Chih-Hung (Alex) Chang

PROFESSOR
Sharp Labs of America Scholar
School of Chemical, Biological and Environmental Engineering
Oregon State University
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EDUCATION

Ph.D. Chemical Engineering, University of Florida, 1999
Thesis Advisor: Timothy J. Anderson
B.S. Chemical Engineering, National Taiwan University, 1991

ACADEMIC POSITIONS

Professor, School of Chemical, Biological and Environmental Engineering, Oregon State University, 2010 - present
Director, Oregon Process Innovation Center for Sustainable Solar Cell Manufacturing, 2010-present
Associate Professor, Department of Chemical Engineering, Oregon State University, 2006 - 2010
Visiting Associate Professor, Department of Materials Science and Engineering, National Taiwan University, Apr 2008 – Sep 2008
Assistant Professor, Department of Chemical Engineering, Oregon State University, 2000 - present
Research Assistant, Department of Chemical Engineering, University of Florida, 1994-1999

NON-ACADEMIC POSITIONS

Founder and Chief Science Officer, CSD Nano Inc., 2009-present
Founder & Chief Technology Advisor, Nanobits Inc., 2005-2009
Research Engineer, Nan-ya plastics Co., 1993-1994
Lieutenant, Republic of China Army, 1991-1993

RESEARCH INTERESTS

Thin Film Growth
Thin Film Electronics
Microreaction Technology
Nanomaterials
Solar Energy Conversion

AWARDS

1. TechConnect National Innovation Award 2015
2. 2011 SME “Innovations That Could Change the Way You Manufacture” Watch List for Microreactor-Assisted Nanomaterial Deposition.
3. Sharp Laboratories of America Scholar 2008-Present.
4. Best Poster Award, Symposium T, MRS 2007 Spring Meeting, San Francisco
5. Lab-to-Market Technology Disclosure Competition 2005.
6. W.M. Keck foundation awardees 2004
7. National Science Foundation CAREER award, 2004
8. Best Poster Award, ASEE ChE Faculty Summer School, 2002
9. Intel Faculty Fellow, Intel Co. (2000 and 2001)
10. Graduate Research Awards, American Vacuum Society, 1999
11. Scholarship for XVIIIth IUCr Congress and General Assembly, 1999
12. Scholarship for 1999 High Resolution Electron Microscopy Winter School, 1999
13. Scholarship for 7th ACA Summer School in Crystallography, 1998
14. College of Engineering Academic Excellence Awards, University of Florida, (1996, 97, 99)
15. International Student Academic Awards, University of Florida, (1995, 96, 97)
16. National Taiwan University Academic Awards, Taiwan ROC, 1989

SCHOLARSHIP AND CREATIVE ACTIVITY

Summary of Scholarship and Research

Scholarship Summary		**Research Summary**	
Refereed Publications (108 in print)	108	Postdoctoral Scholars trained (2 current)	4
		Graduate Research	
Non-Referred Publications (7 invited contributions)	31	Graduate students trained	
		Ph.D. degrees (11 awarded 6 current)	17
Technical Presentations (65 invited presentations)	185	M.S. degrees (13 awarded 3 current)	16
		Honor BS (3 awarded and 1 current)	4
Book & Book Chapters	2	*Grants*	
		External Competitive Grant:	46
Inventions and Patents	*32*	Industrial Grant:	17
		OSU Internal Competitive:	7
(10 issued patents, 2 pending patents, 22 invention disclosures)		Total awards:	$ 14.7 million

H-Index (Google Scholar)

	All	**Since 2010**
Citations	**2441**	**1976**
h-index	**28**	**23**
i10-index	**57**	**53**

PUBLICATIONS

Journal and Refereed Publications

1. Xinyuan Chong, Ki-Joong Kim, Paul R. Ohodnicki, Erwen Li, Chih-Hung Chang, Alan X. Wang, Ultra-Short Near-Infrared Fiber-Optic Sensors for Carbon Dioxide Detection" IEEE Sensors, accepted 2015.
2. Chang-Ho Choi, Elizabeth Allan-Cole, and Chih-hung Chang, Room Temperature Fabrication and Patterning of Highly Conductive Silver Features using In-Situ Reactive Inks by Microreactor-Assisted Printing, *Journal of Materials Chemistry C*. Journal of Materials Chemistry C, DOI: 10.1039/C5TC00947B (2015).

3. Chih-hung Chang, Wei Wang, Xiulei (David) Ji, Paul J. Benning, Preface to the Focus Issue on Printable Functional Materials for Electronics and Energy Applications, *ECS Journal of Solid State Science and Technology* 4(4) Y5-Y5 (2015).
4. Paravee Vas-Umnuay, Ki-Joong Kim, Dae-Hwan Kim, Chih-Hung Chang, Conformal growth of copper sulfide thin films on highly textured surface via microreactor-assisted solution deposition, DOI: 10.1039/C4CE02374A) *CrystEngComm* 17, 2827-2836 (2015).
5. Barath Palanisamy, Brian Paul, Chih-hung Chang Barath Palanisamy, The synthesis of cadmium sulfide nanoplatelets using a novel continuous flow sonochemical reactor *Ultrasonics Sonochemistry* in press (2015).
6. Seung-Yeol Han, Changqing Pan, Dae-Hwan Kim, Chih-hung Chang, Low-cost & low-temperature curable solution-processed silica-based nanostructured antireflective coatings on $CuIn_{1-x}Ga_xSe_2$ thin film solar cells, *RSC Advances* 5, 24712-24717 (2015).
7. Choi, Chang-Ho; Lin, Liang-Yu; Cheng, Chun-Cheng; Chih-hung Chang, Printed Oxide Thin Film Transistors: A Mini Review, *ECS Journal of Solid State Science and Technology* 4(4), Special Issue: SI, P3044-P3051 (2015).
8. Ki-Joong Kim, Xinyuan Chong, Peter B. Kreider, Guoheng Ma, Paul R. Ohodnicki, John P. Baltrus, Alan X. Wang, Chih-Hung Chang, Plasmonics-Enhanced Metal–organic Framework Nanoporous Films for Highly Sensitive Near-Infrared Absorption, *J. Mater. Chem. C.* (2015) DOI: 10.1039/c4tc02846e.
9. Zhenyu Xing, Bao Wang, Wenyang Gao, Changqing Pan, Joshua K Halsted, Elliot S Chong, Jun Lu, Xingfeng Wang, Wei Luo, Chih-Hung Chang, Youhai Wen, Shengqian Ma, Khalil Amine, Xiulei Ji, Reducing CO_2 to dense nanoporous graphene by Mg/Zn for high power electrochemical capacitors, *Nano Energy* 11, 600-610 (2015).
10. Chang-Ho Choi, Seung-Yeol Han, Yu-Wei Su, Zhen Fang, Liang-Yu Lin; Chun-Cheng Cheng, Chih-hung Chang, Fabrication of high-performance, low-temperature solution processed amorphous indium oxide thin-film transistors using a volatile nitrate precursor, *Journal of Materials Chemistry C* 3(4), 854-860, DOI: 10.1039/c4tc01568a (2015).
11. Ki-Joong Kim, Chih-hung Chang, Ho-Geun Ahn, The Effect of Zinc Oxide Addition to Alumina-Supported Gold Catalyst in Low Temperature Carbon Monooxide Oxidation, *J. Nanosci. Nanotechnol.* **15**(1), 660-664, (2015).
12. Kim, Ki-Joong; Oleksak, Richard; Hostetler, Eric; Peterson, Daniel; Chandran, Padmavathi; Schut, David; Paul, Brian; Herman, Gregory; Chang, Chih-Hung, A Continuous Microwave-Assisted Gas-Liquid Segmented Flow Reactor for Controlled Nucleation and Growth of Nanocrystals, *Crystal Growth & Design*, Volume: 14 Issue: 11 Pages: 5349-5355 (2014).
13. Chang-Ho Choi, Chih-hung Chang, Aqueous Synthesis of Tailored ZnO Nanocrystals, Nanocrystal Assemblies, and Nanostructured Films by Physical Means Enabled by a Continuous Flow Microreactor, *Cryst. Growth Des.* **14** (9), 4759–4767 (2014)

14. Chang-Ho Choi, Brian K. Paul, Chih-hung Chang, Microreactor-Assisted Solution Deposition for Compound Semiconductor Thin Films, Invited Review, *Processes* 2014, 2, 1-x manuscripts; doi:10.3390/pro20x000x Special Issue.
15. Yeon Hwang, Doh-Hyung Rui, Ki-Joong Kim, Chih-hung Chang, Porous SiOC beads by freeze-drying polycarbosilane emulsions, *Materials Letters* (2014), dx.doi.org/10.1016/j.matlet.2014.05.194
16. Eric B. Hostetler, Ki-Joong Kim, Richard P. Oleksak, Robert C. Fitmorris, Chih-Hung Chang, Daniel A. Peterson, Padmavathi Chandran, Brian K. Paul, David M. Schut, and Gregory S. Hermana, Synthesis of PbSe Nanoparticles Using a Microwave-Assisted Segmented Flow Reactor, *Materials Letters* 128, 54-59 (2014)
17. Ki-Joong-Kim, Richard P. Oleksak, Changqing Pan, Michael W. Knapp, Peter B. Kreider, Gregory S. Herman, and Chih-hung Chang, "Continuous Synthesis of Colloidal Chalcopyrite Copper Indium Diselenide Nanocrystal Inks," *RSC Advances* **4**, 16418-16424, (2014).
18. Peter B. Kreider, Ki-Joong Kim, and Chih-hung Chang, "Two-step Continuous-Flow Synthesis of $CuInSe_2$ Nanoparticles in a Solar Microreactor," *RSC Advances* **4**, 13827-13830, 2014.
19. Katherine Han and Chih-hung Chang, "Numerical Modeling of Sub-Wavelength Antireflective Structures for Solar Module Applications," *Nanomaterials* 2014, 4, 87-128; doi:10.3390/nano4010087.
20. Katherine Han, Hai-Yue Han, James Stack Jr., and Chih-hung Chang, "Finite difference time domain modeling of subwavelength-structured anti-reflective coatings," *Applied Computational Electromagnetics Society Journal*, Volume: 29 Issue: 1 Pages: 1-8 Published: JAN (2014).
21. Chih-Hung Chang and Brian K. Paul, Microreactor-Assisted Nanomaterial Processing: Scaling by an Equal up and Equal down Approach, *Chemical Engineering & Process Techniques* 1(3):1015, 2013.
22. Ki-Joong Kim,Yong Jun Li, Peter B. Kreider, Chih-Hung Chang, Nick Wannenmacher, Praveen K. Thallapally, and Ho-Geun Ahn, "High-Rate Synthesis of Cu-BTC Metal-Organic Frameworks," *Chem. Commun*. 2013, 4, 11518.
23. Sudhir Ramprasad, Yu-Wei Su, Chih-hung Chang, Brian K. Paul, and Daniel R. Palo, "Continuous Microreactor-Assisted Solution Deposition for Scalable production of CdS films," *ECS Journal of Solid State Science and Technology*, 2(9), P333-P337 DOI: 10.1149/2.003309jss, 2013.
24. Ki-Joong Kim, Peter B. Kreider, Changho Choi, and Chih-Hung Chang, Ho-Geun Ahn, "Visible-light-sensitive Na-doped p-type flower-like ZnO photocatalysts synthesized via a continuous flow microreactor," *RSC Advances*, 3(31), 12702-12710 DOI: 10.1039/c3ra41866a, 2013..

25. Paravee Vas-Umnuay and Chih-hung Chang, "Growth Kinetics of Copper Sulfide Thin Films by Chemical Bath Deposition," *ECS Journal of Solid State Science and Technology*, 2(4), P1-P10, 2013.
26. Ki-Joong Kim, Peter B. Kreider, Chih-hung Chang, Chul-Min Park, Ho-Geun Ahn, "Visible-light-sensitive nanoscale Au-ZnO photocatalyst," *J. Nanopart Res* 15:1606, 2013.
27. Y.W. Su, S. Ramprasad, S.Y. Han, W. Wang, S.O. Ryu, D.R. Palo, B.K. Paul, C.-H. Chang, "Dense CdS Thin Films on Fluorine-doped Tin Oxide Coated Glass by High-rate Microreactor-Assisted Solution Deposition," *Thin Solid Films* 532, 16-21, 2013.
28. Changho Choi, Yu-Wei Su and Chih-hung Chang, "Effects of fluid flow on the growth and assembly of ZnO nanocrystals in a continuous flow microreactor," *CrystEngComm*, 15(17), 3326-3333, DOI:10.1039/C3CE26699K, 2013.
29. S. Murali, J.S. Rajachidambaram, S.-Y. Han, C.-H. Chang, G.S. Herman, J.F. Conley, "Resistive Switching in Zinc-Tin-Oxide," *Solid-State Electronics*, 79, 248-252, 2013.
30. C. Tseng, B.K. Paul, C. Chang and M.H. Engelhard, "Continuous Precipitation of Ceria Nanoparticles from a Continuous Flow Micromixer," *Int J Adv Manuf Technol*, 64 (1-4), 579-586, DOI: 10.1007/s00170-012-4428-1, 2013.
31. B. K. Paul, C.L. Hires, Y.-W. Su, C.-H. Chang, S. Ramprasad and D. Palo, A Uniform Residence Time Flow Cell for the Microreactor-Assisted Solution Deposition of CdS, 12, 5320-5328, *Crystal Growth & Design*, 2012.
32. S.-Y. Han, B.K. Paul, C.-H. Chang, "Nanostructured ZnO as Biomimetic Anti-reflective Coatings on textured Silicon Using a Continuous Solution Process," *Journal of Materials Chemistry*, 22(43), 22906-22912, DOI: 10.1039/c2jm33462c. 2012
33. H.D. Jin, C.-H. Chang, "Synthesis of $CuInSe_2$ nanocrystals using a continuous hot-injection microreactor," *J. Nanopart. Res*., 14, 1180, 2012.
34. B. Flynn, W. Wang, C.-H. Chang, and G.S. Herman, "Microwave assisted synthesis of Cu_2ZnSnS_4 colloidal nanoparticle inks", *Phys. Status Solidi A*, 209, No.11, 2186-2194, 2012.
35. S. Ramprasad, Y.W. Su, C.-H. Chang, B.K. Paul, D.R. Palo, "Cadmium sulfide thin film deposition: A parametric study using microreactor-assisted chemical solution deposition," *Solar Energy Materials and Solar Cells* 96(1), 77-85, 2012.
36. W. Wang, S.Y. Han, S.J. Sung, D.H. Kim, C.-H.Chang, "8.01% $CuInGaSe_2$ solar cells fabricated by air-stable low-cost inks," *Physical Chemistry Chemical Physics*, 14(31), 11154-11159, 2012.
37. Milo D. Koretsky, Kenneth J. Williamson, Jeffrey A. Nason, Goran N. Jovanovic, Chih-hung Chang, Adam Z. Higgins, Craig M. Gates, Richard M. Roehner "Using Studios as a Strategy to Respond to Increasing Enrollment," *Proceedings of the 2012 American Society for Engineering Education Annual Conference & Exposition*, 2012.

38. MS, Rajachidambaram, T. Varga, L. Kovarik, R. Sanghavi, V. Shutthanandan, S. Thevuthasan, S.Y.Han, C.-H.Chang, G.S., Herman, "Formation of zinc oxide films using submicron zinc particle dispersions," *Journal of Vacuum Science & Technology*, 30(4), 041805, 2012.
39. Jin Young Lee, Mi Sun, Park, Tae Jin Lee, Sang-Ouk Ryu, Chih-hung Chang, Si-Ok, Ryu, Synthesis of CdTe Thin Films for Solar Cell using Solution-based Deposition Methods at Low Temperature, *Molecular Crystals and Liquid Crystals*, 551, Special Issue: SI, 181-190, 2011.
40. Seung-Yeol Han, Chih-hung Chang, Effects of Ozone Annealing on Solution-Processed Indium Zinc Oxide (IZO) Thin Film Transistors, *Electrochemical and Solid State Letters*, 14(11), H442-H445, 2011.
41. Hyung Dae Jin, Chih-hung Chang, Continuous Synthesis of SnTe Nanorods, *Journal of Materials Chemistry Communication*, 21, 12218-12220, 2011.
42. Debra K. Gale, Clayton Jeffryes, Timothy Gutu, Jun Jiao, Chih-hung Chang, Gregory L. Rorrer, "Thermal annealing activates amplified photoluminescence of germanium metabolically doped in diatom biosilica," *Journal of Materials Chemistry*, 21, 10658-10665. 2011. (Journal Cover).
43. Wei Wang, Yu-Wei Su, Chih-hung Chang, Inkjet Printed Chalcopyrite $CuIn_xGa_{1-x}Se_2$ Thin Film Solar Cells, Solar Energy Materials and Solar Cells 95 2616, 2011.
44. Seung-Yeol Han, Gregory S. Herman and Chih-hung Chang, "Low-Temperature, High-Performance, Solution-Processed Indium Oxide Thin Film Transistors," *Journal of American Chemical Society* 133, 5166, 2011.
45. Barath Palanisamy, A. Garrison, Y.W. Su, B.K. Paul, C.-H. Chang, Cadmium Sulfide Nanoparticle Synthesis Using Oscillatory Flow Mixing, Proceedings of the 6th International Manufacturing Science & Engineering Conference Paper no. MSEC2011-50276 pp. 591-598 *ASME 2011 International Manufacturing Science and Engineering Conference* June 13–17, 2011, Corvallis, Oregon, USA.
46. Changho Choi, Chih-hung Chang, Shankar Krishnan, Terry J. Hendricks and Ward TeGrotenhuis, Capillary Rise and Evaporative Heat Transfer in Nano-Structured Multi-mode Wicks, *Proceedings of the ASME International Mechanical Engineering Congress & Exposition IMECE 2011*, Nov 11-17, 2011, Denver, Colorado, USA.
47. Wei Wang, Chih-hung Chang, Air-stable solution-deposited chalcopyrite CuIn1-xGaxSe2 thin film solar cells, *Proc. 37th IEEE Photovoltaic Specialists Conference*, Seattle, WA, USA, 2011.
48. Santosh Murali, Jaana Saranya Rajachidambaram, Seung-Yeol Han, Chih-Hung Chang, Gregory S Herman, John F Conley, Bipolar resistive switching of zinc-tin-oxide resistive random access memory, *Nanotechnology (IEEE-NANO), 2011 11th IEEE Conference on Nanotechnology*, page. 740-743, IEEE, 2011.

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50. Hyung Dae Jin, Anna Garrison, Chih Heng T. Tseng, Brian K. Paul, and Chih-hung Chang, "High-rate Synthesis of Phosphine-stabilized Undecagold Nanoclusters using a Multilayered Micromixer," *Nanotechnology* 21, 445604, 2010.
51. S-Y. Han, D.-H. Lee, S.-O. Ryu, and C.-H. Chang, "ZnS Thin Films Deposited by a Spin Successive Ionic Layer Adsorption and Reaction (Spin SILAR) Process," *Electrochemical and Solid-State Letters* 13 (8) D61-D64, 2010.
52. M.S. Park, S-Y. Han, E.J. Bae, T.J. Lee, C.H. Chang, S.O. Ryu, "Synthesis and characterization of polycrystalline $CuInS_2$ thin films for solar cell devices at low temperature processing conditions," *Current Applied Physics*, 10(3), S379-S382, 2010.
53. Chae Rin Kim, Seung Yeol Han, Chih Hung Chang, Tae Jin Lee, Si Ok Ryu, "*A Study on Copper Selenide Thin Films for Photovoltaics by a Continuous Flow Microreactor*," *Molecular Crystals and Liquid Crystals*, 532, 455-463. 2010.
54. Chae Rin Kim, Seung Yeol Han, Chih Hung Chang, Tae Jin Lee, Si Ok Ryu, "Synthesis and Characterization of $CuInSe_2$ Thin Films for Photovoltaic Cells by a Solution-based Deposition Method," *Current Applied Physics*, 10(3), S383-S386, 2010.
55. Terry J. Hendricks, Shankar Krishnan, Changho Choi, Chih-hung Chang, Brian K. Paul, "Enhancement of Pool Boiling Heat Transfer using Nanostructured Surfaces on Aluminum and Copper," *International J. Heat and Mass Transfer* 53(15-16), 3357-3365, (2010).
56. Seung-Yeol Han, Doo-Hyoung Lee, Gregory S. Herman and Chih-hung Chang, "Inkjet Printed High Mobility Transparent Oxide Semiconductors" Invited Submission, *Journal of Display Technology*, Special Issue Transparent Electronics, 5(12), 520-524 2009.
57. DooHyoung Lee, Seung-Yeol Han, Gregory S. Herman, Chih-hung Chang, "Inkjet printed high-mobility indium zinc tin oxide thin film transistors," *J. Mater. Chem.* Communication 19, 3135-3137, 2009.
58. Timothy Gutu, Debra K. Gale, Clayton Jeffryes, Wei Wang, Chih-hung Chang, Gergory Rorrer, Jun Jiao, "Electron Microscopy and Optical Characterization of Cadmium Sulfide Nanocrystals Deposited on the Patterned Surface of Diatom Biosillaca," *Journal of Nanomaterials*, Article ID 860536, doi:10.1155/2009/860536, 2009.
59. Wei Wang, Clayton Jeffryes, Debra Gale, Gregory L. Rorrer, Timothy Gutu, Jun Jiao, and Chih-hung Chang , "Selective Self-Assembly of Biogenic Silica assisted by Layer-by-Layer Deposition and Inkjet Printing," *Journal of the American Chemical Society Rapid Communication* 131 (12), 4178-4179, 2009.
60. Yu-Jen Chang, Yu-Wei Su, Doo-Hyoung Lee, Si-Ok Ryu, and Chih-hung Chang, "Investigate the Reacting Flux of Chemical Bath Deposition by a Continuous Flow Microreactor," *Electrochem. Solid-State Lett*. 12 (7), H244-H247, 2009.

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62. Terry J. Hendricks, Shankar Krishnan, Changho Choi, Chih-hung Chang, Brian K. Paul, "Enhancement of Pool Boiling Heat Transfer using Nanostructured Surfaces on Aluminum and Copper," *Proceedings of the ASME International Mechanical Engineering Congress & Exposition IMECE 2009*, Nov 13-19, 2009, Lake Buena Vista, Florida, USA.

63. Doo-Hyoung Lee, Wei Wang, Timothy Gutu, Clayton Jeffryes, Gregory L. Rorrer, Jun Jiao and Chih-hung Chang, "Biogenic silica based Zn_2SiO_4:Mn^{2+} and Y_2SiO_5:Eu^{3+} phosphor layers patterned by inkjet printing process," *J. Mater. Chem*. 18(31), 3633-3635, 2008.

64. Tian Qin, Timothy Gutu, Jun Jiao, Chih-hung Chang, and Gregory L. Rorrer Biological Fabrication of Photoluminescent Nanocomb Structures by Metabolic Incorporation of Germanium into the Biosilica of the Diatom Nitzschia frustulum, *ACS Nano* 2(6), 1296-1304 2008.

65. No-Kuk Park, You Jin Lee, Gi Bo Han, Si Ok Ryu, Tae Jin Lee, Chih Hung Chang, Gui Young Han, "Synthesis of Various Zinc Oxide Nanostructures with Zinc Acetate and Activated Carbon by a Matrix-Assisted Method," *Colloids and Surfaces A: Physicochemical and Engineering Aspects* 313-314, 66-71, 2008.

66. You Jin Lee, No-Kuk Park, Gi Bo Han, Si Ok Ryu, Tae Jin Lee, Chih Hung Chang, "The Preparation and Desulfurization of Nano-Size ZnO by a Matrix-Assisted Method for the Removal of Low Concentration of Sulfur Compounds," *Current Applied Physics* 8(6), 746-751, 2008.

67. Doo Hyoung Lee, Ji Young Jung, Eun Jin Bae, Chih Hung Chang, Tae Jin Lee, Si Ok Ryu, "Highly uniform ZnS thin-films through the continuous flow reaction process," *Journal of the Korean Physical Society*, 53(1), 102-105, 2008.

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71. Tian Qin, Timothy Gutu, Jun Jiao, Chih-hung Chang, and Gregory L. Rorrer, "Photoluminescence of Nanostructured Silica from Two-Stage Bioreactor Cultivation of the Diatom Nitzschia frustulum," *J. Nanoscience and Nanotechnology* 8, 1-7, 2008.

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73. D.-H. Lee, Y.-J. Chang, W. Stickle, C.-H. Chang, "Functional porous tin oxide thin films fabricated by inkjet printing" *Electrochem. Solid-State Lett*. 10(11), K51-K54, 2007.
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75. P.-H. Mugdur, Y.-J. Chang, S.-Y. Han, A.A. Morrone, S.-O. Ryu, T.J. Lee, C.-H. Chang, "A Comparison of Chemical Bath Deposition of CdS from a Batch Reactor and a Continuous Flow Microreactor," *J. Electrochem. Soc*. 154(9), D482-D488, 2007.
76. D.-H. Lee, T. Gutu, J. Jiao, C. Jeffryes, T. Qin, C.-H. Chang, G.L. Rorrer, "Nanofabrication of Green Luminescent Zn_2SiO_4:Mn using Biogenic Silica," *Electrochemical and Solid State Letters* 10, K13-K16, 2007.
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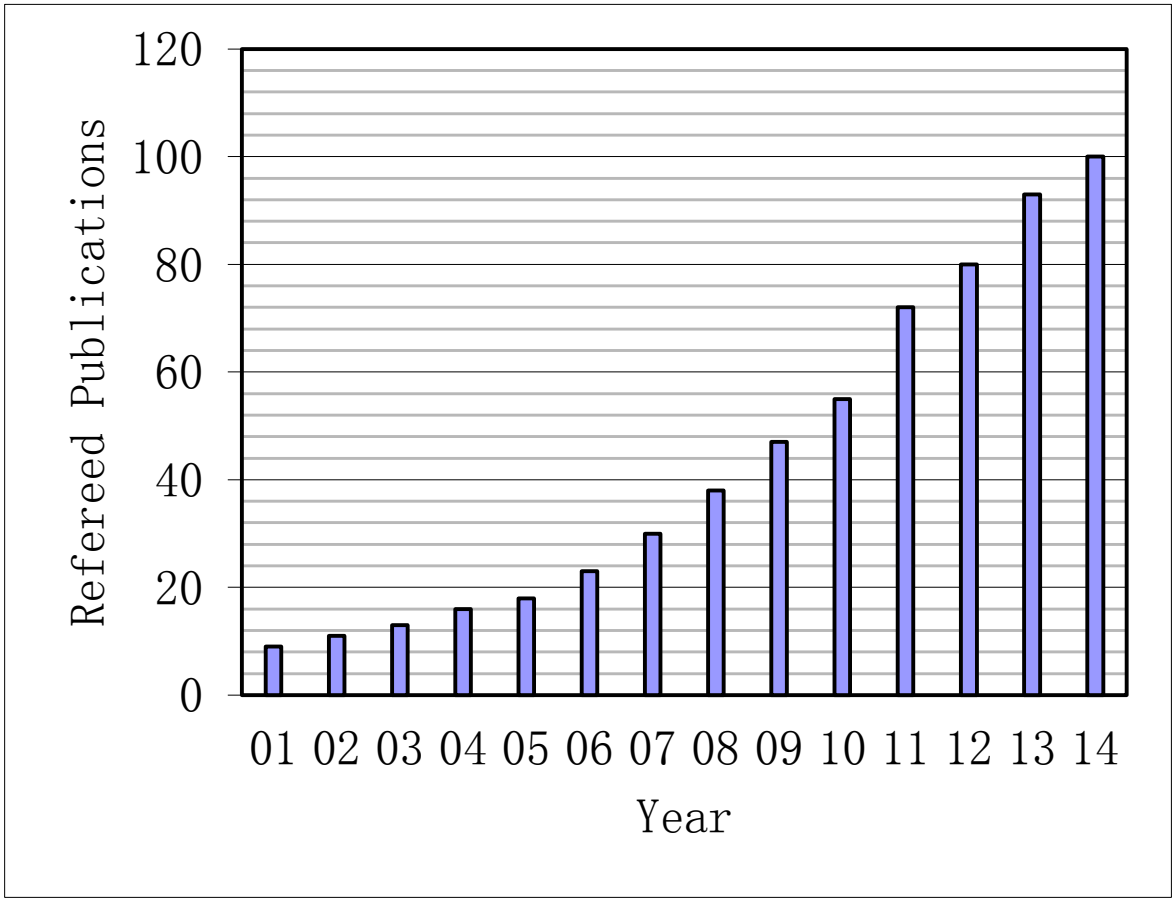

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2. Chih-hung Chang, Seung-Yeol Han, Hyungdae Jin, Yu-Wei Su, Wei-Liang Yen, Wei-Fang Su, Develop Scalable Nanomanufacturing for Hybrid Organic-Inorganic Thin Films for

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3. Seung-Yeol Han, Gregory S. Herman, and Chih-hung Chang, "Low-Temperature, High Performance, Solution-Processed Indium Oxide Thin Film Transistors," Proceedings of International Display Manufacturing Conference 2011, **Invited Paper**.
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Patent Applications

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2. U.S. Provisional Patent Application No. 62/113,967, Sensor Devices Comprising a Metal-Organic Framework Material and Method of Making and using the Same, Filed February 9, 2015 OSU Ref. No. OSU-14-60 Klarquist Ref. No. 245-94336-01, Alan X. Wang, Chih-hung Chang, Ki-Joong Kim, Xinyuan Chong, Paul Ohodnicki.
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Invention Disclosure

1. Invention Disclosure, Microreactor-Assisted Printing of Conductive Traces with in-situ Reactive Inks, Chih-hung Chang, Chang-Ho Choi, 2015. OSU 15-18.
2. Invention Disclosure, Sensor Devices Comprising a Metal-Organic Framework Material and Method of Making and using the Same, OSU-14-60, Alan X. Wang, Chih-hung Chang, Ki-Joong Kim, Xinyuan Chong, Paul Ohodnicki.
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8. Invention Disclosure: Method, Apparatus, and Compositions for Making Nanostrutured Antireflection Coating for Transparent and Absorbing surfaces by low cost solution-based process Inventors: Chih-hung Chang, Brian K. Paul, and Seung-Yeol Han.
9. Invention Disclosure: Graded Bandgap Nanostructured Solar Cell using size dependent quantum dots and nanowire arrays: Inventor Chih-hung Chang.
10. Invention Disclosure: OSU 08-51 Method and Apparatus for Continuous Production of I-III-VI (Cu,Ag)(In,Ga,Al)(Se, S, Te) Semiconcting Nanoparticles Inventors: Chih-hung Chang, Hyudae Jin, Yu-Wei Su.
11. Invention Disclosure: OSU 08-50 Solution Processes for Making I-III-VI-based Thin Film Solar Cells Inventors: Chih-hung Chang, Wei Wang.
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15. Invention Disclosure: Integrated micromixer and jetting device and method of manufacture: Richard Todd Miller, Chih-hung Chang, Brian K Paul.
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18. Invention Disclosure# OSU 05-31; Biological Fabrication of Nanostructured Metal Oxides Possessing Blue Photoluminescence. Greg Rorrer, C.-H. Chang.
19. Invention Disclosure# OSU 04-34; Chemical Bath Deposition. C.-H. Chang, P. Mugdur.
20. Invention Disclosure#OSU-03-36, Oregon State University, Microchemical ‘Fractories’ for High-Yield Synthesis of Converging Dendritic Nanoarchitectures. C.-H. Chang, B.K. Paul, V. Remcho.
21. Invention Disclosure# 200503540; Hewlett-Packard Co. Novel Chemistry Route for Porous Metal Oxides, C.-H. Chang, Y.-J. Chang, D.-H. Lee, D. Punsalan, G.S. Herman.
22. Invention Disclosure# 200407134, Hewlett-Packard Co. Direct dissolution and re-crystallization of metal halide semiconductors Gregory Herman, C.-H. Chang, D.-H. Lee, Y.-J. Chang, C.-H. Park, D. Keszler.

23. Invention Disclosure#200316010, Hewlett-Packard Co. Materials Growth Combining Inkjet Printing and Microwave Processing. G. Herman, P. Mardilovich, C. Betrabet, C.-H. Chang, Y.-J. Chang, D.-H. Lee.
24. Invention Disclosure#200316264, Hewlett-Packard Co. Conversion, Self-Patterning, and Formation of Continuous Film via Microwave Processing. G. Herman, P. Mardilovich, M.W. Hoskins, C.-H. Chang, Y.-J. Chang, D.-H. Lee.

PRESENTATIONS

Invited and Peer-Selected Presentations

a. Invited Presentations

1. Chih-hung Chang, Microreactor-Assisted Chemical Processes for Nanomaterials Synthesis, Assembly and Deposition, March 31 2015, Idaho National Laboratory, Idaho Falls, ID USA.
2. Chih-hung Chang, Scalable Nanomanufacturing for Photovoltaics using Microreactor-Assisted Nanomaterial Synthesis and Deposition Processes, EMN Meeting on Photovoltaics, Jan 13, Orlando FL, USA.
3. Chih-hung Chang, Microreactor-Assisted Nanomaterial Processing: Scaling by an Equal Up and Equal Down Approach, The 2nd SKY International Joint Symposium on Green Chemistry and Clean Technology, Daegu, Korea, Nov 13-15, 2014
4. Chih-hung Chang, Develop Novel Solution-Based Precursors and Processes for High-Performance Earth Abundant Thin Film Solar Cells, 2nd OSU DGIST Bilateral PV Symposium, Daegu, Korea Nov 6, 2014.
5. Chih-hung Chang, Microreactor-Assisted Nanomaterial Processing: Scaling by an Equal Up and Equal Down Approach, ASME Scalable Nanomanufacturing Workshop, Buffalo NY, August 17, 2014.
6. Chih-hung Chang, Microreactor-Assisted Nanomaterial Processing: Scaling by an Equal Up and Equal Down Approach, CMOS Emerging Technologies Research, MINATEC Grenoble, France, July 7, 2014.
7. Chih-hung Chang, Microchannel Assisted Nanomaterial Deposition Technology for Photovoltaic Material Production, Photovoltaic, WCCE9 & APCChE 2013, COEX, Seoul, Korea, Aug 20, 2013.
8. Chih-hung Chang, Fabrication of Compound Semiconductors using Microreactor-Assisted Solution Processes, DGIST, Daegu, Korea, Aug 19, 2013.
9. Chih-hung Chang, Solution Routes towards Amorphous Oxide Semiconductors, SID Taipei, National Chia-Tung University, Hsinchu Taiwan, Aug 2013.
10. Chih-hung Chang, Fabrication of Compound Semiconductors Using Microreactor-Assisted Solution Deposition, FF3.04, Session FF3: Nano-devices Symposium FF Compound

Semiconductors for Generating, Emitting, and Manipulating Energy –II April 2-5, 2013 MRS Spring Meeting, April 3, 2013 San Francisco, California.

11. Chih-hung Chang, Microreactor-Assisted Nanomaterials Deposition, TCO Seminar, DOW Electronics, Marlborough MA, October 26, 2012.
12. Chih-hung Chang, Biomimetic Nanostructured Coatings, Oregon BEST FEST September 12, 2012.
13. Chih-hung Chang, Develop Scalable Nanomanufacturing using Microreactor-Assisted Nanomaterial Deposition Processes, Solid State Seminar, Physics, Oregon State University, May 2012.
14. Chih-hung Chang, Develop Solution-based Process for thin films, Science Colloquium, Linfield College, May 3, 2012.
15. Chih-hung Chang, Microreactor-Assisted Nanomaterial Production and Deposition, 2011-2012 Winter/Spring Seminar Series, Department of Chemical & Biological Engineering, Drexel University, March 16, 2012.
16. Chih-hung Chang, Seung-Yeol Han, Hyungdae Jin, Yu-Wei Su, Wei-Liang Yen, Wei-Fang Su, Develop Scalable Nanomanufacturing for Hybrid Organic-Inorganic Thin Films for Photovoltaics using Microreactor-Assiated Nanomaterial Deposition, 0834, 09/22/2011 Taipei, IUMRS-ICA 2011
17. Chih-hung Chang, Development of Scalable Nanomanufacturing for Photovoltaics using Microreactor-Assisted Nanomaterial Deposition, Sustainable Nanomanufactring, ASME 2011 International Manufacturing Science and Engineering Conference, Oregon State University, Corvallis, June 13-17, 2011.
18. Chih-hung Chang, INNOVATION WATCH: Microreactor-Assisted Nanomaterials Deposition: A Scalable Route for NanomanufacturingInnovations that Could Change the Ways you Manufacture, 2011 SME Annual Conference Seattle, WA June 7, 2011.
19. Chih-hung Chang, "Microreactor-Assisted Nanomaterial Deposition for Scalable Nanomanufacturing," CMOS Emerging Technologies, Whisler, British Columbia, Canada, June 15-17, 2011.
20. Chih-hung Chang, Seung-Yeol Han, Gregory S. Herman "Low-Temperature, High Performance, Solution-Processed Indium Oxide Thin Film Transistors," International Display Manufacturing Conference 2011, Taipei Taiwan, April 19, 2011.
21. C.-H. Chang, Develop Scalable Nanomanufacturing for Photovoltaics using Microreactor-Assisted Nanomaterial Deposition Processes, 8th US Air Force Taiwan Nanoscience Workshop, April, 2011 Seattle WA USA.
22. C.-H. Chang, Microreactor-Assisted Nanomaterial Production and Deposition, January 21 2011, DOE NETL Albany.
23. C.-H. Chang, Develop Scalable Nanomanufacturing for Photovoltaics using Microreactor-Assisted Nanomaterial Deposition Processes Advancements in Nanotechnology Workshop, January 12-13, 2011 EPRI Charlotte.

24. C.-H. Chang, Deposition of Nanoscale Thin Films by Microreactor-Assisted Chemical Solution Deposition, High Performance Solution-Processed Materials for Electronic/Optoelectronic Device Applications, PacificChem 2010, December 2010, Honolulu, Hawaii.
25. C.-H. Chang, Synthesis and post-processing of nanomaterials using microreaction technology, The 10th Emerging Information & Technology Conference, James H. Clark Center, Stanford University, Stanford, California, U.S.A. August 14-15, 2010.
26. Changho Choi, Shankar Krishnan, SeungYeol Han, Terry J. Hendricks and Chih-hung Chang,Enhanced boiling heat transfer using solution-processed ZnO nanostructured surface on aluminum, 7th US Air Force Taiwan Nanoscience Workshop, Taiwan.
27. C.-H. Chang, "Develop Solution-based Processes of Inorganic Semiconductors for Electronics and Energy Applications," Department of Paper and Chemical Engineering Miami University of Ohio October 23 2009.
28. C.-H. Chang, "Chemical Solution Deposition: A Low Cost Process for Photovoltaics" Solar Materials Symposium, Micro Nano Breakthrough Conference September 21 2009.
29. C.-H. Chang, "Microreactor-Assisted Nano Deposition Process," The 9th Emerging Information & Technology Conference Massachusetts Institute of Technology, Boston, August 6 2009.
30. C.-H. Chang, "Oxide Thin-Film Transistors Fabricated by Inkjet Printed Channel Layers," The Sixteenth International Workshop on Active-Matrix Flat Panel Displays and Devices – TFT Technologies and FPD Materials July 1-3, 2009, Nara Centennial Hall, Nara Japan.
31. Brian K. Paul, C.-H. Chang, "Microreactor-Assisted Nanomaterial Synthesis and Deposition (MAND)," March 11 2009 EMSL conference room, PNNL
32. C.-H. Chang, "Develop Solution-based Processes for Flexible and Printing Electronics", Sharp Laboratories of America, June 2009 Camas WA
33. C.-H. Chang, "Develop Solution-based Processes for Flexible and Printing Electronics," Solid-State Seminar, Department of Physics, Oregon State University Spring 2009.
34. C.-H. Chang, "Develop Low Temperature Solution-based Process for Oxide-based TFTs" International Display Manufacturing Conference 2009, Taipei, Taiwan.
35. C.-H. Chang, "Microreactor Assisted Nano Deposition Process," 6th Taiwan/U.S. Air Force Nanoscience Workshop, San Francisco CA, April 2009.
36. C.-H. Chang "Develop Printable Solution Processes for Inorganic Semiconductors" Symposium F Low-Cost Solution-Based Deposition of Inorganic Films for Electronic/Photonic Devices, Boston, MRS Fall 2008.
37. C.-H. Chang "Develop Printable Solution Processes for Inorganic Semiconductors." Proceedings of 2008 Crystal Valley Conference, Nov 12 2008, Sun Moon University, Asan-City, Korea.

38. C.-H. Chang, “Develop Solution-based Processes for Flexible and Printing Electronics.” September 2008, Department of Electrical Engineering, Kun Shan University, Tainan Hsien, Taiwan.
39. C.-H. Chang, “Develop Solution-based Processes for Flexible Electronics” Department of Materials Science and Engineering, National Taiwan University, September 15 2008.
40. C.-H. Chang, “Develop Solution-based Processes for Flexible Electronics”, Department of Chemical Engineering, National Taiwan University of Science and Technology, August 2008.
41. C.-H. Chang, “Develop Solution-Based Processes for Flexible and Printed Electronics,” 2008 Flexible Electronics Seed Teacher Training Class, Aug 4-8, 2008.
42. C.-H. Chang, “Investigation of Chemical Bath Deposition by a Continuous Flow Microreactor,” The 8th Emerging Information and Technology Conference, Jun 26-27, 2008.
43. C.-H. Chang, D.-H. Lee, Y.-J. Chang, S.-Y. Han, G. S. Herman, “Develop Printable Solution Processes for Oxide Semiconductors”, 2008 Taiwan Display Conference Taipei Taiwan 2008.
44. C.-H. Chang, “Develop Solution-based Processes for Flexible and Printed Electronics” NWRC 2007, Portland, Oregon 2007.
45. C.-H. Chang, G.S. Herman, “Inkjet Printed Materials and Devices” Symposium N Printing Methods for Electronics, Photonics, and Biomaterials, MRS 2007 Spring Meeting, San Francisco, April 2007.
46. C.-H. Chang, “Synthesis and Deposition of Nanomaterials Using a Continuous Flow Microreactor,” 2007 Taiwan-US Soft Materials Symposium, Jan 2007.
47. C.-H. Chang, D-H. Lee, Y.-J. Chang, G.S. Herman, “A General and Low-Cost Route to Printable High-Mobility Inorganic Thin Film Transistors,” Digital Fabrication September 2006.
48. C.-H. Chang, “Fabrication of Luminescent Materials using Biogenic Nanostructured Semiconductor Metal Oxides from Marine Diatoms”, NSF/ANR/NASA, France- U.S. Woskshop on Nanobiotechnology, Washington DC, March 2, 2006.
49. C.-H. Chang, “Develop Solution-based Process for Flexible and Printing Electronics”, Yeungnam University, Korea, March 29, 2006.
50. C.-H. Chang, “Develop Solution-based Process for Flexible and Printing Electronic” Advanced Lecture series, Hewlett Packard, March 14, 2006.
51. C.-H. Chang, “Thin Film Electronic Materials via Soft Solution Processes” The 5th International Symposium on Clean Technology, Yeungnam University, Kyongsan, Korea, April 25, 2005.
52. C.-H. Chang, “Process Engineering of Low Temperature Chemical Bath Deposition Technique for Flexible Electronics” International Symposium on Display Materials and Devices, Yosu, Korea, April 22, 2005.

53. C.-H. Chang, "Production of Semiconductor Nanocrystals via Microreaction Technology" Department of Mechanical Engineering, Graduate Institute of Polymer Science and Engineering, National Taiwan University, Taipei Taiwan, April 6, 2004.
54. C.-H. Chang, "Chemical Bath Deposition: A Soft Solution Route to Flexible Electronics" & "Lab-based Unit Operations in Microelectronics processing" School of Chemical Engineering and Technology, Yeungnam University, Kyongsan, Korea, March 26, 2004.
55. C.-H. Chang, "Characterization and Application of Semiconductor Thin Films Deposited by Chemical Bath Deposition" Electronics and Telecommunications Research Institute, Daejeon, Korea, March 24, 2004.
56. C.-H. Chang, "Chemical Bath Deposition: A Soft Solution Route to Flexible Electronics" & "Lab-based Unit Operations in Microelectronics processing" Department of Chemical Engineering Kyungpook National University, Daegu, Korea, March 23, 2004.
57. C.-H. Chang, "Chemical Bath Deposition: A Soft Solution Route to Flexible Electronics" & "Lab-based Unit Operations in Microelectronics processing" Department of Chemical Engineering, University of Washington, Seattle Washington, March 1, 2004.
58. C.-H. Chang, "Long and Short Range Ordering of Copper Indium Selenide Semiconductors" Departmental Seminar, Department of Materials Science and Engineering, University of Washington, WA Seattle, December 2000.

as a co-author to Invited Presentations

1. "Progress Towards Integrated Microchemical Nanofactories: Devices for Efficient Production of Nanomaterials" S.-H. Liu, C.-H. Chang, T. Tseng, R.T. Miller, B.K. Paul, M. Koesdjojo, Y. Tennico, J.T. Rundel, V.T.Remcho, Micro Nano Breakthrough Conference 2007 Portland, Oregon
2. "Routes to Formation of CuInxGa1-xSe2 Thin Film Absorbers for Photovoltaics, Timothy Anderson, Woo Kyoung Kim, Suku Kim, Seokhyun Yoon, Chih-hung Chang, Jianyun Shen, E. Andrew Payzant," Symposium: Materials in Clean Power Systems 2: Fuel Cells, Solar, and Hydrogen-Based Technologies, 2007 TMS Annual Meeting & Exhibition.
3. "Reaction Pathways and Kinetics of CuInxGa1-xSe2 Thin Film Growth" T. J. Anderson, W. K. Kim, S. Kim, S. Yoon, C.H. Chang, J. Shen, and E. A. Payzant, Symposium O Thin Film Chalcogenide Photovoltaic Materials E-MRS 2006 meeting Strasbourg May 29, 2006 France.
4. "Cellular Biosynthesis of Nanostructured Semiconductor Materials" G.L. Rorrer, C.-H. Chang, C. Jeffryes, S.-H. Liu, T. Qin, J. Jiao, 229th National Meeting of the American Chemical Society (ACS), Division of Industrial & Engineering Chemistry (I&EC), Session on Nanotechnology and the Environment, March 2005, San Diego CA.
5. "Progress Towards Next Generation CIGS Solar Cells" C-H Chang, S. Serkan, S. Kim, B. Stanbery, Lei L Kerr, S.S. Li, O.D. Crisalle, T.J. Anderson, O.D. Crisalle, R.N. Noufi The 16th European Photovoltaic Solar Energy Conference, 2001.

6. "Using Computational Thermodynamics to design $CuInSe_2$ Thin Film Solar Cells" Tim Anderson, C.-H. Chang, Weidong Zhuang, Mushin Ider, Billy Stanbery, Jianyun Shen 2001 TMS- The Minerals, Metals & Materials Society Annual Meeting Annual Meeting, New Orleans, Louisiana.
7. "Phase Equilibria in the Cu-In-Ga-Se System and Its Implications for Synthesis of CIS absorber Films" Tim Anderson, C.-H. Chang, Billy Stanbery, L. Li, Weidong Zhuang, Mushin Ider, Materials Research Society Spring Meeting, April 2001, San Francisco, CA.

Peer-Selected Conference Oral Presentations

1. Changho Choi, Elizabeth Allan-Cole, Chih-Hung Chang, "Room Temperature Highly Conductive Silver Film via a Continuous Flow Microreactor Deposition", 2015 Materials Research Society Spring Meeting, April, San Francisco CA.
2. Chih-hung Chang, Ki-Joong Kim, Peter Kreider, Continuous Synthesis of Shape-Controlled Colloidal Chalcopyrite Copper Indium Diselenide Nanocrystal Inks, 372e, Nanocrystal Science and Technologies, AIChE Annual Meeting, San Francisco CA. Nov 5, 2013
3. Chih-hung Chang, Changho Choi, Controlled Aqueous Synthesis of ZnO Nanofilms Using Physical Means, 634b, Nanostructured Thin Films, Nanstructured Thin Films, AIChE Annual Meeting, San Francisco, Nov 7, 2013.
4. Ki-Joong Kim, Chih-hung Chang, A facile synthesis of $CuInSe_2$ nanocrystals using a continuous flow microwave-assisted reactor, Microwave & Flow Conference 2013, Silverado Resort & Spa, Napa Valley, California July 20-23, 2013.
5. Seung-Yeol Han, Wei Wang, Scott Weaver, Brian K Paul, Chih-hung Chang, "Solution-processed Nanoparticles Deposition of Nanostructured Surface Antireflective Coatings (ARCs) for PV Applications", 2012 Materials Research Society Spring Meeting, April, San Francisco CA.
6. Seung-Yeol Han, Chih-hung Chang, Gregory S. Herman, Printed Transparent Amorphous Oxide Semiconductors, High Performance Solution-Processed Materials for Electronic/Optoelectronic Device Applications, PacificChem 2010, December 2010, Honolulu, Hawaii.
7. Seung-Yeol Han, Gregory S. Herman, Chih-hung Chang, Low Temperature, High-Performance, Solution-Processed Indium Oxide Thin Film Transistors, 218th ECS Meeting Las Vegas, Nevada, October 10-15, 2010.
8. Terry J. Hendricks, Shankar Krishnan, Chih-hung Chang and Brian K. Paul, Enhancement of Pool Boiling Heat Transfer using Nanostructured Surfaces on Aluminum, Copper and Silicon, Sixth Annual Micro Nano Breakthrough Conference September 22 2009, Portland Oregon
9. Yu-Jen Chang, Yu-Wei Su, Seung-Yeol Han, Gregory S. Herman, Chih-hung Chang "Investigate the reacting flux of chemical bath depositon by a continuous flow microreactor," Symposium F Low-Cost Solution-Based Deposition of Inorganic Films for Electronic/Photonic Devices, Boston, MRS Fall 2008.

10. Timothy J. Anderson, Chih-hung Chang, Andrew Pazant, Evaluation of Pathways to the Synthesis of Cu(In,Ga)Se2 Solar Cell Absorbers, Thermodynamics and Transport Properties (01a) #356 - John O'Connell 70th Birthday Celebration II (01A02) November 18, 2008 AIChE annual meeting Philadelphia, PA.
11. Debra K. Gale, Timothy Gutu, Jun Jiao, Chih-hung Chang and Gregory L. Rorrer, Antibody Functionalization of Nanostructured Diatom Biosilica for Selective Detection of Biomolecules by Enhanced Photoluminescence, Bionanotechnology (22b) #494 - Nanotechnology and Nanobiotechnology for Sensors II November 19, 2008 AIChE Annual Meeting.
12. Lallie C. McKenzie, Hyungdae Jin, Daniela Hutanu, Chih-hung Chang, Vincent T. Remcho, James E. Hutchinson, Advances in nanoparticle synthesis: Enhanced process control, real-time analysis, and high-throughput production using microscale flow reactors, 235th ACS National Meeting, New Orleans, LA, April 6-10, 2008
13. S.–H. Liu, C.–H. Chang, T. Tseng, R.T. Miller, B.K. Paul, M. Koesdjojo, Y. Tennico, J.T. Rundel, V.T. Remcho, Progress Towards Integrated Microchemical Nanofactories: Devices for Efficient Production of Nanomaterials, 2008 Micro Nano Breakthrough Conference Vancouver, WA, September 8-10, 2008. .
14. C. Jeffryes, Haiyan Li, T. Gutu, J. Jiao, C.-H. Chang, M.E. Jones, G.L. Rorrer, "Biological Fabrication of Nanostructured TiO_2 Thin Films for Solar Cell Applications." 2008 Micro Nano Breakthrough Conference Vancouver, WA, September 8-10, 2008. .
15. C. Jeffryes, T. Gutu, J. Jiao, C.-H. Chang, G.L. Rorrer, "Two-Stage Bioreactor Culture of the Pennate Diatom Pinnularia sp. for the Fabrication of a TiO_2-based Solar Cell." 2008 Meeting of the Northwest Algal Symposium, Charleston, OR, April 5, 2008.
16. Clayton Jeffryes, Gregory Rorrer, Chih-hung Chang, Jun Jiao and Timothy Gutu, Datom Cell Culture for the Self-Assembly of Silicon-Titanium Oxides Ordered at the Submicron and Nanoscales, 2007 AICHE Annual Meeting.
17. T. Gutu, J Wu, C Jeffreys, C-H Chang, G Rorrer and J Jiao, Dual Beam Focused Ion Beam and Transmission Electron Microscopies of Nanoscale Sectioned Diatom Frustules, Microscopy and Microanalysis 2007 in Ft. Lauderdale, Florida, USA, August 5 – August 9, 2007.
18. G.L.Rorrer, C.-H. Chang, C. Jeffryes, T. Qin, J. Jiao, T. Gutu, Biological Fabrication of Metal Oxide Nanostructures Possessing Novel Optoelectronic Properties, Session (638) Supramolecular Assembly of Inorganic Materials I, 2006 AIChE Annual Meeting, San Francisco, CA, Nov 17, 2006.
19. C. Jeffryes, T. Gutu, C.-H. Chang, T. Qin, J. Jiao, G.L. Rorrer, Two-Stage Diatom Cell Culture for the Supramolecular Assembly of Silicon-Germanium Oxides Ordered at the Submicron and Nanoscales, Session (521) Supramolecular Assembly of Inorganic Materials I, 2006 AIChE Annual Meeting, San Francisco, CA, Nov 16, 2006.
20. C.-H. Chang, Y.-J. Chang, D.-H. Lee, S.O. Ryu, T. J. Lee, Investigation of CdS Thin Film Deposition Kinetics using a Continuous Flow Microreactor, Session (45) Reaction Kinetics

in Electronic Materials Processing, 2006 AIChE Annual Meeting, San Francisco, CA, Nov 13, 2006.

21. Y.-J. Chang, P. H. Mugdur, and C.-H. Chang, A Continuous Flow Microreactor for Chemical Bath Deposition, September 21 2006, 2006 Symposium of the Pacific Northwest Chapter of the AVS, Forest Grove, OR
22. D.-H. Lee, C. Jeffryes, T. Qin, G.L. Rorrer, C.-H. Chang, Fabrication of Luminescent Materials using Biogenic Nanostructured Oxides from Marine Diatoms, T4.9, Symposium T: Nanomanufacturing, Materials Research Society 2006 Spring Meeting, San Francisco CA, April 19, 2006.
23. S.-H. Liu, C.-H. Chang, B.K. Paul, V.T. Remcho, B. Abhinkar, Synthesis of Dendrimers using Continuous Floe Microreactors, session 62 Polymerization in Micro-Reactors, AIChE Spring National Meeting, Orlando FL, April 24 2006.
24. Y.-J. Chang, D.-H. Lee, C.-H. Chang Inkjet Printed Inorganic Channel Materials for Thin Film Transistors, M8.6, Materials Research Society 2005 Fall Meeting Symposium, Boston, November, 2005.
25. C.-H. Chang, S.-H. Liu, Y. Tennico, J.T. Rundel, V.T. Remcho, E. Blackwell, T. Tseng, B.K. Paul, Progress Towards Chip-Based High-Throughput Dendrimer Synthesis, IMRET 8th International Conference on Microreaction Technology Atlanta Georgia 2005.
26. S.-H. Liu, C. Jeffryes, G. L. Rorrer, C.-H. Chang, J. Jiao and T. Gutu, Blue Luminescent Biogenic Silicon-Germanium Oxide Nanocomposites, Presented at Materials Research Society 2005 Spring Meeting Symposium "Biological and Bio-Inspired Materials and Devices." San Francisco, March, 2005.
27. Y.-J. Chang, D.-H. Lee, P. H. Mudgar, S. O. Ryu, T-J. Lee, C.-H. Chang, Growth Kinetics of Thin Film Electronic Materials via Soft Solution Processes, presented at session 366 Reaction Kinetics in Electronic Materials Processing, 2004 American Institute of Chemical Engineers Annual Meeting, Austin TX, November, 2004.
28. C.-H. Chang, Y.-J. Chang, D.-H. Lee, S. O. Ryu, T-J. Lee, Characterization and Application of Semiconductor Thin Films Deposited by Chemical Bath, Microscopy and Microanalysis 2004, Savannah Georgia, August, 2004.
29. G. Ma, C.-H. Chang, S. Yoon, R. Noufi, and T.J. Anderson, X-ray Absorption Fine Structure Investigations of the Local Structure of Cadmium in $CuInSe_2$-based Materials, presented at Symposium: Advances in Characterization of Inorganic Materials for Energy and Environmental Applications, 2003 American Institute of Chemical Engineers annual meeting, San Francisco CA, November 2003.
30. C. Jeffreys, S.-H. Liu, G. Rorrer, C.-H. Chang, Biosynthesis of Silicon-Germanium Oxide Nanocomposites by Marine Diatoms, presented at Symposium: Biomimetics III, 2003 American Institute of Chemical Engineers annual meeting, San Francisco CA, November 2003.
31. M. Koretsky, C.-H. Chang, S. Kimura, S. Rochefort, Getting Students to Approach Microelectronics Processing as a Chemical Engineer, presented at Symposium: Teaching

Nanotechnology and Microelectronics, 2003 American Institute of Chemical Engineers Annual Meeting, San Francisco CA, November 2003.

32. Y.-J. Chang, D.-H. Lee, S.O. Ryu. T.-J. Lee, C.-H. Chang, An Impinging Flow Reactor for the Chemical Bath Deposition, presented at Symposium: Film Growth of Electronic Materials, 2003 American Institute of Chemical Engineers Annual Meeting, San Francisco CA, November 2003.
33. C. Jeffreys, S.-H. Liu, G. Rorrer, C.-H. Chang, Biosynthesis of Silicon-Germanium Oxide Nanocomposites by Marine Diatoms, presented at the 14th Pacific Northwest Chapter American Vacuum Society 2003 Annual Symposium, Troutdale OR, September 18 2003.
34. N.-K. Park, J.-D. Lee, S.-O. Ryu, T.-J. Lee, J.-C. Kim, C.-H. Chang, A Study on Deactivation of Zinc-Based Sorbents for Hot Gas Desulfurization, Prensented at the oral session 32.1 of the 20th Annual International Pittsburgh Coal Conference, September 2003, Pittsburgh PA.
35. C. Voss, Y-J. Chang, S. Subramanian, C.-H. Chang, Growth Kinetics of Thin Film Cadmium Sulfide by Ammonia-Thiourea based Chemical Bath Deposition, presented at the 203rd meeting of The Electrochemical Society, Symposium H. Chemical Solution Deposition of Semiconducting and Non-Metallic Films, Paris France, April 2003.
36. G. Ma, C.-H. Chang, S. Yoon, R. Noufi, and T.J. Anderson, XAFS Investigations of the Local Structure of Cadmium in $CuInSe_2$-based Materials, presented at Symposium B Compound Semiconductor Photovoltaics, Materials Research Society spring meeting, San Francisco CA, April 2003.
37. C.-H. Chang, C. Voss, M. Subramanian, Cadmium Sulfide Thin Film Transistors Fabricated by Low Temperature Chemical Bath Deposition, presented at 13th Pacific Northwest Chapter American Vacuum Society Annual Symposium, Vancouver WA, September 2002.
38. C. Voss, C.-H. Chang, M. Subramanian, Cadmium Sulfide Thin Film Transistors Fabricated by Low Temperature Chemical Bath Deposition, presented at Materials Research Society Spring Meeting, Symposium G, Materials for Flexible Electronic Displays and Devices, San Francisco, CA, 2002.
39. C.-H. Chang, Structure Investigations of In-rich Copper Indium Selenide Compound Semiconductor: from Local Structure to Long Range Order, presented at Material Research Society Spring, Symposium H, II-VI Compound Semiconductor Photovoltaic Material, San Francisco, CA, 2001.
40. C.-H. Chang, W. Zhuang, A. Davydov, T.J. Anderson, Thermodynamical Assessment of the Cu-Se, In-Se and Ga-Se systems" presented at CALPHAD (Computer Coupling of Phase Diagrams and Thermochemistry) XXIX, MIT, Boston, MA 2000.
41. C.-H. Chang, S.H. Wei, J.W. Johnson, B.J. Stanbery, T.J. Anderson, R.N. Bhattacharya, G. Bunker, R. Duran, Long and Short Range Ordering of $CuInSe_2$, presented at 12th International Conference on Ternary and Multinary Compounds, Hsin-chu Taiwan, March 2000.

42. C.-H. Chang, T. J. Anderson, E. Fodran, P. Ahrenkiel, A. Payzant, R. Duran, Crystal Structure Solution of Compound Semiconductor $Cu_3In_7Se_{12}$ from Combined Convergent Beam Electron Diffraction, X-ray Powder Diffraction, and X-ray Absorption Fine Structure Data, presented at XVIIIth International Union of Crystallography Congress and General Assembly, Glasgow UK August 1999.
43. P. Nagaranjan, M. Ider, C.-H. Chang, T.J. Anderson, Thermodynamic Stability of Selected Ternary Compounds in the Cu-In-Se system by solid electrolyte EMF techniques, presented at 128th TMS- the Minerals, Metals & Materials Society Annual Meeting, San Diego, CA 1999.
44. C.-H. Chang, B.J. Stanbery, A. Morrone, A. Davydov, T.J. Anderson, Novel Multilayer Process for $CuInSe_2$ Thin Films Formation by Rapid Thermal Processing, Presented at MRS-Material Research Society Fall meeting, Boston, MA 1997.
45. C.-H. Chang, C. Mallika, A, Davydov, T.J. Anderson, Phase Equilibria and Thermochemistry of the In-Se System, Presented at the 126th TMS- The Minerals, Metals & Materials Society Annual Meeting, Orlando, FL, 1996.

Peer-Selected Conference Poster Presentations

1. Seon Young Park, Jin Young Lee, Seung-Yeol Han, Chih-hung Chang, and Si-Ok Ryu, “Copper(I) Selenide Thin Films Deposited by a Solution-Based method for Photovoltaic Applications” IUMRS-ICA 2012.
2. Brendan Flynn, Richard Oleksak, Ian Braly, Philip Glover, Wei Wang, Chih-hung Chang, Gregory S Herman, “Continuous Flow Synthesis of Cu_2ZnSnS_4 Nanoparticle Inks for Thin Film Solar Cell Manufacturing”, 2012 Materials Research Society Spring Meeting, April, San Francisco CA.
3. Richard P Oleksak, Gregory S Herman, Brendan Flynn, Wei Wang, Chih-Hung Chang, “Microwave-enhanced Synthesis of Copper Indium Diselenide Nanoparticles in Non-absorbing Solvents”, 2012 Materials Research Society Spring Meeting, April, San Francisco CA.
4. Wei Wang, Seung-Yeol Han, Dae-Hwan Kim, Shi-Joon Sung, Chih-hung Chang, “8.01% $CuInGaSe_2$ Solar Cells Fabricated by Air-Stable Low-Cost Ink”, 2012 Materials Research Society Spring Meeting, April, San Francisco CA.
5. Paravee Vas-Umnuay, Chih-hung Chang, "Chemical Bath Deposition of Cu_xS Thin Films: In Situ Growth Study by Quartz Crystal Microbalance and the Chemical Mechanism through Study of the Film Microstructure" Poster Presentation, 22th Annual Symposium of the PNWAVS, Wilsonville OR, September 15-16, 2011.
6. Wei Wang, Seung-Yeol Han, Dae-Hwan Kim, Shi-Joon Sung, Chih-hung Chang, “Solution-deposited highly efficient Chalcopyrite Cu(InxGa1-x)Se2 Thin Film Solar Cells”, BEST FEST 2011.

7. Katherine Han, Wei Wang, Chih-Hung Chang, Jaana Saranya Rajachidambaram, Gregory S. Herman, James Hudson, and Greg Horner, "Characterization of Thin Film Solar Cell Processes Using Flash Quantum Efficiency", BEST FEST 2011.
8. Brendan Flynn, Richard Oleksak, Gregory S. Herman, Wei Wang, Changqing Pan, and Chih-Hung Chang, "Synthesis of Cu_2ZnSnS_4 Nanoparticle Inks for Thin Film Solar Cell", BEST FEST 2011.
9. Wang, Yu-Wei Su, Chih-hung Chang, Inkjet Printed Chalcopyrite Cu(inxGa1-x)Se2 Thin Film Solar Cells, Wei 21st Annual Symposium of the Pacific Northwest Chapter of the AVS, September 16-17, 2010, Environmental Molecular Sciences Laboratory Pacific Northwest National Laboratory Richland, WA.
10. Changho Choi, Shankar Krishnan, Chih-hung Chang, Characterization of Nano-Structured Coatings on Microwicks by Capillary Rise Method, 21st Annual Symposium of the Pacific Northwest Chapter of the AVS, September 16-17, 2010, Environmental Molecular Sciences Laboratory Pacific Northwest National Laboratory Richland, WA.
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15. Seung-Yeol Han, Yu-Wei Su, Clayton Hires, Sudhir Ramprasad, Dan Palo, Brina K. Paul, Chih-hung Chang, Microreactor-Assisted Chemical Solution Deposition Process, Symposium C, Solution Processing of Inorganic and Hybrid Materials for Electronics and Photonics, 2011 MRS Spring, April, San Francisco CA.
16. Wei Wang, Yu-Wei Su, Chih-hung Chang, Inkjet Printed Chalcopyrite $Cu(In_xGa_{1-x})Se_2$ Thin Film Solar Cells, BEST FEST 2010.
17. Seung-Yeol Han, Brain K. Paul, and Chih-hung Chang, Growth of Nanostructured ZnO on Textured Silicon from Aqueous Chemical Solution by Microreactor Assisted-Nanomaterial Deposition (MAND^{TM}), 218th ECS Meeting Las Vegas, Nevada, October 10-15, 2010.

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21. Debra M. Gilbuena, Chih-hung Chang, Wei Wang, Gregory S. Herman, Yu-Wei Su, Seung-Yeol Han, Wei-Liang Yen, Wei-Fang Su, Develop Printable Processes for Inorganic and Hybrid Photovoltaics, Symposium C, "Solution Processing of Inorganic and Hybrid Materials for Electronics and Photonics", 2010 Materials Research Society Spring Meeting, April, San Francisco CA.
22. Wei Wang, Yu-Wei Su, Chih-hung Chang, "Inkjet Printed Chalcopyrite Cu(InxGa1-x)Se2 Thin Film Solar Cells", BEST FEST 2010.
23. Wei Wang, Seung-Yeol Han, Debra Gilbuena, and Chih-hung Chang, "Develop Printable Solution Processes for Thin Film Photovoltaics," Symposium M, "Thin-Film Compound Semiconductor Phtovoltaics", 2009 Materials Research Society Spring Meeting, April, San Francisco, CA.
24. Wei Wang, Doo-Hyoung Lee, Clayton Jeffryes, Debra Gale, Gregory L. Rorrer, Timothy Gutu, Jun Jiao, and Chih-hung Chang, "Selective self-assembly of biogenic silica assisted by layer-by-layer deposition and inkjet printing," 2009 Symposium, Pacific Northwest Chapter of the AVS September 18-19, 2008.
25. Chae Rin Kim, Doo Hyoung Lee, Tae Jin Lee, Si OK Ryu, Chih Hung Chang, “Characterization of CuInSe2 Material based on the Solution Deposition,” 24th European Photovoltaic Solar Energy Conference and Exhibition, Hamburg, Germany September 22 2009.
26. Chae Rin Kim, Tae Jin Lee, Chih Hung Chang, and Si Ok Ryu, “A Study on p-type Copper Selenide (CuSe) Thin Films for Photovoltaic Applications by a CFR (Continuous Flow Reactor) Process,” The 13th International Symposium On Advanced Display Materials and Devices (ADMD 2009) Hiroshima, Japan July 23 2009.
27. Wei Wang, Seung-Yeol Han, Debra Gilbuena, and Chih-hung Chang, “Develop Printable Solution Processes for Thin Film Photovoltaics,” Symposium M Thin-Film Compound Semiconductor Phtovoltaics, 2009 Materials Research Society Spring Meeting, San Francisco, CA.
28. Seung-Yeol Han, Anna Putnam, Si-Ok Ryu, Tae-Jin Lee, Brina K. Paul, and Chih-hung Chang, “Low Reflectance Nanostructured Metal Oxide Thin Films Deposited by

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42. P.H. Mugdur, Y.J. Chang, S.Y. Han, S.O. Ryu, T.J. Lee, C.-H. Chang, "A Continuous Flow Microreactor for Chemical Bath Deposition," 9th International Conference on Microreaction Technology, IMRET 9 2006.
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49. Shuhong Liu, C.-H. Chang, B. K. Paul, V. K. Remcho, "High-rate Synthesis of PAMAM Dendrimers," 16th Annual Symposium of the Pacific Northwest Chapter of the AVS Science and Technology Society, Troutdale OR, September 15 2005.
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52. P.H. Mugdur, A.A. Morrone, S.-Y. Han, Y.-J. Chang, S.O. Ryu, T.J. Lee, C.-H. Chang, "Micro-& nano-characterizations of Nanocrystalline CdS Thin Films from a Continuous Impinging Flow Microreactor," Mcroscopy and Microanalysis, 2005.
53. S.-H. Liu, C. Jeffryes, G. L. Rorrer, C.-H. Chang, C. Wang, J. Jiao, J. A. Hedberg, "Characterizations of Biogenic Oxide Nanocomposites," Micro Nano Breakthrough Conference, Portland, OR, July 2004.
54. Y.-J. Chang, D.-H. Lee, C. Munsee, J.F. Wager, S. O. Ryu, T-J. Lee, C.-H. Chang, "Growth, Characterization, and Application of Semiconductor Thin Films Deposited by Chemical Bath Deposition," Surface Analysis 04, Richland WA, June 2004.
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56. Y.-J. Chang, C. Munsee, J. Anderson, J.F. Wager, D. A. Keszler and C.-H. Chang, "Flexible CdS MISFET Fabricated by Low Temperature Solution-based Deposition Technique," presented at Session I7.1: Flexible Materials and Device Technology II, 2004 Materials Research Society Spring meeting, San Francisco CA, April 2004.
57. L. L. Kerr, T. J. Anderson, R. N. Noufi, K. Ramanathan, S.S. Li, S. Yoon, X. Wong, K. Kim, S. Kim, R. Kaczynski, R. Acher, C-H, Chang, and O.D. Crisalle, "Rapid Thermal Processing of CIS Precursors," presented at Symposium: Materials Science and Engineering Division Poster Session, 2003 American Institute of Chemical Engineers annual meeting, San Francisco CA, November 2003.
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News Media & Press Releases

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12. “The Sun Performs Double Duty” Chemical Engineering Progress May 2014. P.15.
13. “Energy breakthrough uses sun to create solar energy materials,” OSU Press Release, 04/03/2014, David Stauth.
14. “Bright Idea”, OSU Press Release, September 14, 2011, David Stauth.
15. “OSU Solar Vehicle Team and the Oregon Process innovation Center (OPIC) Lab,” Green Science Oregon, Episode 11, broadcast February 5, 2011, Rick Coyle.
16. “Bright Idea”, Terra, Fall 2010 Issue.
17. “New OSU Solar Research Center to Open in May,” Portland Business Journal, Sustainable Business Oregon, March 15, 2010, Erik Siemers.
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19. “New Solar Reactor Facility to Open in Corvallis in Spring,” The Daily Barometer, January 20, 2010, Michelle Ofelt.
20. “Solar Research Center May Spur innovation, Industry Development in Oregon,” OSU Press Release, January 8, 2010, David Stauth.
21. “Inkjet Printing Could Change the Face of Solar Cell Industry”, OSU Press Release, June 28, 2011.
22. "Project uses inkjets to produce solar cells", Gazette-Times, July 15, 2011, Grady Garrett.
23. "Inkjet printing solar panels: cheap and almost green", PBS, July 12, 2011, Bianca Seidman.
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26. "OSU scientists find inkjet technology for solar cells", Sustainable Business Oregon, June 28, 2011, Christina Williams.
27. “OSU Solar Vehicle Team and the Oregon Process Innovation Center (OPIC) Lab”, Green Science Oregon, Episode 11, broadcast February 5, 2011, Rick Coyle.
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49. The Daily Barometer, February 18, 2004, Flexible electronics key to CAREER grant.
50. Corvallis Gazette-Times, April 14 2000, Intel names 2000 faculty fellows.

POSTDOCTORAL STUDENTS

Major Professor: Postdoctoral Scholar

Name & Degree		
Ki-Joong Kim	Ph.D.	2011-present
Chang-Ho Choi	Ph.D.	2013-present
Yu-Wei Su	Ph.D.	2011-2012
Seung-Yeol Han	Ph.D.	2010-2012

GRADUATE STUDENTS

Major Professor: Current Graduate Students

5 Ph.D./ 3 M.S.

Name & Degree		Thesis Topics	Date
Yujing Zhang	M.S	TBD	
Guoheng Ma	M.S.	TBD	
Fang Zhen	M.S.	TBD	
Zhongwei Gao	Ph.D.	TBD	
Yujuan He	Ph.D.	TBD	
Peter Kreider (co-advisor)	Ph.D.	TBD	
Dick Chiu	Ph.D.	Solution-Processed Thin Absorber Solar Cells	
Paul Ahrens	Ph.D.	Self-Assembled Peptides	On-leave
Changqing Pan	Ph.D.	Solution-Processed Chalcogenides for Thin Film Photovoltaics	

Major Professor: Former Graduate Students

11 Ph.D. / 13 M.S.

Katherine Han (*SunPower*)	Ph.D.	Nanostructures for Solar PV Applications: Simulation and Fabrication	2014
Paravee Vas-Umnuay *(Chulalongkorn University)*	Ph.D.	Growth, and Characterization and Applications of Copper Sulfide Thin Films by Solution-Based Processes	2013
Chang-Ho Choi *(OSU)*	Ph.D.	Synthesis of Colloidal Metal Oxide Nanocrystals and Nanostructured Surfaces Using a Continuous Flow Microreactor System and Their Applications in Two-phase Boiling Heat Transfer	2013

Wei Wang (*IBM TJ Watson*)	Ph.D.	Fabrication of $CuInGaSe_2$ Thin Film Solar Cells using Low-cost Air-Stable Inks	2012
Yong Jun Li (*Wafer Tech*)	M.S.	Continuous Synthesis of Metal-organic Frameworks Under High Pressure	2012
Michael Knapp (*OSU*)	M.S.	Continuous Flow Synthesis of Lead Sulfide and Copper Indium Diselenide Nanocrystals	2012
Yu-Wei Su (*National Chiao Tung University*)	Ph.D.	CdS Nanocrystalline Thin Films Deposited by the Continuous Microreactor-Assisted Solution Deposition (MASD) Process: Growth Mechanisms and Film Characterizations	2011
Wei-Liang Yen (*Amkor Technology*)	M.S.	Synthesis of Titanium Dioxide Nanorods using a Continuous flow Microreactor	2011
Seung-Yeol Han (*CSD Nano*)	PhD	Investigation of Solution-based Processes for Functional Metal Oxides: Printing, Nanostructures, and Applications	2010
Hyundae-Dae Jin (*Toray*)	PhD .	Continuous and Rapid Synthesis of Nanoclusters and Nanocrystals using Scalable Microstructured Reactors	2010
Changho Choi *(OSU)*	M.S.	Fabrication of nanostructured surfaces for enhanced heat transfer	2009
Mark Hoskins (*Hewlett Packards*)	M.S.	Ag films from liquid precursors in a closed cell Microwave	2009
Wei Wang (IBM TJ Watson)	M.S.	Selective Self-Assembly of Biogenic Silica Assisted by Layer-by-Layer Deposition and Inkjet Printing	2008
Shu-hong Liu (*Albany Molecule Research Inc*)	Ph.D.	Synthesis, Characterization and Deposition of Dendrimers using a Continuous Flow Microreactor	2007
Doo-Hyoung Lee (*Samsung*)	Ph.D.	Development of Solution-based Reaction Processes for Micro-and-Nano-Structured Semiconductors	2007
Yu-Jen Chang (*Stion*)	Ph.D.	Investigation of Low Temperature Solution-Based Deposition Process for Flexible Electronics	2007
Su-Yu W (*National Chiao Tung University*)	M.S.	Fabrication and Characterization of Ferrimagnetic Film for RF/Microwave Crosstalk Suppression	2007
Prakash Mugdur	M.S.	Continuous Flow Microreactor for Chemical Bath Deposition: A Novel Approach to the Deposition of	2005

(*Saint-Gobain*)		Polycrystalline Semiconductor Thin Films	
Jiqing Hu (*Microsoft*)	Ph.D.	Growth and Characterization of Zinc Ferrite Thin Films for High Frequency Applications	2005
Shu-hong Liu (*Albany Molecule Inc.*)	M.S.	Characterizations of Silicon-Germanium Nanocomposites Fabricated by the Marine Diatom *Nitzschia frustulum*	2005
Nathan Coussen (*Oregon State Univ.*)	B.S.	Lanthanum Sulfide Thin Film Deposition via Microreactor-Assisted Nanoparticle Deposition	2009
Joani Kroon (Hewlett Packard)	M.S.	Production of Monodispersed Semiconductor Nanoparticles via Microreactors	2004
Rina Permanasari (Wafer Tech)	M.S.	Electrochemical Deposition of Thin Film CuGaSe2 for Photovoltaics	2004
Giang N. Ma (Micron)	M.S.	XAFS Investigation of the Local Structure of Cadmium in CuInSe2-Based Materials	2004
Curtis L. Voss (Hewlett Packard)	M.S.	Fabrication of a Cadmium Sulfide Thin Film Transistor Using Chemical Bath Deposition	2002

Major Professor: Honor College Students

Harrison R. Holzgang	B.S.	Inkjet Printing of Nanoparticle-based Anti-Reflective Thin Films	2015
Anna Putnam (*Stanford University*)	B.S.	Inkjet Printed Lithium Iron Phosphate Thin Films	2009
Nathan Coussen (*Oregon State Univ.*)	B.S.	Lanthanum Sulfide Thin Film Deposition via Microreactor-Assisted Nanoparticle Deposition	2009
Yosuke Yamamoto (*JSR Micro*.)	B.S.	Fabrication and Cheracterization of Metal-Semiconductor Field Effect Transistors on Polymeric Substrates by Chemical Bath Deposition Technique	2003

VISITING SCHOLARS
Prof. Sun Yu, Department of Chemical Engineering, Tianjian University of Technology, Tianjian, China.
Prof. Si Ok Ryu, School of Chemical Engineering and Technology, Yeungnam University, Kyongsan, Korea.
Prof. Myung Yul Kim, Sunchon National University, Department of Polymer Science & Engineering, 315 Maegok, Sunchon, Jeonnam, 540-742, Korea
Prof. Seok-Kyun Noh, School of Chemical Engineering and Technology, Yeungnam University, Kyongsan, Korea.
Mr. Seung-Yeol Han, School of Chemical Engineering and Technology, Yeungnam University, Kyongsan, Korea.
Ms. Ji Young Jung, School of Chemical Engineering and Technology, Yeungnam University, Kyongsan, Korea.
Ms. Jin Young Lee, School of Chemical Engineering and Technology, Yeungnam University, Kyongsan, Korea.
Ms. Won Hae Choi School of Chemical Engineering and Technology, Yeungnam University, Kyongsan, Korea.
Ms. Eun Jin Bae, School of Chemical Engineering and Technology, Yeungnam University, Kyongsan, Korea.
Dr. Ki-Joong Kim, Department of Chemical Engineering, Sunchon National University, Sunchon, Jeonnam, Korea
Prof. Hyukhyun Ryu, School of Nano Eng., Inje University, Korea
Prof. Yeon Hwang, Department of Materials Science and Engineering, Seoul National University of Science & Technology, Korea
Prof. Xiaojing Xu, College of Veterinary, Inner Mongolia Agricultural University, China
Dr. Dae Hwan Kim, Daegu Kyeongbuk Institute of Science & Technology
Dr. Jin Kyu Kang, Daegu Kyeongbuk Institute of Science & Technology

UNDERGRADUATE RESEARCHERS

Mike Brooks (URISC)
Bradley Eagleson (2007-2010) (Johnson Summer Intern 2008)
Miri Goldade-Holbrook (2010) (Johnson Summer Intern)
Andrew Pfau (2011) (Johnson Summer Intern)
Kenneth Huang (2011) (Work Study)
Jameson Taylor (2012) (Johnson Summer Intern)
Karen Zhen (2013) (Johnson Summer Intern)
Janssen Levin (2013) (Johnson Summer Intern)

Elizabeth Alan-Cole (2014) (2nd year Johnson Summer Intern)
Gondhalekar, Vikram Baldini URISC (2014)
Cassi Remple (2014) (Johnson Summer Intern)
Allen Marshall (2014) (Johnson Summer Intern)

Grants and Contracts

The total award for all grants and contracts with C.-H. Chang as P.I. or Co-PIs is $14.7 milllion.

a. Competitive, External Grant Awards

1. OSU Venture Fund, $ $139,825, "Innovative Micro-and-Nanotechnology Enhanced Steam Generator/Boiler" PI: Chih-hung Chang, co-PI: Hailei Wang, 11/31/2014-12/01/2015.
2. NSF SNM, $1,500,000, "SNM: Physics-guided innovation of integrated flash-light-sintering, continuous nanomaterial synthesis and roll-to-roll deposition processes" PI: Chih-hung Chang, co-PIs: Rajiv Malhortra, Alan Wang, Greg Herman, 01/01/15-12/31/19.
3. AU Optronics, $80,000 “Develop solution-based P-type Semiconductor Channel Materials” PI: Chih-hung Chang, 05/01/14-05/01/15.
4. NSF I-Corps, $50,000, “I-Corps Demonstration of Microreactor-Assisted Nanomaterials Deposition for Customer Discovery and Value Creation," Chih-hung Chang, 05/01/2014-10/31/2014.
5. Adams Communication & Engineering Tech/Army CERDEC, $169,172.50, “System Optimizations and Performance Improvement on Heat Activated Cooling Systems based on Expander / Compressor Cycle, PI: Hailei Wang, Chih-hung Chang, 03/31/2014 to 09/11/2014.
6. DGIST $42,000, “Develop Novel Solution-Based Precursors and Processes for High-Performance Earth Abundant Thin Film Solar Cells,” PI: Chih-hung Chang, 03/06/2014 to 12/31/2014.
7. NETL $114,000, “Near-Infrared Absorption Sensors Using Plasmonic-Enhanced Nano-Composite Films for Fossil Energy Applications,” PIs: Alan Wang, Chih-hung Chang, 06/01/12-03/31/14.
8. NAVFAC-ARPA-E, $746,359, (subaward from PNNL + ONAMI cost share to OSU), B.K. Paul, C. Chang and G. Herman, “Genset Heat Recovery Adsorption Chiller for Navy Forward Operations Bases,” 5/15/13-4/30/16.
9. NSF STTR Phase 2 Low-Cost Nanostructured Anti-Reflection Coating for Solar Energy Applications, CSD Nano and OSU, Total Award Amount: $536,000 (NSF + ONAMI and Oregon BEST Cost Share) , CSD Nano PI Paul Ahrens, OSU ($215,000) PIs, Ken Williamson, C.H. Chang, B.K Paul, Award Period Covered: 10/29/12-07/31/14.
10. Oregon BEST, $130,000 Proof-of-Concept of Energy Efficient Window Coatings, OSU and CSD Nano, OSU PIs Ken Williamson, C.H. Chang, B.K Paul, 01/01/13-09/01/13.

11. Oregon BEST, $150,000, "Low Cost High Efficiency Concentration Optics for CPV" with Inspired Light, 06/01/12-12/31/12.
12. ONAMI GAP, $247,900, "Nano-structured Anti-Reflective Coatings for Solar Cover Glass" with CSD Nano, OSU PIs Ken Williamson, C.H. Chang, B.K Paul, Award Period Covered: 09/01/11-06/30/13.
13. ONAMI-GAP "Microwave Assisted Continuous Flow Reactors" with Voxtel Nano Inc., $247,900. PI: G.S. Herman, Co-PI C.-H. Chang, Brian K. Paul, March 2010.
14. NSF EAGER/ONAMI/BEST: Production of Nanoscale Solar Energy Materials using a Solar Microreactor: $110,000 PI: Chih-hung Chang, 01/01/2011-12/31/2011.
15. US Army CERDEC, Enhanced Transport on Nano-Coated Surfaces: Application to Absorption Cooling Cycle $71,901 PI: Chih-hung Chang, 03/15/11-03/16/12.
16. DGIST: Develop a Low-cost Manufacturing Process for High Efficiency CIGS Thin Film PVs, $170,000, PI Chih-hung Chang, 09/15/10-12/31/12.
17. MRI: Acquisition of a High Resolution Field Emission Transmission Electron Microscope at Oregon State University $890,000 PIs: Vincent Remcho, John Conley, Mas Subramanian, Jamie Kruzic, Chih-hung Chang, 04/21/10.
18. NSF STTR Phase 1B/CSD Nano, Develop a Low-Cost Solution-Based Process of Nanostructured Anti-Reflection Coating for Solar Energy Applications, $30K, PIs Scott Weaver, Gregory S. Herman, Chih-hung Chang, Brian K. Paul, Jimmy Yang. 07/01/10-06/30/11.
19. M. J. Murdock Charitable Trust, "Acquisition of Engineering Research Equipment for the ONAMI Microproducts Breakthrough Institute," B.K. Paul, C. Chang, S. Leith and D. King, $430K + $1M in real dollar cost share (State of Oregon, OSU RO, MBI, various grants), 9/1/10-8/31/11.
20. Oregon BEST Acquisition and development of Quantum Efficiency Measurement Tooling for Process Optimization, $355,000, PIs: Gregory S. Herman, Chih-hung Chang, 9/1/10-9/31/11.
21. ONR/ONAMI, Mechanism of Electrical Switching in Nanoscale Oxide Memristor Devices $300,254 PIs: Gregory S. Herman, John Conley, Chih-hung Chang, S. Thevuthasan, 04/1/10-12/31/11
22. OSU Venture Fund, Demonstrate High Value Nanoparticle Synthesis, $24,995 PIs. Greg Herman, Chih-hung Chang, Brian K. Paul.
23. NSF STTR Phase 1/CSD Nano, Develop a Low-Cost Solution-Based Process of Nanostructured Anti-Reflection Coating for Solar Energy Applications, $159K, PIs Scott Weaver, Gregory S. Herman, Chih-hung Chang, Brian K. Paul, Jimmy Yang. 07/01/10-06/30/11.
24. US Air Force Office of Scientific Research/University of Oregon, Microsystem Development for Metal Nanoparticle Production, $ 200,000 PIs: C.-H. Chang, B. K. Paul, V.T. Remcho, 10/01/09-09/30/10.

25. Oregon Process Innovation Center, Oregon BEST, $282,000 (including OSU match 50K), PI: Chih-hung Chang, 2009.
26. US Army CERDEC, Towards Digital Fabrication of Surface Conformable Lithium Batteries, $18,000 Chih-hung Chang, 2009.
27. US Army CERDEC, Nano-Structured Coatings on Microwicks for Enhanced Boiling Heat Transfer, $70,000 Chih-Hung Chang, 2009.
28. Microchannel Assisted Nanomaterial Deposition Technology for Photovoltaic Material Production" U.S. DOE, Office of EERE ITP program, $2.465,000 (including ONAMI match 300K) PNNL/OSU/ CH2M Hill/ Voxtel PIs: Dan Palo, Chih-hung Chang, Brian K. Paul, Vincent T. Remcho
29. US National Science Foundation, Graduate Research Supplement CAREER: Process Engineering of Chemical Bath Deposition-A soft Solution Route to Flexible Electronics. PI: C.-H. Chang, $39,317, 12/31/08 –12/31/09.
30. OSU Venture Fund, Demonstrate High Efficiency Solar Cells by Inkjet Printing" $19,997, PI: Chih-hung Chang 09/30/08-10/01/09.
31. Oregon BEST, $75,000, Design and Control of a Microchannel-based Solar Receiver and Development of Scalable Catalytic Microchannel Reactors for Biofuels Processing, PI: Sourabh Apte, John Schmitt, Vinod Narayanan, Chih-hung Chang, Brian K. Paul 06/15/08-06/15/09.
32. US Army Research/University of Oregon, Micro/Nano-Structured Micro-Channel Heat Exchangers for Advanced Cooling, $300,000. PIs. C.-H. Chang, B.K. Paul, T.J. Hendricks, D. Palo. 08/31/08-08/30/09.
33. US Army Research/University of Oregon, Drop-On Demand Fabrication of Li-Ion Batteries Using Ultra-Dry Inks, $210,000. PIs. Rieke, Pederson, Viswanathan, Towne, Holbery, Chang, Chappell and Buckley 08/31/08-08/30/09.
34. US Air Force Office of Scientific Research/University of Oregon, Microsystem Development for Metal Nanoparticle Production, $ 249,642 PIs: C.-H. Chang, B. K. Paul, V.T. Remcho, 10/18/05-04/18/09.
35. US Army Research/University of Oregon, Micro/Nano-Structured Micro-Channel Heat Exchangers for Advanced Cooling, $160,000. PIs. C.-H. Chang, B.K. Paul, T.J. Hendricks, D. Palo. 10/15/07-3/15/08.
36. US Army Research/University of Oregon, Drop-On Demand Fabrication of Li-Ion Batteries Using Ultra-Dry Inks, $90,000. PIs. Rieke, Pederson, Viswanathan, Towne, Holbery, Chang, Chappell and Buckley 10/15/07-3/15/08.
37. US National Science Foundation, Microreactor-Assisted Nanoparticle Deposition: An Efficient, Green Route to Functionally Gradient Films, $299,265. PIs: B. K. Paul, C.-H. Chang, J. Yang, 06/15/07-09/01/10.
38. ONAMI GAP Fund, Demonstration of Microreactor-Assisted Nanomaterial Production, $162,221, PIs: B. K. Paul, C.-H. Chang, 05/25/07-09/15/08.

39. US Air Force Office of Scientific Research/University of Oregon, Microsystem Development for Metal Nanoparticle Production, $, 165,001 PIs: C.-H. Chang, B. K. Paul, V.T. Remcho, 10/18/05-04/18/09.
40. US Army Fort Belvoir Advanced Catalyst Fabrication Processing for the Economical Production of Catalytic Microreactors$163, 705, PIs: C.-H. Chang, B. K. Paul, D. Palo, 01/01/07-12/31/07.
41. US Air Force Office of Scientific Research, Microsystem Development for Metal Nanoparticle Production, $420,836, PIs: C.-H. Chang, B. K. Paul, V.T. Remcho, 9/1/05-8/31/06.
42. US National Science Foundation, NIRT: Whole-Cell Biosynthesis of Nanostructured Metal Oxide Semiconductors, PI: G. Rorrer, Co-PIs: C.-H. Chang and J. Jiao, $1,300,000, 08/15/04 –07/31/08.
43. US National Science Foundation, Novel, High Performance On-Chip Tunable Components and Crosstalk Suppression, PI: R. Settaluri, Co-PI: C.-H. Chang, $180,000, 04/15/04 – 3/31/07.
44. W.M. Keck Foundation, MICRO2NANO: Microchemical 'Fractories' for the High-Yield Synthesis of Dendritic Nanoarchitectures. PI: C.-H. Chang Co-PI: B. K. Paul, V.T. Remcho, $650,000, 01/15/04 –12/31/06.
45. US National Science Foundation, CAREER: Process Engineering of Chemical Bath Deposition-A soft Solution Route to Flexible Electronics. PI: C.-H. Chang, $400,000, 01/15/04 –12/31/08.
46. US National Science Foundation, Flexible Thin Film Transistors Using Low Temperature Chemical Bath Deposition. PI: C.-H. Chang, $70,000, 05/15/03 – 04/30/04.
47. US National Science Foundation, Biosynthesis of Germanium Oxide Nanoparticles. PI: Greg Rorrer, Co-PI: C.-H. Chang, $100,000, 08/01/02 – 07/31/03.
48. US National Science Foundation, CCLI: Lab Based Unit Operations in Microelectronics Processing. PI: C.-H. Chang, Co-PIs: M.D. Koretsky, S. Rochefort, S. Kimura, C. Shaner, $ 116,172, 03/15/02 – 03/15/03.
49. US Department of Energy National Renewable Energy Laboratory/University of Florida, X-ray Absorption Fine Structure Investigation of Local Structure of CIGS and the Na Related Compounds. PI: C.-H. Chang, $ 60,000, 03/15/01 – 03/15/03.
50. US Department of Energy National Renewable Energy Laboratory/University of Florida, Develop Electrodeposition Process of $CuGaSe_2$ for Low Cost High Performance Tandem Solar Cell Application. PI: C.-H. Chang, $ 18,000, 03/15/02 – 03/15/03.
51. US Department of Energy INEEL, Steam Reforming in Micro-reactors for Destruction of Hazardous Organic Materials. PI: G. Jovanovic, Co-PIs: C.-H. Chang, B.K. Paul, S. Rochefort, P. Watson, $96,000, 01/01/01 – 09/30/02.

b. Industrial Awards and Contracts

Industrial Gifts, Awards, and Contracts

1. Sol Arrays LLC, $6000, CIGS thin film solar cells, 2012-2013.
2. "Solution Processed CIGS Solar Cells," Sharp Laboratories of America Gift Funds, $50,000. C.H. Chang, November 1, 2012.
3. "Solution Processed CIGS Solar Cells," Sharp Laboratories of America Gift Funds, $80,000. C.H. Chang ($40,000), G.S. Herman ($40,000), April 1, 2012
4. “Solar Energy Research Using Microreactors,” Sharp Laboratories of America Gift Funds, $50,000. G.S. Herman ($25,000), C.-H. Chang ($25,000), April 1, 2011
5. “Solar Energy Research on Earth Abundant Materials,” Sharp Laboratories of America Gift Funds, $106,000. G.S. Herman ($49,240), C.-H. Chang ($49,240), B. Paul ($7,520). April 1, 2010
6. “Solar Energy Research on Earth Abundant Materials,” Shapr Laboratories of America Gift Funds, $80,000. C.H. Chang ($40,000), G.S. Herman ($40,000), April 1, 2012
7. “Solar Energy Research Using Microreactors,” Sharp Laboratories of America Gift Funds, $50,000. G.S. Herman ($25,000), C.-H. Chang ($25,000), April 1, 2009.
8. “Solar Energy Research on Earth Abundant Materials,” Sharp Laboratories of America Gift Funds, $106,000. G.S. Herman ($49,240), C.-H. Chang ($49,240), B. Paul ($7,520). April 1, 2008
9. Sharp Labs of Americas Gift Fund $340,000.
10. AU Optronics Corporation, Printed Oxide TFT Research Award Amount: $69,557.00. PI. Chih-hung Chang.
11. Levitronics, High efficiency hybrid solar collector and receiver, $12,897, PI Chih-hung Chang 10/1/09-12/31/10.
12. Hewlett Packard Co. Thin-Film High-Performance Devices via Additive Processing, PI: D. Keszler, Co-PIs: C.-H. Chang and J. Wager, $700,000, 09/15/04 – 09/14/06.
13. Hewlett-Packard Co. Printable Inorganic Materials for Flexible Electronics. PIs: C.-H. Chang, Doug Kezsler, John Wager, $252,202, 03/01/03 – 02/27/04.
14. Hewlett-Packard Co. Synthesis of Nanoparticle Solution for Printing. PI: C.-H. Chang $5,000, 0/01/03 – 06/15/04.
15. Intel Co. Development of Unit Operation Education Modules for Multiple-Course Projects in Microelectronics Processing. PI: C.-H. Chang, Co-PIs: S. Kimura, M. Koretsky, M. Subramanian, C. McConica, $ 50,000, 03/15/01 – 09/30/02.
16. Intel Co. Integrated Microelectronics Processing Program Phase II. PI: M. Koretsky, Co-PIs: C.-H. Chang, M. Subramanian, C. McConica, $ 35,000, 06/15/00 – 06/15/01.

OSU Internal Competitive Awards for Research

1. OSU/Research Equipment Reserved Fund. Scrubber System for Atomic Layer Deposition PI: C.-H. Chang $ 27,493, 05/2005
2. Kelly Family Equipment Fund A Laser System Tunable from the Infrared to the Ultraviolet. PIs: W. Kong, C.-H. Chang, $112,850, 12/18/ 2000 – 12/18/2002.
3. OSU General Research Fund. Pulse Nanocrystal Deposition by Thermal Ink Jet Technology and Applications to Fabrication of Flexible $CuInSe_2$ Thin Film Photovoltaics. PI: C.-H. Chang $ 8,000 06/15/2002 – 06/15/ 2003
4. OSU/Research Equipment Reserved Fund. Acquisition of Electrochemical Interface for Teaching and Research. PI: C.-H. Chang $ 5,950
5. OSU/Research Equipment Reserved Fund. Acquisition of an automated scanning monochromator for FLN and PLE measurements. PI: C.-H. Chang $ 8,641

TEACHING, ADVISING, AND OTHER ASSIGNMENTS

1. Instructional Summary

Table B-1. Summary of credit courses taught at Oregon State University

Undergraduate Courses & Times Taught		**Graduate Courses & Times Taught**	
ChE 311	13	ChE 537	11
ChE 312	1	ECE 511	1
ChE 412	1	ChE 599	3
ChE 450	3	ChE 550	2
Total	**18**	**Total**	**17**

2. Credit Courses (Reverse Chronological Listing)

OSU Course Number	**Course Title**	**%**	**Cr.**	**Term**	**Year**	**Enrolled Students**
ChE 311	Thermodynamics Properties & Relationship	30	3	Fall	2000	33
ChE 312	Chemical Engineering Thermodynamics	100	3	Winter	2001	34
ChE 311	Thermodynamics Properties & Relationship	100	3	Fall	2001	33
ECE 511	Electronic Materials Processing	100	3	Fall	2001	33
ChE 311	Thermodynamics Properties & Relationship	100	3	Fall	2002	51
ChE 537	Chemical Engineering Thermodynamics I, II	100	4	Spring	2002	6
ChE 311	Thermodynamics Properties & Relationship	100	3	Fall	2003	40

ChE 412	Mass Transfer Operations	100	3	Winter	2004	7
ChE 537	Chemical Engineering Thermodynamics I, II	100	4	Spring	2004	13
ChE 311	Thermodynamics Properties & Relationship	100	3	Fall	2004	47
ChE 537	Chemical Engineering Thermodynamics I, II	100	4	Winter	2005	3
ChE 311	Thermodynamics Properties & Relationship	100	3	Fall	2006	61
ChE 537	Chemical Engineering Thermodynamics I, II	100	4	Winter	2007	17
ChE 599	Catalysis and Catalytic Process	100	4	Spring	2007	6
ChE 311	Thermodynamics Properties & Relationship	100	3	Fall	2008	84
ChE 537	Chemical Engineering Thermodynamics I, II	100	4	Spring	2008	11
ChE 537	Chemical Engineering Thermodynamics I, II	100	4	Winter	2009	10
ChE 599	Catalysis and Catalytic Process	100	4	Spring	2009	6
ChE 311	Thermodynamics Properties & Relationship	100	3	Fall	2009	93
ChE 537	Chemical Engineering Thermodynamics I, II	100	4	Winter	2010	19
ChE 599	Solar Cells: Devices, Materials and Processes	100	4	Spring	2010	10
ChE 311	Thermodynamics Properties & Relationship	100	3	Fall	2010	104
ChE 537	Chemical Engineering Thermodynamics I, II	100	4	Winter	2011	15
ChE 311	Thermodynamics Properties & Relationship	100	3	Fall	2011	121
ChE 537	Chemical Engineering Thermodynamics I, II	100	4	Winter	2012	22
ChE 311	Thermodynamics Properties & Relationship	100	3	Fall	2012	148
ChE 537	Chemical Engineering Thermodynamics I, II	100	4	Winter	2013	16
ChE 450/550	Conventional and Alternative Energy	100	3	Spring	2013	56
ChE 311	Thermodynamics Properties & Relationship	100	3	Fall	2013	148
ChE 537	Chemical Engineering Thermodynamics I, II	100	4	Winter	2014	28
ChE 450/550	Conventional and Alternative Energy	100	3	Spring	2014	60
ChE 311	Thermodynamics Properties & Relationship	100	3	Fall	2014	149

3. Noncredit Courses and Workshops
Micro-Nano Technology & Engineering Development Workshop, Microproducts Breakthrough Institute (MBI)/Oregon State University July 20 to July 24, 2009.

4. Curriculum Development

Unique Efforts in Course Development, 2000-present

Chemical Engineering Thermodynamics, CHE 311 – I have developed lectures, problems, in-class demonstrations, and in-class exercises to illustrate the principles of chemical engineering thermodynamics to chemical process and real life examples.

I have worked with CBEE school team to implement studio approach in 2011-2012 ChE 311 class. In particular, I developed 18 new worksheets for the studios and modified my lectures for this teaching approach.

Graduate Chemical Engineering Thermodynamics, *CHE 537* – I have incorporated molecular and statistical thermodynamics into this graduate level chemical engineering thermodynamics. Written and oral communications and projects were incorporated into the graduate chemical engineering thermodynamic course.

Chemical Engineering Laboratory, CHE 414, 415 – I have developed laboratory modules using unit processes in new chemical engineering technologies to provide more opportunities for lab-based teaching. These modules are presenting to students as open-ended problems similar to a research project. The design of these laboratory modules are based on the synthesis of the research literature. I have collaborated with Profs. Koretsky, Kimura, Rochefort, and Hackleman to develop laboratory modules in the areas of microfabrication techniques (e.g. plasma etching, chemical mechanical planarization, electrodeposition, chemical vapor deposition, and spin coating) commonly used in the microelectronics industries and microreaction technology.

Catalysis and Catalytic Process, ChE 541 – Catalysts and catalytic reactions are critical to both chemical and energy industry. There is no course in this area provided at OSU. To fill this gap, I have developed a graduate level catalysis course ChE 599 which I have taught successfully for two times. A category II proposal has been submitted to formally established ChE 541: Catalysis and Catalytic Process in the course catalog. This course covers topics related to catalysts and catalytic reactions including catalytic reaction mechanisms and kinetics, catalyst characterizations and activity testing, catalyst preparation and manufacturing processes. I have also designed hands-on projects to enhance the student learning experience.

Solar Cells: Devices, Materials and Processes – I have developed a graduate level solar cell course that were offered at spring 2010. This course introduces key solar cell technologies including silicon photovoltaics, thin film photovoltaics, dye sensitized cells and more advanced cell concepts to the students. The lectures cover devices, materials and processes associated with these PVs. Hands-on projects that offer students an opportunity to actually build and characterize solar cells were incorporated in this course.

I have worked with Prof. Jiyao Chen for his BA 458, “Innovation and New Product Development” for undergraduates. In this course, students study how to formulate innovation

strategies such as selecting innovation projects, building collaboration partnerships, and protecting and leveraging IP, how to implement innovation strategies including new product development (NPD) processes such as identifying market opportunities, generating product concepts, testing and refining product concepts, and managing innovation teams, etc. Students are required to apply course materials to analyze a real NPD project to deepen students' understanding and to improve their innovation capabilities. I have actively participated in this course in Spring 2012 by providing my IPs in the area of nanostructured antireflection coatings as a case for the business students. I worked with Prof. Chen to structure the course. The business students were exposed to the science behind the invention via my in-class presentations and interaction with them. The students were all exciting about the real world applicability of their assignment. At the end of the course, many student groups have come up with innovative ideas of new products for the IPs.

5. Team or Collaborative Teaching Efforts

I have co-taught ChE 414 with professors Skip Rochefort and Carol McConica during winter 2000 as a mentoring process for me to learn hand-on teaching.

I have co-taught ChE 311 with Professor Milo D. Koretsky during Fall 2000 as a mentoring process for me to learn the teaching techniques.

6. International Teaching

"Develop Solution-Based Processes for Flexible and Printed Electronics," 2008 Flexible Electronics Seed Teacher Training Class, National Cheng Kung University, Tainai, Taiwan Aug 4-8, 2008.

7. Student and Participant/Client Evaluation Summary

Student evaluation for courses taught from Fall 2000 Winter to Spring 2003 are based on a 4.0 scale (4.0 is highest) are reported as average values. The number of students responding to the survey was equal to or less than the number of students enrolled in the course. The student evaluation is based on the average response to Question #12 of the student Assessment of Teaching form, which states "*All things considered, I was favorably impressed by this instructor*."

Student evaluations for courses taught from Fall 2003 to present are based on a 6.0 scale (6.0 is highest). The student evaluation is based on the average response to Question #2, which states "The instructor's contribution to the course was:"

Current Student Evaluation System, Fall 2003 to present (6.0 basis)

						Question #1	**Question #2**
OSU Course Number	Course Title	Cr.	Term	Year	No. Students	Student Eval.	Student Eval.
ChE 311	Thermodynamics Properties & Relationship	3	Fall	2003	40	5	5

ChE 412	Mass Transfer Operations	3	Winter	2004	7	5	5
ChE 537	Chemical Engineering Thermodynamics I, II	4	Spring	2004	13	5	5
ChE 311	Thermodynamics Properties & Relationship	3	Fall	2004	47	4.5	4.5
ChE 537	Chemical Engineering Thermodynamics I, II	4	Spring	2005	3	5.1	5.2
ChE 311	Thermodynamics Properties & Relationship	3	Fall	2005	47	4.3	4.4
ChE 311	Thermodynamics Properties & Relationship	3	Fall	2006	61	4.8	5.0
ChE 537	Chemical Engineering Thermodynamics I, II	4	Fall	2006	17	5.0	5.4
ChE 599	Catalysis and Catalytic Processes	4	Spring	2007	6	5.0	5.3
ChE 311	Thermodynamics Properties & Relationship	3	Fall	2007	84	4.7	4.9
ChE 537	Chemical Engineering Thermodynamics I, II	4	Winter	2008	11	5.1	5.2
ChE 311	Thermodynamics Properties & Relationship	3	Fall	2008	93	4.3	4.6
ChE 537	Chemical Engineering Thermodynamics I, II	4	Winter	2009	10	4.9	5.0
ChE 599	Catalysis and Catalytic Processes	4	Spring	2009	6	5.9	6.0
ChE 311	Thermodynamics Properties & Relationship	3	Fall	2009		4.3	4.6
ChE 537	Chemical	4	Winter	2010	19	5.6	5.8

	Engineering Thermodynamics I, II						
ChE 599	Solar Cells: Devices, Materials and Processes	4	Spring	2010	10	5.6	5.4
ChE 311	Thermodynamics Properties & Relationship	3	Fall	2010	104	4.7	4.8
ChE 537	Chemical Engineering Thermodynamics I, II	4	Winter	2011	15	5.0	5.3
ChE 311	Thermodynamics Properties & Relationship	3	Fall	2011	121	4.5	4.5
ChE 537	Chemical Engineering Thermodynamics I, II	4	Winter	2012	22	5.1	5.3
ChE 311	Thermodynamics Properties & Relationship	3	Fall	2012	148	4.5	4.5
ChE 537	Engineering Thermodynamics I, II	4	Winter	2013	16	5.3	5.5
ChE 450/550	Conventional and Alternative Energy	3	Spring	2013	56	5.5	5.5
ChE 311	Thermodynamics Properties & Relationship	3	Fall	2013	148	4.8	5.0
ChE 537	Engineering Thermodynamics I, II	4	Winter	2014	28	5.8	5.8
ChE 450/550	Conventional and Alternative Energy	3	Spring	2014	56	5.6	5.5
ChE 311	Thermodynamics Properties & Relationship	3	Fall	2014	150	4.9	5.0
ChE 537	Engineering Thermodynamics I, II	4	Winter	2015	29	5.5	5.5
ChE 450/550	Conventional and Alternative	3	Winter	2015	70	5.5	5.5

	Energy

Previous Student Evaluation System, Fall 1989 to Spring 2003 (4.0 basis)

						Question #12 (4.0 basis)
OSU Course Number	Course Title	Cr.	Term	Year	No. Students	Student Eval.
ChE 312	Chemical Engineering Thermodynamics	3	Winter	2001	34	3.35
ChE 537	Chemical Engineering Thermodynamics I, II	4	Spring	2001	6	3.44
ECE 511	Electronic Materials Processing	4	Fall	2001	33	2.89/OSU 4.0/OCATE
ChE 537	Chemical Engineering Thermodynamics I, II	4	Spring	2002	8	3.88
ChE 311	Thermodynamics Properties & Relationship	3	Fall	2002	51	2.86
ChE 537	Chemical Engineering Thermodynamics I, II	4	Spring	2003	12	3.58

8. Advising

From 2002 to present, I serve as the academic advisor for a mix of 25-30 undergraduate chemical engineering students of freshman, sophomore, junior, and senior standing. Individual advising and counseling sessions focus on discussion of class schedule for the following term, charting student progress toward satisfaction of degree requirements, and career/personal counseling.

Term	**Year**	**Task**	**#Clients**	**Time per Client**
F, W, S	02-03	Individual Advising	25-30	15 min
F, W, S	03-04	Individual Advising	25-30	15 min
F, W, S	03-04	Individual Advising	25-30	15 min
F, W, S	04-05	Individual Advising	25-30	15 min

F, W, S	05-06	Individual Advising	25-30	15 min
F, W, S	06-07	Individual Advising	25-30	15 min
F, W	07-08	Individual Advising	25-30	15 min
F, W, S	08-09	Individual Advising	25-30	15 min
F, W, S	09-10	Individual Advising	25-30	15 min
F, W, S	10-11	Individual Advising	25-30	15 min
F, W, S	11-12	Individual Advising	25-30	15 min
F, W, S	12-13	Individual Advising	25-30	15 min
F, W, S	13-14	Individual Advising	25-30	15 min

SERVICE

1. Departmental Service

Undergraduate Advising

Advisor for 25 undergraduate students (freshman-senior), 2003-present

School, of Chemical, Biological and Environmental Engineering (CBEE)

Committees

Member, School Head Search Committee, 2013-present
Member, Johnson Building Planning Committee, 2013
Member, Faculty Status Committee, 2013-present
Member, Graduate Committee, 2011-present
Faculty Status Committee, 2011-2012
Chair, Graduate Committee, 2009 – 2011
Member, Status Committee, 2007 – present
Member, Graduate Committee, 2007 – 2009
Member, Curriculum Committee, 2005 – 2006
Chair, Computer and Facility Committee, 2004-2005
Member, ChE Graduate Committee, 2003-2005
Member, Computer and Facility Committee, 2004-2005
Member, CHE Vision Committee, 2000

2. College Service

ONAMI (Oregon Nanoscience and Microtechnology Institute) Nano/Micro Fabrication Facility Steering Committee

International Exchange Program
I have established a formal exchange program with Yeungnam University, South Korea and am currently working on finalizing the exchange agreement with National Taiwan University. These programs offer opportunities for our students to study and do research in top rank Asian University and to get exposure to Asian culture, the social stimulation of a large city, and the perspective of a major technology center for the Far Eastern Asia.

Service to the Profession

Oregon Process Innovation Center (OPIC) for Sustainable Solar Cell Manufacturing

The PV industry has seen 40% annual growth, despite suffering from high costs, consuming large amounts of energy, providing low solar capture efficiency, employing hazardous materials, and operating with poor material utilization efficiencies. To address many of these concerns, I have helped establish the Oregon Process Innovation Center (OPIC) for Sustainable Solar Cell Manufacturing to support and enhance the rapid growth of solar cell manufacturing companies in Oregon. The center focuses on developing solar cell manufacturing methods that are environmentally benign, economical, and energy-efficient. The center is located within the Microproducts Breakthrough Institute to leverage existing operating strategies for the commercialization of university intellectual property.

OPIC is a collaborative center for the research, development and commercialization of sustainable manufacturing technologies within the PV industry. OPIC provides an environment for industrial and academic researchers to collaborate in the development of innovative processes for reducing the costs and environmental impacts of PV manufacturing. Capabilities in the center include the staff and expertise to conduct benchtop development and in-process characterization. Plans are moving forward to install pilot production facilities within OPIC in the coming year to prove out bench-scale technologies at pilot scale. To facilitate this, OPIC is developing a network of strategic industrial partnerships to ensure that these pilot-scale facilities can be scaled-up at production quantities. Current OPIC capabilities include the development of novel cross-cutting manufacturing technologies for current PV products (optimization, waste and cost reduction) as well as exploratory research and development for future PV product development. The center will provide opportunities to conduct industrial-scale manufacturing process problem solving as well as a training ground for the future PV workforce.

Graduate Council Representative and Thesis Committee

Kate, Kunal Hemant	Ph.D.
Cheng Li	Ph.D.
Xingyuan Chong	Ph.D.
Tang Longteng	Ph.D.
Clement Bommier	Ph.D.
Chang Li	Ph.D.

Amila U. Liyanage	Ph.D.		
Malachi Bunn	Ph.D.		
Justin Pommerenck	Ph.D.		
Daniel Peterson	Ph.D.	Fluidic and Thermal Modeling for the High Production Rate Synthesis of High Quality Nanoparticles	2014
Rajesh Saranam	Ph.D.		
Brian Johnson	Ph.D.		
Richard P. Olesak	Ph.D.		2014
Brendan Flynn	Ph.D.		2014
Zhou Zheng	M.S.		2014
Yihao Du	M.S.		2014
Yili Wu	M.S.	Pressure Sensitive Adhesive Based on Oleic Acid	2014
Kevin Caple	Ph.D.	Detailed Analysis of the Hydrogen Sulfide production Step in a Sulfur-Sulfur Thermochemical Water Splitting Cycle	2014
Chris J. Durgen	M.S.		2013
Fang-Yu Lee	M.S.		2013
Eric Hostetler	M.S.	Processing of Nanoscale Materials: Microwave Synthesis of PbSe Nanocrystals and Thermal Oxidation of Zr-Cu-Al-Ni Metallic Glass	2013
Xiangru Fan	M.S.	Finite Volume Method modeling of corona discharge microractor oxidization of dibenzothiphene	2013
Barath Palanisamy	Ph.D.	Micromixer assisted continuous flow synthesis of nanoparticles of binary compounds and their application	2013
Ravindranadh Eluri	Ph.D.	Nanoparticle-Assisted Diffusion Brazing of Metal Microchannel Arrays: Nanoparticle Synthesis, Deposition and Characterization	2012
Hui Nian	Ph.D.	Investigation on Chemopreventive Mechanism for Methylselenocysteine Deaminated Metabolite Methylselenopyruvate as Histone Deacetylase Inhibitor	2010
Lisa Troung	Ph.D.	Developing Rapid *in Vivo* Assays to Investigate Structure-Activity Relationships	2011
Matthew A. Delaney	MS	Study of Graphite-Polyurethane Composite Thin Film Electrodes for Their Use in Electrochemical	2011

		Antifouling Systems	
Justin Ong	M.S.	Impurity effect on magnetism of nickel for under bump metallization via magnetron sputtering	2010
Kasidid Asumpinpong	M.S.	Development of a Microchannel Device for Adsorption Cooling Application	2009
Santosh Tiwari	Ph.D.	Nickel Nanoparticle-Assisted Diffusion Brazing of Stainless Steel Surfaces for Microfluidic Applications	2010
Robert Kimmell	M.S.	Syntheses and Characterization of Nano Sized Iron Particles	2009
James Parker	Ph.D.	A Novel Lattice Boltzmann Method for Treatment of Multicomponent Convection, Diffusion, and Reaction Phenomena in Multiphase Systems	2008
Nick AuYeung	Ph.D.	Hydrogen Production via a Sulfur-Sulfur Thermochemical Water-Splitting Cycle	2011
Debra K. Gale	Ph.D.	Immunocomplex Sensing Using Antibody-Functionalized Diatom Biosilica Containing Photoluminescent Germanium	2011
Aaron Goodwin	Ph.D.	Conversion of Biomass Constituents to Hydrogen-rich Gas by Supercricital Water in a Microchannel Reactor	2010
Clayton Jeffryes	Ph.D.	Biological Insertation of Nanostructured Germanium and Titanium Oxides into Diatom Biosilica	2009
Yolanda Tennico	PhD	Magnetic particles for selective extraction of trace analytes in microfluidic devices	2010
Esha Chatterjee	PhD	Sensitive biomarker detection using liposomes encapsulating quantum dots as labels	2011
TaeHyeong Kim	Ph.D	Organic solvent Resistant Ultrafiltration and Nanofiltration Membrane Modules for Separation and Purification of Nanoparticles	2011
Seunghwa Kwon	Ph.D.	Effects of doping, cation stoichiometry, and the processing conditions on the dielectric properties of high-K $CaCu_3Ti_4O_{12}$ ceramics	2008
Myra Koesdjojo	Ph.D.	Fabrication and Application of Polymeric Based Microfluidic Devices	2009
Paravee Vas-Umnuay	M.S.	Flow characterization of multiple-tube reactors for synthesis of nano-sized silicon nitride powder via silicon monoxide ammonolysis	2008
Ayako Nakagawa	MS	Catalytic chemical vapor deposition synthesis of carbon nanotubes from methane on SiO supported Fe and Fe-Ni catalysts	2008
Seunghwa Kwon	PhD	Influences of Doping and Stoichiometry on the Dielectric Properties of High-K $CaCu_3Ti_4O_{12}$	2007
Bindiya Abhinkar	MS	Modeling and Development of Fabrication Method	2007

		for Embedding Membrane Based Microvalve in Bulk Microfluidic Device	
Carmen A. Velasco	MS	Microwave extraction of peppermint oil and comparison to the current practice of steam extraction	2007
YongJae Choi	M.S.	Cellulose Nanocrystal in the Carboxymethy Cellulose Composites	2005
Michiru Hirayama	M.S.	Synthesis of Nano-Sized Silicon Nitride Powder in Microchannel Reactors	2006
Carlos Cruz-Fierro	Ph.D.	Hydrodynamic Effects of Particle Chaining in Liquid-Solid Magnetofluidized Beds: Theory, Experiments, and Simulation	2005
Clayton Jeffryes	M.S.	Kinetics of Nanoscale Ge and Si Assimilation into the Cell Wall of the Marine Diatom *Nitzschia frustulum*	2005
Arjun Venkataraman	M.S.	Etching of Polyphenylene Oxide in a Downstream Microwave Plasma using NF3, SF6,O2 and Ar Gas Mixtures	2004
Ali H. Al-Raie	M.S.	Desulfurization of Thiophene and Dibenzothiophene with Hydrogen Peroxide in a Photochemical Microreactor	2005
Ahmad A. Al-Dhubabian	M.S.	Production of Biodiesel from Soybean Oil in Micro Scale Reactor	2005
Soujanya Vuppala	M.S.	Radiation Effects in III-V Heterojunction Bipolar Transistors	2004
Diana Djokotoe	M.S.	Burning Emulsified Sulfur to Stabilize Sodium Compounds in a Lime Kiln	2004
Seung Yoo	M.S.	MyTeam Portal: Integrating Exchange Web Applications with Rainbow Portal Framework	2003
David Hu	M.S.	Fault Probability and Confidence Interval Estimation of Random Defects seen in Integrated Circuit Processing	2003
Hai Q. Chiang	M.S.	Development of Zinc Tin Oxide-based Transparent Thin Film Transistor	2003
Carlos Cruz-Fierro	M.S.	Coupled Momentum and Heat Transport in Laminar Axisymmetric Pipe Flow of Ferrofluids in Non-uniform Magnetic Field: Theory and Simulation.	2003
Taran V. Harman	M.S.	Ferroelectric Thin Film Development	2003
ChyiShiun Li	M.S.	Radiation Effects in III-V Compound Semiconductor Heterostructure Devices	2003
Ploenpun Sakrittichai	M.S.	Declorination of p-Chlorophenol on a Palladium based Support Catalyst in a Microreactor; Experiment and Theory	2001
Wimol Lertwiwattrakul	M.S.	Fabrication of Ultrathin SiC Film Using Grafted	2000

		Poly(methylsilane)	
Thana Sornchamni	M.S.	The Production of Voidage Distribution in a Non-uniform Magnetically Fluidized Bed: Theory and Experiment	2000

Conference Leadership

1. Chair PNWAVS 2011 Symposium, September 2011, Wilsonville OR
2. Workshop Co-Chair and Organizer of the 11th Emerging Information & Technology Conference, University of Chicago, 2011.
3. Vice Chair PNWAVS 2010 Symposium, September 2010, EMSL Richland WA.
4. Workshop Co-Chair and Organizer of the 10th Emerging Information & Technology Conference, Stanford University 2010.
5. Organizing Committee: PNWAVS 2009 Symposium, September 2009, Troutdale OR.
6. Session Chair, AM-FPD 09, Nara, Japan July 2009.
7. Session Chair, Digital Fabrication 2006, Denver September 2006.
8. Chair, Poster session: Materials Science and Engineering Divisions, AIChE 2006 annual meeting, San Francisco, CA.
9. Chair, Poster session: Materials Science and Engineering Divisions, AIChE 2005 annual meeting, Cincinnati, OH.
10. Chair, Advances in Nanolithography, AIChE 2005 annual meeting, Cincinnati, OH.
11. Organizing Committee: 16th PNWAVS 2005 Symposium, September 2005, Troutdale OR.
12. Co-Chair, Poster session: Materials Science and Engineering Divisions, AIChE 2004 annual meeting, Austin TX.
13. Co-Chair, Chemical Vapor Deposition, AIChE 2004 annual meeting, Austin TX.
14. Organizing Committee: 26th Annual Symposium on Applied Surface Analysis, 2004, Richland WA.
15. Co-Chair, Poster session: Materials Science and Engineering Divisions, AIChE 2003 annual meeting American Institute of Chemical Engineers, Nov, 2003, San Francisco CA.
16. Organizing Committee: 14th PNWAVS 2003 Symposium, September 2003, Troutdale OR.

External Peer Review: Journals, Grant Proposals, Conference Proceedings, and Textbooks

Promotion &Tenure Evaluator
Physics and Physical Science, Marshall University
Materials Science and Engineering, North Texas Tech University
College of Electrical Engineering and Computer Science, National Taiwan University
College of Electrical and Computer Engineering, National Chiao Tung University
College of Engineering, National Central University

***Journal Article Review*: (>25 papers review in 2013)**
ACS Applied Materials & Interfaces
ACS Nano
Advanced Materials
Advanced Functional Materials
Applied Physics Letters
Applied Physics A

Applied Physics D.
AIChE Journal
Applied Surface Science
Biotechnology Progress
Chemical Physics Letters
Chemistry of Materials
Chemical Engineering Journal
Chemical Engineering Education
CrystEngComm
Desalination
Electrochemical and Solid State Letters
European J Applied Physics
IEEE Transactions on Electron Devices
IEEE Electron Device Letters
Industrial & Engineering Chemistry Research
International Journal of Hydrogen Energy
Journal of Alloys and Compounds
Journal of Electronic Materials
Journal of the American Chemical Society
Journal of Materials Chemistry and Physics
Journal of Materials Chemistry
Journal of Materials Chemistry C
Journal of Applied Physics
Journal of Crystal Growth
Journal of Display Technology
Journal of Phase Equilibria
Journal of Physics D: Applied Physics
The Journal of Physical Chemistry
Journal of Physical Chemistry
Journal of the Electrochemical Society
Japanese Journal of Applied Physics
Journal of Biomolecular Structure and Dynamics
JVST B: Journal of Vacuum Science and Technology
Materials Science and Engineering B
Materials Science in Semiconductor Processing
Materials Research Bulletin
Molecular Simulation
Nanoscale
Nanotechnology
Optics Letters
Recent Progress in Photovoltaics
Physica Status Solidi
PLOS One
Review of Scientific Instruments
RSC Advances
Science
Sensors
Small
Solid State Science

Scripta Materialia
Separation and Purification Technology
Surface Science
Vacuum

***Competitive Proposal Review*:**
US National Science Foundation (CBET, ECS, DMR, CMMI, IIP, STC, SEP)
Army Research Office
US Department of Energy Basic Energy Science
US DOE BTO
Hong Kong Innovation and Technology Fund
ACS Petroleum Research Fund
Louisiana State Board of Regents Support Fund R&D Program

Conference Proceeding Review:
Materials Research Society Symposium G Proceedings, MRS Fall 2008
The 4th Asia-Pacific Chemical Reaction Engineering Symposium Proceedings, 2005
Compound Semiconductor Photovoltaics, Materials Research Society Proceedings 763, 2003
Thin-Film Structures for Photovoltaics, Materials Research Society Proceedings 485, 1997

Professional Activities

Editorial Board member, *Chemical Engineering and Process Technology*, SciMed Central, July 2013 - present
Editorial Board member, *Journal of Materials*, Hindawi, July 2012 - present
Honorary editorial board, *Reports in Electrochemistry*, April 2011 - present
Editorial Board Member, *Nanomaterials*, MDPI, 2010-present.

Board membership: Pacific Northwest Chapter American Vacuum Society

Professional membership: American Institute of Chemical Engineers, The Electrochemical Society, American Vacuum Society, Institute of Electrical and Electronics Engineers, American Chemical Society, Material Research Society, American Association for the Advancement of Science, Microscopy Society of American, Society of Information Display.

5. Service to the Public

Outreach
Mentor, Summer Experience in Science and Engineering for Youth, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2008, 2009 OSU
Mentor, Apprenticeships in Science and Engineering Program, 2002, 2004, 2005, 2006, 2008, 2009, 2011, 2012 OSU

Alvin Chang – Corvallis High School, Corvallis OR 2013, 2014
"Growth and Characterizations of Copper Oxide Nanowires"

Derek Wong – Corvallis High School, Corvallis OR 2012
"Photochemical Deposition of Copper Sulfide Thin Films"

Matthew Carlson – Corvallis High School, Corvallis OR 2009
"Novel automatic dispensing system for thin film development"

David Ni – Crescent Valley High School, Corvallis OR 2008
"The fabrication of a nanoporous electrode for a new type of Li-ion battery"

Mon-Ting "Megan" Lu – Corvallis High School, Corvallis OR 2006
"Chemical bath deposition of nanostructured ZnO"

Genevieve Handloser – Philomath High School, Philomath, OR 2005
"Fabrication of thin film electronics using soft solution deposition techniques"

Christopher Breeden – Marist High School, Eugene, OR 2004
"Microcontact printing of surface monolayer for patterning of CBD CdS semiconductor layer"

Mary Fowler – Crescent Valley High School, Corvallis OR 2002
"Plasma etching"

Danielle Villaret – Crescent Valley High School, Corvallis OR 2002
"Copper electrodeposition"