sankar, "A micromechanics method to predict the micro-cracking of the LH2 composite tank at cryogenic temperature", *Proceedings of the 5th International Congress on Thermal Stresses and Related Topics, TS 2003*, Eds. L. Librescu and P. Marzocca, Virginia Polytechnic Institute & State University, Blacksburg, VA, 8-11 June 2003, pp. WM441-444.



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NASA Funding

FY04, and FY05 grants

Task Title

Co-PI for: Multi-scale Surface Plate Fabrication for Next Generation Fuel Cells

Students

1. Jeffrey Bardt, MS – Graduation Date: 8/05, Employed at Samsung
2. Nathan Mauntler, PhD – Expected Graduation Date: 5/09

Publications

1. Sawyer, W.G., Ziegert, J., Bardt, J., and Mauntler, N., 2005, Precision Molding of Metallic Micro-Components, *Proceedings of 2005 National Science Foundation DMII Grantees Conference*, Scottsdale, AZ (on CD).
2. Bardt, J., Mauntler, N., Boure, G., Schmitz, T., Ziegert, J., Sawyer, W.G., Metallic Glass Surface Patterning by Micro-molding, IMECE2005-81099, to appear in *Proceedings of the 2005 ASME International Mechanical Engineering Congress and Exposition* (peer-reviewed).
3. Bardt, J., Mauntler, N., Sawyer, W.G., and Ziegert, J.C., Precision Molding of Metallic Micro-Components, to appear in *Proceedings of the 2005 ASPE Annual Meeting*.
4. Sawyer, W.G., Bardt, J., Mauntler, N., Bourne, G., and Schmitz, T., Surface Patterning on Metallic Glasses, to appear in *Proceedings of the 2005 STLE Annual Meeting and Exhibition*.



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NASA Funding

FY04, and FY05 grants

Task Title

Multi-scale Surface Plate Fabrication for Next Generation Fuel Cells

Students

1. G. Bourne, PhD – Graduation Date: 03/06, Employed at UF. Research Assistant Scientist in the Department of Materials Science and Engineering and the Major Analytical Instrumentation Center (MAIC).
2. C. H. Cheng: Received PhD. Interviewing for faculty positions.

Collaborations

(Academic) We have initiated discussions with Dr. Laura Schaefer, Assistant Professor, University of Pittsburgh (Mechanical Engineering Department), regarding a potential collaboration. In this work, we would apply our manufacturing processes to metallic plates that will be used in her micro-PEM/DMFC research.

Funding Received by Leveraging the NASA Grant

The NASA funds were used to leverage follow-on funding from the National Institute of Standards and Technology (NIST). In this two-year project (50K/year for two years - 5/1/06 to 8/30/08), the research collaboration is focused on the development of a reference standard for atomic force microscope (AFM) cantilever stiffness calibration. The end goal is production of flexure-based artifacts that exhibit: low fabrication expense, stiffness adjustability by design, insensitivity to load application point, mechanical robustness, and good reproducibility. Experimental determination of the spring constants of AFM cantilevers is important because the measured forces are inferred from the cantilever displacement and the linear relationship between force and displacement.

Rather than rely on the AFM displacement sensor and various other measurements (of geometry and mass, for example) to determine cantilever stiffness, the purpose of this research is to develop a reference artifact that provides a more direct (force) traceability path. Specifically, it is our intent to design an artifact that can be calibrated using the electronic force balance (EFB) developed by J. Pratt *et al.* at NIST and subsequently used as a transfer standard to determine the stiffness of commercial AFM cantilevers. Our final design goals for the artifact are:

1. inexpensive to manufacture;
We will use the micro-molding process for bulk metallic glass.
2. ability to vary stiffness;

Multiple artifacts of varying geometry (and, therefore, stiffness) can be produced in a single mold. Our stiffness design range will be 0.5 N/m to 1.0 N/m, which corresponds both to nominal cantilever stiffness values and the preferred range of operation for the EFB.

3. insensitive to load application location;
Flexure-based geometries will be applied to reduce/eliminate sensitivity of stiffness to the location of the applied load.
4. mechanical robustness; and
Because the artifact will be metal and have a size scale of ~1 mm, it will be easier to handle and use.
5. good reproducibility
We anticipate that the micro-molding process is sufficiently accurate and that the bulk metallic glass properties will be acceptably reproducible to produce the “same” artifact(s) from one mold to the next. This could reduce the number of required EFB measurements once the process reproducibility is verified.

Publications

1. Bardt, J., Bourne, G., Ziegert, J., Schmitz, T., and Sawyer, W.G., 2007, Micromolding Three-Dimensional Amorphous Metal Structures, *Journal of Materials Research* (accepted).
2. Bardt, J., Bourne, G., Schmitz, T., Sawyer, W.G., and Ziegert, J., 2007, Closed Channel Fabrication using Micromolding of Metallic Glass, to appear in Proceedings of the 2007 International Manufacturing Science & Engineering Conference (MSEC2007), October 15-18, 2007, Atlanta, GA.
3. Cheng, C.-H. and Schmitz, T., 2007, RCSA Application to Micro/Meso-scale Endmills, to appear in Proceedings of the 2007 International Manufacturing Science & Engineering Conference (MSEC2007), October 15-18, 2007, Atlanta, GA.
4. Bardt, J., Ziegert, J., Schmitz, T., Sawyer, W.G., and Bourne, G., 2006, Precision Molding of Complex Metallic Micro-structures, 1st International Conference on Micromanufacturing, University of Illinois, Urbana-Champaign, September 13-15.
5. Bardt, J., Mauntler, N., Ziegert, J., Sawyer, W.G., and Schmitz, T., 2005, Precision Molding of Metallic Micro-components, Proceedings of American Society for Precision Engineering Annual Meeting, October 9-14, Norfolk, VA.
6. Bardt, J., Mauntler, N., Bourne, G., Schmitz, T., Ziegert, J., and Sawyer, W.G., 2005, Metallic Glass Surface Patterning by Micro-molding, Proceedings of American Society of Mechanical Engineers International Mechanical Engineering Congress and Exposition, IMECE2005-81099, Orlando, FL.
7. Bardt, J., Mauntler, N., Bourne, G., Schmitz, T., Ziegert, J., and Sawyer, W.G., 2005, Fuel Cell Collector Plate Fabrication by Micro-molding, 1st Symposium on Manufacturing of MEAs for Hydrogen Applications, August 9-11, Dayton, OH.
8. Cheng, C.-H., Schmitz, T., Arakere, N., and Duncan, G.S., 2005, An Approach for Micro End mill Frequency Response Predictions, Proceedings of American Society of Mechanical Engineers International Mechanical Engineering Congress and Exposition, IMECE2005-81215, Orlando, FL.



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NASA Funding

FY04, and FY05 grants

Task Title

Micro-machined Floating Element Hydrogen Flow Rate Sensor

Students

1. Stephen Horowitz, PhD - Expected Graduation Date: 08/05
2. Tai-An Chen, PhD – Expected Graduation Date: 12/08

Collaborations

1. Ken Tedjojuwono, at NASA-LaRC research center.
2. Toshi Nishida and Lou Cattafesta at UF.

Funding Received by Leveraging the NASA Grant

“Moiré-Based Optical MEMS Shear Stress Sensor Technology,” Office of Naval Research (\$73K).

Publications

Conference Papers

1. Sheplak, M., Cattafesta, L., and Tian, Y., "Micromachined Shear Stress Sensors for Flow Control Applications," IUTAM Symposium on Flow Control and MEMS, Springer, ed. J.F. Morrison, pp. 67-73, 2006.
2. Horowitz, S., Chen, T., Chandrasekaran, V., Tedjojuwono, K., Nishida, T., Cattafesta, L., and Sheplak, M., "A Micromachined Geometric Moire Interferometric Floating-Element Shear Stress Sensor," AIAA Paper 2004-1042, 42nd Aerospace Sciences Meeting and Exhibit, Reno, NV, January 2004. (Best Paper, AIAA Aerodynamic Measurement Technical Committee, 2004)
3. Sheplak, M., Cattafesta, L., and Nishida, T., "MEMS Shear Stress Sensors: Promise and Progress," AIAA Paper AIAA 2004-2606, 24th AIAA Aerodynamic Measurement Technology and Ground Testing Conference, Portland, OR, June 2004. - **Invited**
4. Horowitz, S., Chen, T., Chandrasekaran, V., Tedjojuwono, K., Nishida, T., Cattafesta, L., and Sheplak, M., "A Wafer-Bonded, Floating Element Shear-Stress Sensor Using a Geometric Moiré Optical Transduction Technique," Technical Digest, Solid-State Sensor and Actuator Workshop, June 6-10, Hilton Head, SC, pp. 13-18, June 2004.



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NASA Funding

FY02 grant

Task Title

Liquid Hydrogen Storage Onboard Spacecraft in Microgravity

Students

1. Ahmad M. Mahmoud, MS and PhD, Graduation Dates: 12/04 (MS) and 07/08 (PhD)
2. Midhun Thomas Vergis, MS - Graduation Date: 08/07
3. Sherif Kandil, PhD (Co-Chair), Graduation Date: 05/06
4. Shankar Venkat, PhD, (on sick leave)
5. Kevin Freudenberg, Undergraduate

Publications

Journal Publications

1. Sherif, S.A., Barbir, F., and Veziroglu, T.N., "Towards a Hydrogen Economy," The Electricity Journal, Vol. 18, No. 6, July 2005, pp. 62-76.
2. Sherif, S.A., Barbir, F., and Veziroglu, T.N., "Wind Energy and the Hydrogen Economy: Review of the Technology," Solar Energy, Vol. 78, No. 5, May 2005, pp. 647-660.
3. Sherif, S.A., Barbir, F., and Veziroglu, T.N., "Principles of Hydrogen Energy Production, Storage and Utilization," Journal of Scientific and Industrial Research, Vol. 62, No. 1, January-February 2003, pp. 46-63.
4. Kandil, S.M., Lear, W.E., and Sherif, S.A., "Performance of a Jet-Pumped Cryogenic Refrigeration System," AIAA Journal of Propulsion and Power, Vol. 20, No. 6, November/December 2004, pp. 1018-1025.
5. Kandil, S.M., Lear, W.E., and Sherif, S.A., "Mass Advantages in a Jet-Pumped Active Thermal Management System," SAE Transactions-Journal of Aerospace, Vol. 111, No. 1, 2002, ISBN 0-7680-1285-6, pp. 765-773.
6. Freudenberg, K., Lear, W.E., Sherif, S.A., and Golliher, E.L., "Mass-Based Optimization of Thermal Management and Power Systems for Space Applications," AIAA Journal of Propulsion and Power, Vol. 18, No. 6, November-December 2002, pp. 1161-1169.

Conference Papers

1. Kandil, S.M., Lear, W.E., and Sherif, S.A., "Design and Performance of Two-Phase Ejectors for Space Thermal Management Applications," 4th International Energy Conversion Engineering Conference and Exhibit, Sheraton San Diego Hotel and Marina, San Diego, California, June 26-29, 2006, Paper No. AIAA-2006-4058.

2. Mahmoud, A.M., Sherif, S.A., and Lear, W.E., "Analysis of Boil-off Losses of Various Cryogenic Fluids in Storage Systems," 44th AIAA Aerospace Sciences Meeting and Exhibit, Reno, Nevada, January 9-12, 2006, Paper No. AIAA-2006-0577
3. Mahmoud, A.M., Lear, W.E., and Sherif, S.A., "Boil-Off Losses Associated with Venting Charging Tanks in Cryogenic Storage Systems," 44th AIAA Aerospace Sciences Meeting and Exhibit, Reno, Nevada, January 9-12, 2006, Paper No. AIAA-2006-0578
4. Kandil, S.M., Lear, W.E., and Sherif, S.A., "Analysis of Two-Phase Supersonic Flow in Jet Pumps," Proceedings of the ASME Fluids Engineering Summer Conference, Wyndham Greenspoint Hotel, Houston, Texas, June 19-23, 2005, Paper No. FEDSM2005-77476.
5. Mahmoud, A.M., Lear, W.E., and Sherif, S.A., "Transient Analysis of Pressure-Induced Transfer of Cryogenic Hydrogen in Storage Systems," 42nd AIAA Aerospace Sciences Meeting and Exhibit, Reno, Nevada, January 5-8, 2004, Paper No. AIAA-2004-0480.
6. Venkat, S. and Sherif, S.A., "Self-Pressurization and Thermal Stratification in a Liquid Hydrogen Tank under Varying Gravity Conditions," 42nd AIAA Aerospace Sciences Meeting and Exhibit, Reno, Nevada, January 5-8, 2004, Paper No. AIAA-2004-1341.
7. Kandil, S.M., Lear, W.E., and Sherif, S.A., "Regenerative Jet-Pumped Thermal Management Systems for Spacecraft Mass Reduction," 41st AIAA Aerospace Sciences Meeting and Exhibit, Reno, Nevada, January 6-9, 2003, AIAA Paper 2003 0501.
8. Kandil, S.M., Lear, W.E., and Sherif, S.A., "Mass Advantages in a Jet-Pumped Active Thermal Management System," Proceedings of the 2002 SAE Power Systems Conference, Coral Springs, Florida, October 29-31, 2002, SAE Paper No. 2002-01-3200.
9. Kandil, S., Lear, W.E., and Sherif, S.A., "Performance of Jet-Pumped Cryogenic Refrigeration System," 40th AIAA Aerospace Sciences Meeting and Exhibit, Reno, Nevada, January 14-17, 2002, AIAA Paper 2002-1031.



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NASA Funding

FY02, and FY03 grants

Task Title

Cryogenic Two-Phase Flow and Heat Transfer in Reduced Gravity

Students

1. Francois, M., PhD, Graduation Date: 8/03
2. Jackson, J., MS, Graduation Date: 12/03
3. Uzgoren, E., PhD – Expected Graduation Date: 5/06
4. Utturkar, Y., PhD, – Expected Graduation Date: 5/06

Publications

1. Francois, M. and Shyy, W., "Computations of Drop Dynamics with the Immersed Boundary Method; Part 1- Numerical Algorithm and Buoyancy Induced Effect," *Numerical Heat Transfer, Part B, Vol. 44*, (2003), pp. 101-118.
2. Francois, M. and Shyy, W., "Computations of Drop Dynamics with the Immersed Boundary Method; Part 2 - Drop Impact and Heat Transfer," *Numerical Heat Transfer, Part B, Vol. 44*, (2003) pp. 119-143.
3. Francois, M., Uzgoren, E., Jackson, J. and Shyy, W., "Multigrid Computations with the Immersed Boundary Technique for Multiphase Flows," *International Journal of Numerical Methods for Heat and Fluid Flow*, 14(1) (2003), 98-115.
4. Shyy, W., "Multiphase Computations Using Sharp and Continuous Interface Techniques," Keynote Paper, *3rd International Conference on Computational Heat and Mass Transfer*, 2003.
5. Utturkar, Y., Thakur, S. and Shyy, W., "Accurate Time-Dependent Computations and Reduced-Order Modeling for Multiphase Flows," submitted to ASME Heat Transfer Summer Conference, 2004.



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NASA Funding

FY04, and FY05 grants

Task Title

Co-PI for: Rational Design of Higher Conductivity Solid Oxide Electrolytes



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NASA Funding

FY02 and FY03 grants

Task Title

Ortho-Para Hydrogen Ratiometry
New Propellants and Cryofuels

Students

1. Dr. J. A. Hamida – Post Doctoral Fellow
2. Dr. D. Zhou, – Post Doctoral Fellow

Publications

1. Marcin Matusiak, J. Hamida, G. G. Ihas, N. S. Sullivan, NMR measurements in hydrogen/helium slush at 4.2 K, *Bull. Am. Phys. Soc.* 48, 928 (2003).
2. M. Matusiak, J. A. Hamida, G. G. Ihas, N. S. Sullivan, Measurements of the nuclear spin relaxation times for small grains of solid hydrogen suspended in liquid helium, Presented at Quantum fluids and Solids International Symposium, 2003.
3. M. Matusiak, J. A. Hamida, G. G. Ihas and N. S. Sullivan, *Journal of Low Temperature Physics*, 134, 775 (2004).
4. J. A. Hamida and N. S. Sullivan, Transport properties of bulk hydrogen and hydrogen-helium slush at 4 MHz using NMR measurements, *Bull. Am. Phys. Soc.* 49, 550 (2004).
5. J. A. Hamida and N. S. Sullivan, Nuclear spin relaxation times in hydrogen-helium and methane-helium slush at 4 MHz using pulse NMR, *Bull. Am. Phys. Soc.* 50, 1009 (2005).
6. J. A. Hamida and N. S. Sullivan, Nuclear spin relaxation times for methane-helium "slush" at 4 MHz using pulsed NMR, Abstract submitted to LT 24 Conference 2005.
7. D. Zhou, G.G. Ihas and N.S. Sullivan, Determination of Ortho-Para Ratio in Gaseous Hydrogen Mixtures, *Journal of Low Temperature Physics*, **134**, 401 (2004).
8. D. Zhou, G. G. Ihas, and N. S. Sullivan, *Bull. Am Phys. Soc.*, **48**, 1277 (2003).



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NASA Funding

FY02, FY03, FY04, and FY05 grants

Task Title

Rational Design of Higher Conductivity Solid Oxide Electrolytes
Hydrogen Production Using Advanced Protonic Conductor

Students

1. Jianlin Li, PhD
2. Dilpuneet S. Aidhy, Ph. D.
3. Doh Won Jung, Ph. D.
4. Sun-Ju Song, PhD – Graduation Date:05/03
5. Ruchita Bagul, MS – Graduation Date:05/04
6. Jamie M. Rhodes, PhD – Graduation Date:05/05
7. Guojing Zhang, PhD – Graduation Date:09/05
8. Tak-keun Oh, PhD – Graduation Date:05/07
9. Jianlin Li, PhD – Graduation Date:05/08

Post Doctoral Associate

Dr. Heesung Yoon

Funding Received by Leveraging NASA Grant

High temperature electrochemistry center: \$1.3M

FL State Center of Excellence – FISE Energy Technology Incubator: \$4.5M

Publications

Task : Rational Design of Higher Conductivity Solid Oxide Electrolytes

Journal Publications

3. "Doubly doped Bi₂O₃ electrolytes with higher conductivity," D. Jung, K. L. Duncan and E. D. Wachsman, *Solid State Ionic Devices IV, ECS Transactions*, E. Wachsman, V. Birss, F. Garzon, R. Mukundan, and E. Traversa, Ed., Vol.1 [7] pp. 63 (2006).
4. "Development of Higher Ionic Conductivity Ceria Based Electrolyte," S. Omar, E. D. Wachsman, and J. C. Nino, *Solid State Ionic Devices IV, ECS Transactions*, E.D. Wachsman, F.H. Garzon, E. Traversa, R. Mukundan, and V. Birss, Ed., Vol.1 [7] pp. 73-82 (2004).

5. "A Co-Doping Approach towards Enhanced Ionic Conductivity in Fluorite-Based Electrolytes," S. Omar, E. D. Wachsman, and J. C. Nino, *Solid State Ionics*, 177 [35-36] pp. 3199-3202 (2006).

Conference Papers

1. Study of the Structure of Cubic Bismuth Oxide using Molecular Dynamics Simulation (Poster) – International Center for Materials Research Conference on Oxide Materials, Bangalore India, December 2007.
2. Oxygen Diffusion Mechanism in Cubic Bismuth Oxide using Molecular Dynamics Simulations - The 31st International Cocoa Beach Conference & Exposition on Advanced Ceramics and Composites, Daytona Beach, Florida, January 2007
3. Atomic Level Processes in Solid Oxide Fuel Electrolytes – Third Annual Meeting of the Florida Society for Materials Simulation, University of South Florida, 7th July 2007.
4. "Effect of dopant concentration of doubly doped Bi₂O₃ electrolyte on ionic conductivity and anion ordering", D. Jung, M. A. Camaratta, K. L. Duncan, and E. D. Wachsman, 31st International Conference & Exhibition on Advanced Ceramic & Composites, Daytona Beach, Florida, USA, January 21-26, 2007.
5. Characterization of Oxygen Vacancy Clusters in Bi₂O₃ using Molecular Dynamics Simulations- The American Ceramics Society: The 30th International Conference and Exposition on Advanced Ceramics and Composites, Cocoa Beach, Florida. January 22-27, 2006.
6. "Optimization of doubly doped Bi₂O₃ electrolyte composition", D. Jung, K. L. Duncan, and E. D. Wachsman, 30th International Conference & Exhibition on Advanced Ceramic & Composites, Cocoa Beach, Florida, USA, January 24, 2006.
7. "Microstructural Effects on the Grain Ionic Conductivity of Gd_{0.10}Ce_{0.90}O_{2-δ}", S. Omar, H. El-Shall, E. D. Wachsman, and J. C. Nino, 31st International Conference & Exhibition on Advanced Ceramic & Composites, Daytona Beach, Florida, USA, January 21-26, 2007.
8. "Effect of Microstructure on the Grain Ionic Conductivity of Ceria based Electrolytes", S. Omar, H. El-Shall E. D. Wachsman, and J. C. Nino, 2006 MRS Fall Meeting, Boston, Massachusetts, USA, November 27-December 1, 2006.
9. Oxygen Vacancy Behavior in Cubic Bismuth Oxide (Poster) - Florida Chapter of American Vacuum Society (FLAVS), March 12-16, 2006.
10. "A Co-Doping Approach towards Enhanced Ionic Conductivity in Fluorite-Based Electrolytes", S. Omar, E. D. Wachsman, and J. C. Nino, European Materials Research Society Spring Meeting, Nice, FRANCE, June 1st, 2006.
11. "Effect of Co-Doping on the Electrical Properties of Ceria Electrolyte", S. Omar, E. D. Wachsman, and J. C. Nino, 30th International Conference & Exhibition on Advanced Ceramic & Composites, Cocoa Beach, Florida, USA, January 24, 2006.
12. "A study on doubly doped Bi₂O₃ electrolytes with higher conductivity", D. Jung, K. L. Duncan, and E. D. Wachsman, 208th Electrochemical Society Meeting, Los Angeles, California, USA, October 19, 2005.
13. "Development of Higher Ionic Conductivity Ceria Based Electrolyte," S. Omar, E. D. Wachsman, and J. C. Nino, 208th Electrochemical Society Meeting, Los Angeles, California, USA, October 19, 2005.

Task: Hydrogen Production Using Advanced Protonic Conductor

Journal Publications

1. "Determination of Optimal Eu dopant Concentration in SrCe_{1-x}Eu_xO_{3-δ} for Hydrogen Permeation" T. Oh, H. Yoon and E. Wachsman, to be submitted.
2. "Transport Phenomena of SrCe_{1-x}Eu_xO_{3-δ} under Hydrogen atmosphere". T. Oh, H. Yoon and E. Wachsman, to be submitted.

3. "Stability of $\text{SrCe}_{0.9}\text{Eu}_{0.1}\text{O}_{3-\square}$ and $\text{SrZr}_{0.2}\text{Ce}_{0.7}\text{Eu}_{0.1}\text{O}_{3-\square}$ under dry/wet H_2 and CO atmosphere," T. Oh, J. Li, H. Yoon and E. Wachsman, to be submitted.
4. "Tubular-type Proton Conducting Membrane Process and Permeability of $\text{SrCe}_{1-x}\text{Eu}_x\text{O}_{3-\square}$," T. Oh, H. Yoon and E. Wachsman, to be submitted.
5. "Stability improvement of SrCeO_3 using zirconium dopant under $\text{CO}/\text{H}_2\text{O}$ atmosphere," J. Li, H. Yoon, T. Oh and E. Wachsman, to be submitted to *J. Am. Ceram. Soc.*
6. "Non-galvanic Hydrogen Production Using High Steam Pressure Gradients," Sun-Ju Song and Eric D. Wachsman, *Chemistry Letters* Vol.35, No.9 (2006)
7. "Hydrogen Permeability and Microstructure Effect on Mixed Protonic-Electronic Conducting Eu-doped Strontium Cerate", S.-J. Song, E.D. Wachsman, J.M. Rhodes, H.-S. Yoon, G. Zhang, K.-H. Lee, S.E. Dorris and U. Balachandran, *Journal of Materials Science*, **40**, 4061-4066 (2005).
8. "Hydrogen Production from Fossil Fuels with High Temperature Ion Conducting Ceramics", E. D. Wachsman and M.C. Williams, *Interface*, 13-3, 32-37 (2004).
9. "Hydrogen Permeability of $\text{SrCe}_{0.95}\text{Eu}_{0.05}\text{O}_{3-\square}$ ($x = 0.05$, $M = \text{Eu}, \text{Sm}$)", S. J. Song, E. D. Wachsman, J. Rhodes, S. E. Dorris and U. Balachandran, *Solid State Ionics*, **167**, 99-105 (2004).
10. "Numerical Modeling of Hydrogen Permeation in Chemical Potential Gradients", S. J. Song, E. D. Wachsman, J. Rhodes, S. E. Dorris and U. Balachandran, *Solid State Ionics*, **164**, 107-116 (2003).
11. "Defect Structure and n-Type Electrical Properties of $\text{SrCe}_{0.95}\text{Eu}_{0.05}\text{O}_{3-\square}$ ", S. J. Song, E. D. Wachsman, S. E. Dorris and U. Balachandran, *Journal of the Electrochemical Society*, **150**, A1484 (2003).
12. "Electrical Properties of p-Type Electronic Defects in the Protonic Conductor $\text{SrCe}_{0.95}\text{Eu}_{0.05}\text{O}_{3-\square}$ ", S. J. Song, E. D. Wachsman, S. E. Dorris and U. Balachandran, *Journal of the Electrochemical Society*, **150**, A790 (2003).
13. "Defect Structure and n-Type Electrical Properties of $\text{SrCe}_{0.95}\text{Eu}_{0.05}\text{O}_{3-\square}$ ", S. Song, E.D. Wachsman, S.E. Dorris and U. Balachandran, *Solid State Ionic Devices III*, Electrochem. Soc., E.D. Wachsman, K.S. Lyons, M. Carolyn, F. Garzon, M. Liu and J. Stetter, Ed., **2002-26**, 456-470 (2003).

Conference Papers

1. "Eu Dopant Contents Optimization for Maximum Hydrogen Production on $\text{SrCeO}_{3-\square}$," T. Oh, H. Yoon and E. Wachsman, presented in the Symposium "Hydrogen Production, Transport, and Storage 2," of the 211th Meeting of the Electrochemical Society which held in Chicago, Illinois from May 6 - May 10, 2007.
2. "Phase Stability and Hydrogen Permeation Properties of SrCeO_3 for Methane Steam Reforming," H. Yoon, T. Oh, J. Li, E.D. Wachsman, *31st International Cocoa Beach Conference Exposition on Advanced Ceramics & Composites in Daytona Beach, Florida (2007)*.
3. "Determination of Optimal Eu dopant Concentration in $\text{SrCe}_{1-x}\text{Eu}_x\text{O}_{3-\square}$ for Hydrogen Permeation," T. Oh, H. Yoon, E. D. Wachsman, *31st International Cocoa Beach Conference Exposition on Advanced Ceramics & Composites in Daytona Beach, Florida (2007)*.
4. "Hydrogen Transport Water Gas Shift Membrane Reactor," J. Li, H. Yoon, T. Oh, E. D. Wachsman, *31st International Cocoa Beach Conference Exposition on Advanced Ceramics & Composites in Daytona Beach, Florida (2007)*.
5. "Electrochemical Studies of Mixed Protonic Electronic Conduction in Eu-doped SrCeO_3 ," T. Oh, H. Yoon, E. Wachsman, *209th ECS meeting in Denver, Colorado (2006)*.
6. "Hydrogen Permeation through Dense $\text{SrCe}_{0.9}\text{Eu}_{0.1}\text{O}_{3-\square}$ Membrane on Ni- SrCeO_3 Tubular Supports," E. Wachsman, H. Yoon, *209th ECS meeting in Denver, Colorado (2006)*.
7. "Fabrication of Thin Film Eu-doped SrCeO_3 Hydrogen Membrane on Ni- SrCeO_3 support," H. Yoon, T. Oh, E. Wachsman, *209th ECS meeting in Denver, Colorado (2006)*.

8. "Fabrication and Hydrogen permeation properties of Dense Eu-doped SrCeO₃ Membrane on Ni-SrCeO₃ Support," H. Yoon, T. Oh, and E. Wachsman, *208th ECS meeting in Los Angeles*, (2005)
9. "The Stability and Permeation properties of SrCe_{0.9}Eu_{0.1}O₃," T. Oh, H. Yoon, and E. Wachsman, *208th ECS meeting in Los Angeles*, (2005)
10. "Fabrication of Dense Eu-doped SrCeO₃ Membrane on Ni-SrCeO₃ Tubular-type Support", H.-S. Yoon, E.D. Wachsman and J.M. Rhodes, 29th International Cocoa Beach Conference and Exposition on Advanced Ceramics and Composites, Cocoa Beach, January 2005.
11. "Preparation of Thin Film Inorganic Hydrogen Separation Membranes on Ni-GDC Tubular-type Supporters Using Tape Casting Process", H.-S. Yoon, S.-J. Song, E.D. Wachsman and J.-H. Lee, 28th International Cocoa Beach Conference and Exposition on Advanced Ceramics and Composites, Cocoa Beach, January 2004.
12. "Hydrogen Permeability of Mixed Protonic-Electronic Conducting Multivalent Cation Doped Strontium Cerate", S.-J. Song, E.D. Wachsman, J. Rhodes, H.-S. Yoon and G. Zhang, 204th Meeting of The Electrochemical Society, Orlando, October 2003.
13. "Preparation of Dense Barium Cerate Film on Planar Porous Substrate for Hydrogen Separation Membranes", R. Bagul, H.-S. Yoon, S.-J. Song and E.D. Wachsman, 204th Meeting of The Electrochemical Society, Orlando, October 2003.

Invited Presentations

1. "Hydrogen Permeation Through Mixed Protonic-Electronic Conducting Perovskites," Gordon Research Conference on Solid State Studies in Ceramics, August 10-15, 2003, New London, NH.
2. "Hydrogen Separation with Protonic Conductors," Gordon Research Conference on Chemistry of Hydrocarbon Resources, January 12-17, 2003, Ventura, CA.



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NASA Funding

FY04, and FY05 grants

Task Title

Ultrahigh Vacuum Investigations of Bimetallic Catalysts and the Development of Nanoparticle Catalysts for High-Pressure Applications

Students

1. Samuel Jones, PhD – Expected Graduation Date: 5/09



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NASA Funding

FY04, and FY05 grants

Task Title

Ultrahigh Vacuum Investigations of Bimetallic Catalysts and the Development of Nanoparticle Catalysts for High-Pressure Applications

Students

2. Sunil Devarajan, PhD – Graduation Date: 5/07
3. Luke M. Neal, Ph.D. (partially supported), Expected Graduation Date: 5/09

Publications

1. Steam Reforming of Methanol using Cu-ZnO Catalysts Supported on Nanoparticle Alumina, Samuel D. Jones, Luke M. Neal and Helena E. Hagelin-Weaver, *Submitted for Publication*.
2. Steam Reforming of Methanol over CeO₂- and ZrO₂-Promoted Cu-ZnO Catalysts Supported on Nanoparticle Al₂O₃, Samuel D. Jones and Helena E. Hagelin-Weaver, *Submitted for Publication*.

Conference Papers

1. Role of Copper Spinels in methanol reforming using Cu-ZnO catalysts on Nano-particle Alumina, presented by Samuel D. Jones at the AIChE (American Institute of Chemical Engineers) Annual Meeting in San Francisco, CA on November 15th, 2006.
2. Steam Reforming of CH₃OH over ZrO₂-Promoted Cu-ZnO/Nano-Al₂O₃ Catalysts, presented by Helena Hagelin-Weaver at the Florida AVS (American Vacuum Society) meeting, in Orlando, FL on March 11, 2008.



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NASA Funding

FY04, and FY05 grants

Task Title

Bimetallic Catalysts for the Electro oxidation of Hydrocarbon Fuels

Students

1. Christina McCall, Undergraduate
2. Casie Hilliard, Undergraduate
3. Marie Correia, Graduate Student
4. Daniel Serra, PhD – Graduation Date: 1/07
5. Corey Anthony, PhD – Expected Graduation Date: 5/06
6. Jianye Zhang, MS – Graduation Date: 05/07
7. Ying Yang, PhD, Graduation Date: 12/04

Publications

1. "Electrochemical Oxidation of Methanol Using Alcohol-Soluble Ru/Pt and Ru/Pd Catalysts," Serra, D.; McElwee-White, L. *Inorg. Chim. Acta*, **2008**, 361, 3237-3246.
2. "Catalysis of the Electrooxidation of Biomass-Derived Alcohol Fuels," Anthony, C.R.; Serra, D.; McElwee-White, L. in *Materials, Chemicals and Energy from Forest Biomass*. Argyropoulos, D.S., Ed. ACS Symposium Series, **2007**, 954, 296-310.
3. "Electronic Interactions in Fe- and Ru-Containing Heterobimetallic Complexes: Structural and Spectroscopic Investigations," Serra, D.; Abboud, K.A.; Hilliard, C.R.; McElwee-White, L., *Organometallics*, **2007**, 26, 3085-3093.
4. "Electrocatalytic Oxidation of Methanol," Anthony, C.R.; McElwee-White, L., in *Feedstocks for the Future: Renewables for the Production of Chemicals and Materials*. Bozell, J., Ed. ACS Symposium Series No. 921, **2006**, pp. 130-142.
5. "Electrochemical oxidation of methanol using dpmm-bridged Ru/Pd, Ru/Pt, and Ru/Au catalysts," Yang, Y.; McElwee-White, L. *Dalton Trans.*, **2004**, 2352-2356.
6. "Selective electrochemical oxidation of methanol to dimethoxymethane using Ru/Sn catalysts," Anthony, C.R.; McElwee-White, L. *J. Mol. Catal. - A: Chem.*, **2004**, 227, 113-117.

Presentations (invited)

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| 1. University of Mississippi | April 17, 2008 |
| 2. Jackson State University | June 20, 2008 |
| 3. Georgia Southern University (Eminent Scientist Lecture) | Nov.19, 2007 |

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| 4. | University of California, Berkeley | February 10, 2004 |
| 5. | University of Illinois, Chicago | September 21, 2004 |
| 6. | Western Kentucky University | November 19, 2004 |
| 7. | Wayne State University (Frontiers in Chemistry Lecture) | April 18, 2005 |
| 8. | Université Pierre et Marie Curie (Paris 6) | September 6, 2005 |
| 9. | Eastman Chemical Company | May 18, 2006 |
| 10. | University of Illinois | April 2, 2007 |
| 11. | Washington and Lee University | April 27, 2007 |
| 12. | "Electrooxidation of Alcohols Using Heterobimetallic Catalysts," Symposium on Feedstocks for the Future: Renewables for the Production of Chemicals and Materials, 227th National Meeting of the American Chemical Society, March 2004, Anaheim, California. Abstract CELL 80. | |
| 13. | "Bimetallic catalysts for electrooxidation of methanol," NASA-UF Workshop for Advanced Fuel Cell Research, May 2004, Gainesville, Florida | |
| 14. | "Heterobimetallic complexes as electrocatalysts for the oxidation of methanol," McElwee-White, L.; Serra, D.; Yang, Y.; Anthony, C.R. Symposium on Materials, Chemicals and Energy from Forest Biomass, 2005 International Congress of Pacific Basin Societies, December 2005, Honolulu, Hawaii. | |
| 15. | "Electrooxidation of ethanol and methanol using heterobimetallic catalysts," Symposium on Feedstocks for the Future, 234th National Meeting of the American Chemical Society, August 2007, Boston, Massachusetts. | |

Invited Conference Presentations

(invited poster, presented by Casie Hilliard) "Synthesis and characterization of ruthenium-containing heterobimetallic complexes: catalytic application in the electrochemical oxidation of ethanol," Symposium on Celebrating Ten Years of Beckman Scholars in Chemistry, 235th National Meeting of the American Chemical Society, April 2008, New Orleans, Louisiana. Abstract PRES 6.

Presentations (contributed)

1. "Heterobimetallic Catalysts for the Electrooxidation of Methanol and Ethanol," Correia, M.; McElwee-White, L. Florida Inorganic Mini-Symposium, September 2007, Gainesville, Florida.
 2. "Electrochemical oxidation of alcohols using heterobimetallic catalysts," Sweeney, C.; McElwee-White, L.; Correia, M. 235th National Meeting of the American Chemical Society, April 2007, New Orleans, Louisiana. Abstract CHED 1164.
 3. "Selective Electrochemical Oxidation of Methanol to Dimethoxymethane Using Ru/Sn Catalysts," Anthony, C.R.; McElwee-White, L. 2004 Florida Annual Meeting and Exposition, May 2004, Orlando, Florida.
 4. "Selective Electrochemical Oxidation of Methanol to Dimethoxymethane Using Ru/Sn Catalysts," Anthony, C.R.; McElwee-White, L. 228th National Meeting of the American Chemical Society, August 2004, Philadelphia, Pennsylvania. Abstract INOR 672
 5. "Selective electrochemical oxidation of methanol to dimethoxymethane using Ru/Sn catalysts," Anthony, C.R.; McElwee-White, L., Florida Inorganic Mini-Symposium, October 2004, Tampa, Florida
- "Synthesis and Characterization of Heterobimetallic Catalysts for Electrochemical Oxidation of Methanol: Comparative Reactivity Between Ru and Fe Complexes," Serra, D.; McElwee-White, L. Florida Inorganic Mini-Symposium, September 2005, Gainesville, Florida

6. "Electrocatalytic oxidation of methanol by Ru and Fe heterobimetallic complexes," Serra, D.; McElwee-White, L. 231st National Meeting of the American Chemical Society, March 2006, Atlanta, Georgia. Abstract INOR 650.
7. "Electrocatalytic Oxidation Of Methanol By Ru And Fe Heterobimetallic Complexes," Serra, D.; McElwee-White, L. 2006 Florida Annual Meeting and Exposition, May 2006, Orlando, Florida.
8. "Electrochemical oxidation of methanol by heterobimetallic Ru and Fe analogue complexes," Serra, D.; McElwee-White, L. 230th National Meeting of the American Chemical Society, September 2006, San Francisco, California. Abstract INOR 679.
9. "Electrochemical oxidation of methanol by heterobimetallic Ru and Re analogue complexes," Serra, D.; McElwee-White, L. Florida Inorganic Mini-Symposium, October 2006, Gainesville, Florida.