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Professor
Materials Science and Engineering
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Research Interests and Key Research Concepts

Nanoscale engineering and growth of novel semiconductor and composite electronic materials for energy conversion and electronic devices

Molecular beam epitaxy, growth of nanocomposites, dilute bismuthides, thermoelectrics, terahertz sources and detectors, characterization of electronic materials and devices, new techniques for epitaxial growth of materials, materials for (opto)electronic devices including mid-infrared sources and detectors.

Education

9/2002 –6/2007
University of California, Santa Barbara, California
Doctor of Philosophy in Materials
Thesis Advisor: Professor Arthur Gossard

9/1998-6/2002
Stanford University, Stanford California
Bachelor of Science with Distinction, Materials Science and Engineering, 6/2002

Appointments

8/2007 – present
University of Delaware, Newark, Delaware
Professor – Materials Science and Engineering (5/2018-present)
Affiliate in Mechanical Engineering (5/2018-present)
Associate Professor – Materials Science and Engineering (9/2013-5/2018)
Affiliate in Mechanical Engineering (9/2013-5/2018)
Assistant Professor – Materials Science and Engineering (1/2009-9/2013)
Electrical and Computer Engineering (8/2007-12/2008)
Affiliate appointment in Mechanical Engineering (9/2007-9/2013)

9/2002 – 6/2007
University of California, Santa Barbara, California
Graduate Student Researcher – Department of Materials

9/2006 – 12/2006
University of California, Santa Barbara, California
Assistant Instructor – Materials 288O: Characterization of Electronic Materials

Selected Honors during Appointment at the University of Delaware

- Outstanding Junior Faculty Member – University of Delaware College of Engineering, 2017-2018
- Invited Participant – National Academy of Engineering U.S. Frontiers of Engineering Symposium, 2017
- American Vacuum Society – Peter Mark Memorial Award, 2014
- Department of Energy Early Career Award, 2012
- North American Molecular Beam Epitaxy Young Investigator, 2011
- Office of Naval Research Young Investigator, 2009
- Nominee – University of Delaware Teaching Award, 2009, 2011
- Nominee – University of Delaware Outstanding Graduate Advising and Mentoring Award, 2012

Honors Prior to Appointment at the University of Delaware

- Goldsmid Award – International Thermoelectric Society 2007
- Outstanding Student Paper Award – North American Conf. on Molecular Beam Epitaxy 2006
- Best Student Abstract – North American Conf. on Molecular Beam Epitaxy 2006
- Student Speaker Award – Symposium F, Materials Research Society Fall Meeting 2005
- NSF IGERT Fellowship (2003-2005)
- Tau Beta Pi (President, California Gamma Chapter [Stanford University] 2001-2002)

Key Research Concepts:

Molecular beam epitaxy, growth of nanocomposites, dilute bismuthides, thermoelectrics, terahertz sources and detectors, characterization of electronic materials and devices, new techniques for epitaxial growth of materials, materials for (opto)electronic devices including mid-infrared sources and detectors.

Research Support

The Zide lab has received >\$3M in research funding since 9/1/2007. Zide is PI on ~\$2M in funding and co-PI on > \$15M in funding. Funding sources include DARPA (Nanostructured Materials for Power program), ONR (Young Investigator Program, additional funding), NSF (DMR-Electronic and Photonic Materials program, Condensed Matter Physics programs, Engineering-Electronic, Photonic, and Magnetic Devices program), Department of Energy Office of Science (Early Career Award), the Keck Foundation, the University of Delaware Energy Institute, and the University of Delaware Research Foundation.

Journal Publications at UD [*h-index* = 30, Total citations: 5,209 (per Google Scholar)]

Zide group members are underlined, and Zide group undergraduates are denoted with ^U.

1. Eric Y. Chen, Zhuohui Li, Christopher C. Milleville, Kyle R. Lennon, Joshua M. O. Zide, and Matthew F. Doty. "CdSe(Te)/CdS/CdSe Rods Versus CdTe/CdS/CdSe Spheres: Morphology-Dependent Carrier Dynamics for Photon Upconversion." *IEEE Journal of Photovoltaics*, **8**, 746-751. (2018).
2. Cory C. Bomberger, Matthew R. Lewis, Laura R. Vanderhoef, Matthew F. Doty, and Joshua

- M. O. Zide. "Review Article: Overview of lanthanide pnictide films and nanoparticles epitaxially incorporated into III-V semiconductors." **Journal of Vacuum Science and Technology B**, **35**, 030801. (2017).
3. Henry Aldridge, Jr, Aaron G. Lind, Cory C. Bomberger, Yevgeniy Puzyrev, Joshua M. O. Zide, Sokrates T. Pantelides, Mark E. Law, and Kevin S. Jones. "N-type doping strategies for InGaAs." **Materials Science in Semiconductor Processing**, **57**, 39-47. (2017).
 4. Cory C. Bomberger, Bo E. Tew, Matthew R. Lewis, and Joshua M. O. Zide. "Growth and Characterization of TbAs films." **Applied Physics Letters**, **109**, 202104 (2016).
 5. Cory C. Bomberger, Jesus Nieto-Pescador, Matthew R. Lewis, Bo E. Tew, Yuejing Wang, D. Bruce Chase, Lars Gundlach, and Joshua M. O. Zide. "Growth and Characterization of ErAs:GaBi_xAs_{1-x}." **Applied Physics Letters**, **109**, 172103 (2016).
 6. Matthew Lewis, ^UKevin Bichoupan, S. Ismat Shah, and Joshua M. O. Zide. "Growth of ErAs Nanoparticles by Pulsed Laser Ablation in an Inert Environment." **Journal of Electronic Materials**, **45**, 6247. (2016). <http://dx.doi.org/10.1007/s11664-016-4775-z>
 7. Henry Aldridge, Jr., Aaron G. Lind, Cory C. Bomberger, Yevgeniy Puzyrev, Christopher Hatem, Russell M. Gwilliam, Joshua M. O. Zide, Sokrates T. Pantelides, Mark E. Law, and Kevin S. Jones. "Implantation and Diffusion of Silicon Marker Layers in In_{0.53}Ga_{0.47}As." **Journal of Electronic Materials** **45**, 8, pp. 4282-4287. (2016).
 8. Diane G. Sellers, Jing Zhang, Eric Y. Chen, Yujun Zhong, Matthew F. Doty, and Joshua M. O. Zide. "Novel nanostructures for efficient photon upconversion and high-efficiency photovoltaics." **Solar Energy Materials and Solar Cells**, **155**, p. 446-453. (2016).
 9. Eric Y. Chen, Jing Zhang, Diane G. Sellers, Yujun Zhong, Joshua M. O. Zide, and Matthew F. Doty. A Kinetic Rate Model of Novel Upconversion Nanostructures for High-Efficiency Photovoltaics." **IEEE Journal of Photovoltaics**, **PP**, 99 1-8
 10. D. Wei, C. Harris, C. C. Bomberger, J. Zhang, J. Zide, and S. Law. "Single-materials semiconductor hyperbolic metamaterials." **Optics Express**, **24**, 8, 8735 (2016).
 11. A. G. Lind, H. L. Aldridge Jr., C. C. Bomberger, C. Hatem, J. M. O. Zide, and K. S. Jones. "Fermi-level effects on extended defect evolution in Si⁺ and P⁺ implanted In_{0.53}Ga_{0.47}As." **ECS Journal of Solid State Science and Technology**, **5**, 4, P3073-3077 (2016).
 12. G. M. T. Chai, C. A. Broderick, E. P. O'Reilly, Z. Othaman, S. R. Jin, J. P. Petropoulos, Y. Zhong, P. B. Dongmo, J. M. O. Zide, S. J. Sweeney, and T. J. C. Hosea. "Experimental and modeling study of InGaBiAs/InP alloys with up to 5.8% Bi, and with $\Delta_{so} > E_g$." **Semiconductor Science and Technology**, **30**, 094015. (2015).
 13. Cory C. Bomberger, Laura R. Vanderhoef, Abdur Rahman, Deesha Shah, D. Bruce Chase, Antoinette J. Taylor, Abul K. Azad, Matthew F. Doty and Joshua M. O. Zide. "Determining the band alignment of TbAs:GaAs and TbAs:In_{0.53}Ga_{0.47}As." **Applied Physics Letters** **107**, 102103. (2015).
 14. A. G. Lind, H. L. Aldridge, Jr., C. C. Bomberger, C. Hatem, J. M. O. Zide, and K. S. Jones. "Comparison of thermal annealing effects on electrical activation of MBE grown and ion implant Si-doped In_{0.53}Ga_{0.47}As." **Journal of Vacuum Science & Technology B**, **33**, 021206. (2015).

15. D. G. Sellers, S. J. Polly, Y. Zhong, S. M. Hubbard, J. M. O. Zide, and M. F. Doty. "New Nanostructured Materials for Efficient Photon Upconversion." **IEEE Journal of Photovoltaics**, **5**, 224. (2015).
16. P. B. Dongmo, M. Hartshorne, ^UT. R. Cristiani, M. L. Jablonski, C. C. Bomberger, D. Isheim, D. N. Seidman, M. Taheri, and J. M. O. Zide. "Observation of Self-Assembled Core-Shell Structures in Epitaxially-Embedded TbErAs Nanoparticles." **small**, **10**, 4290. (2014).
17. C. R. Haughn, E. H. Steenbergen, L. J. Bissell, E. Y. Chen, K. G. Eyink, J. M. O. Zide, and M. F. Doty, "Carrier transfer from InAs quantum dots to ErAs metal nanoparticles." **Applied Physics Letters**, **105**, 103108. (2014).
18. L. R. Vanderhoef, A. K. Azad, C. C. Bomberger, D. R. Chowdhury, D. B. Chase, A. J. Taylor, J. M. O. Zide, and M. F. Doty, "Charge carrier relaxation processes in TbAs nano-inclusions in GaAs measured by optical-pump THz-probe transient absorption spectroscopy." **Physical Review B**, **89**, 045418. (2014).
19. ^UP. M. Attia, M. R. Lewis, C. C. Bomberger, A. K. Prasad, J. M. O. Zide, "Experimental studies of thermoelectric power generation in dynamic temperature environments." **Energy**, **60**, 453. (2013).
20. Y. Zhong, P. B. Dongmo, L. Gong, S. Law, D. B. Chase, D. Wasserman, and J. M. O. Zide, "Degenerately doped InGaBiAs:Si as a highly conductive and transparent contact material in the infrared range." **Optical Materials Express**, **3**, 1197. (2013).
21. P. Jha, T. D. Sands, P. Jackson, C. Bomberger, T. Favaloro, S. Hodson, J. M. O. Zide, X. Xu, and A. Shakouri, "Cross-plane thermoelectric transport in p-type $\text{La}_{0.67}\text{Sr}_{0.33}\text{MnO}_3/\text{LaMnO}_3$ oxide metal/semiconductor superlattices." **Journal of Applied Physics**, **113**, 193702 (2013).
22. C. R. Haughn, K. J. Schmieder, J. M. O. Zide, A. Barnett, C. Ebert, R. Opila, and M. F. Doty, "Quantification of trap state densities in GaAs heterostructures grown at varying rates using intensity-dependent time resolved photoluminescence." **Applied Physics Letters** **102**, 182108 (2013).
23. C. C. Bomberger, ^UP. M. Attia, A. K. Prasad, J. M. O. Zide, "Modeling passive power generation in a temporally-varying temperature environment via thermoelectrics." **Applied Thermal Engineering** **56**, 1-2, 152 (2013)
24. I. Marko, Z. Batool, K. Hild, S. Jin, N. Hossain, T. J. C. Hosea, J. P. Petropoulos, Y. Zhong, P. B. Dongmo, J. M. O. Zide, S. J. Sweeney, "Temperature and Bi-concentration dependence of the bandgap and spin-orbit splitting in InGaBiAs/InP semiconductors for mid-infrared applications." **Applied Physics Letters** **101**, 221108 (2012).
25. R. Kudrawiec, J. Kopaczek, J. Misiewicz, W. Walukiewicz, J. P. Petropoulos, Y. Zhong, P. B. Dongmo, and J. M. O. Zide, "Temperature dependence of E_0 and $E_0 + \Delta_{SO}$ transitions in $\text{In}_{0.53}\text{Ga}_{0.47}\text{Bi}_x\text{As}_{1-x}$ alloys studied by photoreflectance." **Journal of Applied Physics** **112**, 113508 (2012).
26. P. B. Dongmo, Y. Zhong, ^UP. Attia, C. Bomberger, R. Cheaito, J. F. Ihlefeld, P. E. Hopkins, and J. M. O. Zide, "Enhanced room temperature electronic and thermoelectric properties of the dilute bismuthide InGaBiAs." **Journal of Applied Physics**, **112**, 093710 (2012).

27. P. Jha, T. D. Sands, L. Cassels, P. Jackson, T. Favaloro, B. Kirk, J. M. O. Zide, X. Xu, and A. Shakouri, "Cross-plane electronic and thermal transport properties of p-type $\text{La}_{0.67}\text{Sr}_{0.33}\text{MnO}_3/\text{LaMnO}_3$ perovskite oxide metal/semiconductor superlattices." *Journal of Applied Physics*, **112**, 064714 (2012).
28. L. E. Clinger, G. Pernot, T. E. Buehl, A. C. Gossard, C. J. Palmstrøm, A. Shakouri, and J. M. O. Zide, "Thermoelectric properties of epitaxial TbAs:InGaAs nanocomposites." *Journal of Applied Physics*, **111**, 094312 (2012).
29. Y. Zhong, P. B. Dongmo, J. P. Petropoulos, J. M. O. Zide, "Effects of molecular beam epitaxial growth conditions on composition and optical properties of InGaBiAs." *Applied Physics Letters*, **100**, 112110 (2012).
30. A. T. Ramu, L. E. Clinger, P. B. Dongmo, J. T. Imamura, J. M. O. Zide, and J. E. Bowers. "Incompatibility of standard III-V compound semiconductor processing techniques with terbium doped InGaAs of high terbium concentration," *Journal of Vacuum Science and Technology A*, **30**, 031508 (2012).
31. E. Selezneva, L. Cassels, A. Ramu, G. Pernot, T. Buehl, T. Favaloro, J. Bahk, Z. Bian, J. Bowers, J. Zide, and A. Shakouri. "Thermoelectric transport in InGaAs with high concentration of rare-earth TbAs embedded nanoparticles." *Journal of Electronic Materials*, **41**, 1820 (2012).
32. R. Kudrawiec, J. Kopaczek, J. Misiewicz, J. P. Petropoulos, Y. Zhong, and J. M. O. Zide, "Contactless electroreflectance study of E_0 and $E_0 + \Delta_{SO}$ transitions in $\text{In}_{0.53}\text{Ga}_{0.47}\text{Bi}_x\text{As}_{1-x}$ alloys," *Applied Physics Letters*, **99**, 251906 (2011).
33. D. O. Klenov and J. M. O. Zide, "Structure of the InAlAs/InP interface by atomically resolved energy dispersive spectroscopy," *Applied Physics Letters* **99**, 141904 (2011).
34. J. P. Petropoulos, Y. Zhong, P. B. Dongmo, and J. M. O. Zide, "Optical and electrical characterization of InGaBiAs for use as a new mid-infrared optoelectronic material," *Applied Physics Letters*, **99** 031110 (2011).
35. L. E. Cassels, T. E. Buehl, P. G. Burke, C. J. Palmstrøm, A. C. Gossard, G. Pernot, A. Shakouri, C. R. Haughn, M. F. Doty, and J. M. O. Zide, "Growth and characterization of TbAs:GaAs nanocomposites," *Journal of Vacuum Science and Technology B*, **29**, 03C114 (2011).
36. J. P. Petropoulos, ^UT. R. Cristiani, P. B. Dongmo, and J. M. O. Zide, "A simple thermodynamic model for the doping and alloying of nanoparticles," *Nanotechnology*, **22**, 245704 (2011).
37. V. D. Dasika, A. V. Semichaevsky, J. P. Petropoulos, J. C. Dibbern, A. M. Dangelewicz, M. Holub, P. K. Bhattacharya, J. M. O. Zide, H. T. Johnson, and R. S. Goldman, "Influence of Mn dopants on InAs/GaAs quantum dot electronic states," *Applied Physics Letters*, **98**, 141907 (2011).
38. A. T. Ramu, L. E. Cassels, N. H. Hackman, H. Lu, J. M. O. Zide, J. E. Bowers, "Thermoelectric transport in the Coupled Valence-Band Model," *Journal of Applied Physics*, **109**, 033704 (2011).

39. J. M. O. Zide, J.-H. Bahk, R. Singh, M. Zebarjadi, G. Zeng, H. Lu, J. P. Feser, D. Xu, S. L. Singer, Z.X. Bian, A. Majumdar, J. E. Bowers, A. Shakouri, and A. C. Gossard, "High efficiency semimetal/semiconductor nanocomposite thermoelectric materials," *Journal of Applied Physics*, **108**, 123702 (2010).
40. A.T. Ramu, L. E. Cassels, N. H. Hackman, H. Lu, J. M. O. Zide, J. E. Bowers, "Rigorous calculation of the Seebeck coefficient and mobility of thermoelectric materials," *Journal of Applied Physics*, **107**, 083707 (2010).

Publications Prior to Appointment at the University of Delaware/Based on Prior Work:

41. K. J. Russell, F. Capasso, V. Narayanamurti, H. Lu, J. M. O. Zide, A. C. Gossard, "Scattering-assisted tunneling: Energy dependence, magnetic field dependence, and use as an external probe of two-dimensional transport," *Physical Review B*, **82**, 115322 (2010).
42. J.-H. Bahk, G.H. Zeng, J. M. O. Zide, H. Lu, R. Singh, D. Liang, A.T. Ramu, P. Burke, Z.X. Bian, A.C. Gossard, A. Shakouri, and J. E. Bowers, "High-temperature thermoelectric characterization of III-V semiconductor thin films by oxide binding," *Journal of Electronic Materials*, **39**, 1125 (2010).
43. J.-H. Bahk, Z. X. Bian, M. Zebarjadi, J. M. O. Zide, H. Lu, D. Xu, J. P. Feser, G. Zeng, A. Majumdar, A. C. Gossard, A. Shakouri, J. E. Bowers, "Thermoelectric Figure of Merit of InGaAlAs III-V semiconductor alloys," *Physical Review B*, **81**, 235209 (2010).
44. M. Zebarjadi, K. Esfarjani, A. Shakouri, J. Bahk, Z. Bian, G. Zeng, J. Bowers, H. Lu, J. Zide, and A. Gossard, "Effect of nanoparticle scattering on thermoelectric power factor," *Applied Physics Letters*, **94**, 202105 (2009).
45. Y.K. Koh, S.L. Singer, W. Kim, J.M. Zide, H. Lu, D.G. Cahill, A. Majumdar, and A.C. Gossard, "Comparison of the 3ω method and time-domain thermoreflectance for measurements of the cross-plane thermal conductivity of epitaxial semiconductors," *Journal of Applied Physics*, **105**, 054303 (2009).
46. R. Singh, Z. Bian, A. Shakouri, G. Zeng, J. Bahk, J.E. Bowers, J.M. Zide, and A.C. Gossard, "Direct measurement of thin-film thermoelectric figure of merit," *Applied Physics Letters*, **94**, 212508 (2009).
47. M. Zebarjadi, K. Esfarjani, A. Shakouri, Z.X. Bian, J. Bahk, G. Zeng, J. Bowers, H. Lu, J. Zide, and A. Gossard, "Effect of Nanoparticles on Electron and Thermoelectric Transport," *Journal of Electronic Materials*, **38**, 954 (2009).
48. E.R. Brown, K. Williams, W. Zhang, J.Y. Suen, H. Lu, J. Zide, and A.C. Gossard, "Electrical Transport in a Semimetal–Semiconductor Nanocomposite," *IEEE Transactions on Nanotechnology*, **8**, 402 (2009).
49. J. Lim, W. Lee, H. Sim, R.D. Averitt, J.M. Zide, A.C. Gossard, and J. Ahn, "Effect of nonuniform continuum density of states on a Fano resonance in semiconductor quantum wells," *Physical Review B*, **80**, 035322 (2009).
50. G. Zeng, J. Bahk, J.E. Bowers, H. Lu, J.M. Zide, A.C. Gossard, R. Singh, Z. Bian, A. Shakouri, S.L. Singer, W. Kim, and A. Majumdar, "Power Generator Modules of Segmented Bi_2Te_3 and $\text{ErAs}:(\text{InGaAs})_{1-x}(\text{InAlAs})_x$," *Journal of Electronic Materials*, **37**, 1786 (2008).

51. W. Kim, S.L. Singer, A. Majumdar, J.M. Zide, D. Klenov, A.C. Gossard, and S. Stemmer, "Reducing thermal conductivity of crystalline solids at high temperature using embedded nanostructures." *Nano Letters*, **8**, 2097 (2008).
52. A. Azad, R. Prasankumar, D. Talbayev, A. J. Taylor, J. F. O'Hara, R. D. Averitt, J. M. O. Zide, H. Lu, A. C. Gossard. "Carrier dynamics in InGaAs with embedded ErAs nanoislands." *Applied Physics Letters*, **93**, 121108 (2008).
53. H.-T. Chen, S. Palit, T. Tyler, C. M. Bingham, J. M. O. Zide, J. F. O'Hara, D. R. Smith, A. C. Gossard, R. D. Averitt, W. J. Padilla, N. M. Jokerst, A. J. Taylor. "Hybrid metamaterials enable fast electrical modulation of freely propagating terahertz waves." *Applied Physics Letters*, **93**, 091117 (2008).
54. M. A. Scarpulla, J. M. O. Zide, J. M. LeBeau, C. G. Van de Walle, A. C. Gossard, and K. T. Delaney. "Near-infrared absorption and semimetal-semiconductor transitions in 2 nm ErAs nanoparticles embedded in GaAs and AlAs." *Applied Physics Letters*, **92**, 173116 (2008).
55. G. Zeng, J.-H. Bahk, J. E. Bowers, J. M. O. Zide, A. C. Gossard, Z. X. Bian, R. Singh, and A. Shakouri. "ErAs:(InGaAs)_{1-x}(InAlAs)_x alloy power generator modules." *Applied Physics Letters*, **91**, 263510 (2007).
56. Z. X. Bian, M. Zebarjadi, R. Singh, Y. Ezzahri, A. Shakouri, G. Zeng, J.-H. Bahk, J. E. Bowers, J. M. O. Zide, and A. C. Gossard. "Cross-plane Seebeck coefficient and Lorenz number in superlattices." *Physical Review B*, **76**, 205311 (2007).
57. H.-T. Chen, W. J. Padilla, J. M. O. Zide, S. R. Bank, A. C. Gossard, A. J. Taylor, and R. D. Averitt. "Ultrafast optical switching of terahertz metamaterials fabricated on ErAs/GaAs nanoisland superlattices." *Optics Letters*, **32**, 1620 (2007).
58. W. Yi, V. Narayanamurti, J. M. O. Zide, S. R. Bank, and A. C. Gossard. "Probing energy barriers and quantum confined states of buried semiconductor heterostructures with ballistic carrier injection." *Physical Review B*, **75**, 115333. (2007).
59. M. P. Hanson, S. R. Bank, J. M. O. Zide, J. D. Zimmerman, and A. C. Gossard. "Controlling electronic properties of epitaxial nanocomposites of dissimilar materials." *Journal of Crystal Growth*, **301-302**. 4-9. (2007).
60. D. O. Klenov, J. M. O. Zide, J. M. LeBeau, A. C. Gossard, and S. Stemmer. "Ordering of ErAs nanoparticles embedded in epitaxial InGaAs layers." *Applied Physics Letters*, **90**, 121917. (2007).
61. G. Zeng, J. M. O. Zide, W. Kim, J. E. Bowers, A. C. Gossard, Z. X. Bian, Y. Zhang, A. Shakouri, S. L. Singer, and A. Majumdar. "Cross-plane Seebeck coefficient of ErAs:InGaAs/InGaAlAs superlattice." *Journal of Applied Physics*, **101**, 034502 (2007).
62. J. M. O. Zide, D. Vashaee, Z. X. Bian, G. Zeng, J. E. Bowers, A. Shakouri, and A. C. Gossard. "Demonstration of electron filtering to increase the Seebeck coefficient in ErAs:InGaAs/InGaAlAs superlattices." *Physical Review B*, **74**, 205335 (2006).
63. H. -T. Chen, W. J. Padilla, J. M. O. Zide, A. C. Gossard, A. J. Taylor, and R. D. Averitt. "All Solid State Terahertz Metamaterial Devices." *Nature*, **444**, 597 (2006).

64. J. F. O'Hara, J. M. O. Zide, A. C. Gossard, A. J. Taylor, and R. D. Averitt. "Enhanced terahertz detection via ErAs:GaAs nanoisland superlattices." *Applied Physics Letters*, **88**, 251119 (2006).
65. W. Kim, S. L. Singer, A. Majumdar, D. Vashaee, Z. X. Bian, A. Shakouri, G. Zeng, J. E. Bowers, J. M. O. Zide, and A. C. Gossard. "Cross-plane lattice and electronic thermal conductivities of ErAs:InGaAs/InGaAlAs superlattices." *Applied Physics Letters*, **88**, 242107 (2006).
66. J. M. O. Zide, A. Kleiman-Shwarstein, N. C. Strandwitz, J. D. Zimmerman, T. Steenblock-Smith, A. C. Gossard, A. Forman, A. Ivanovskaya, and G. D. Stucky. "Increased efficiency in multijunction solar cells through the incorporation of semimetallic ErAs nanoparticles into the tunnel junction." *Applied Physics Letters*, **88**, 162103 (2006).
67. G. Zeng, J. E. Bowers, J. M. O. Zide, A. C. Gossard, W. Kim, S. Singer, A. Majumdar, R. Singh, Z. X. Bian, Y. Zhang, and A. Shakouri. "ErAs:InGaAs/InGaAlAs superlattice thin-film power generator array." *Applied Physics Letters*, **88**, 113502 (2006).
68. W. Kim, J. M. O. Zide, A. Gossard, D. Klenov, S. Stemmer, A. Shakouri, and A. Majumdar. "Thermal Conductivity Reduction and Thermoelectric Figure of Merit Increase by Embedding Nanoparticles in Crystalline Semiconductors." *Physical Review Letters*, **96**, 045901 (2006).
69. J. M. Zide, D. O. Klenov, S. Stemmer, A. C. Gossard, G. Zeng, J. E. Bowers, D. Vashaee, and A. Shakouri. "Thermoelectric power factor in semiconductors with buried epitaxial semimetallic nanoparticles." *Applied Physics Letters*, **87**, 112102 (2005).
70. D. O. Klenov, J. M. Zide, J. D. Zimmerman, A. C. Gossard, and S. Stemmer. "Interface atomic structure of epitaxial ErAs layers on (001) In_{0.53}Ga_{0.47}As and GaAs." *Applied Physics Letters*, **86**, 241901 (2005).
71. R. P. Prasankumar, A. Scopatz, D. J. Hilton, A. J. Taylor, R. D. Averitt, J. M. Zide, and A. C. Gossard. "Carrier dynamics in self-assembled ErAs nanoislands embedded in GaAs measured by optical-pump terahertz-probe spectroscopy." *Applied Physics Letters*, **86**, 201107 (2005).

Book Chapter

1. Yujun Zhong, Pernell Dongmo, Joshua Zide, "Dilute Bismuthides on an InP Platform." in *Bismuth-Containing Compounds*, Springer Series in Materials Science, Volume 186, pp. 89-116). (2013).

Refereed Conference Proceedings

1. Yuejing Wang, Charles Jabbour^U, and Joshua Zide. "Materials for 1.55 μ m-pumped terahertz photoconductive switches: a review." *Proc. SPIE*, **10383**, 103830N (2017)
2. Matthew Doty, Xiangyu Ma, Joshua Zide, Garnett Bryant. "Molecular engineering with artificial atoms: designing a material platform for scalable quantum spintronics and photonics." *Proc. SPIE* **10357**, 1035739 (2017)

3. J. M. O. Zide, H. Lu, T. Onishi, J. L. Schroeder, J. E. Bowers, N. P. Kobayashi, T. D. Sands, A. C. Gossard, and A. Shakouri, "Novel metal/semiconductor nanocomposite and superlattice materials and devices for thermoelectrics," *Proc. SPIE*, **7683**, 76830V (2010)
4. R. D. Averitt, W. J. Padilla, H.-T. Chen, J. F. O'Hara, A. J. Taylor, C. Highstrete, M. Lee, J. M. O. Zide, S. R. Bank, and A. C. Gossard. "Terahertz metamaterial devices." *Proc. SPIE* **6772**, 677209 (2007).
5. N. I. Landy, H.-T. Chen, J. F. O'Hara, J. M. O. Zide, A. C. Gossard, C. Highstrete, M. Lee, A. J. Taylor, R. D. Averitt, W. J. Padilla. "Terahertz materials for active, tunable, and dynamic devices." *Proc. SPIE* **6581**, 65810P (2007).

Patents (6) and published applications (2)

1. M. F. Doty and **J. M. O. Zide**. "Systems for efficient photon upconversion." US Patent #9,954,129, issued 2018.
2. **J. M. O. Zide**, A. C. Gossard, A. Shakouri, J. E. Bowers. "High efficiency thermoelectric materials based on metal/semiconductor nanocomposites." US Patent #9,136,456, issued 2015.
3. M. Bell, P. Gleckman, **J. Zide**, H. Shaughnessy. "Computer vision based touch screen." US Patent #8,035,624, issued 2011.
4. M. Bell, P. Gleckman, **J. Zide**, H. Shaughnessy. "Interactive video window." US Patent #8,035,614, issued 2011.
5. M. Bell, P. Gleckman, **J. Zide**, H. Shaughnessy. "Self-contained interactive video display system." US Patent #8,035,612, issued 2011.
6. M. Bell, P. Gleckman, **J. Zide**, H. Shaughnessy. "Processing an image utilizing a spatially varying pattern." US Patent #7,710,391, issued 2010.
7. **J. M. O. Zide**. "Multijunction high efficiency photovoltaic device and methods of making the same." USPTO Application #20100006136 (2010).
8. A. C. Gossard, **J. M. O. Zide**, J. D. Zimmerman. "Enhanced tunnel junction for improved performance in cascaded solar cells." USPTO Application #20070227588. (2007).

Invited Conference/Workshop Presentations

1. (*Plenary*) **J. M. O. Zide**. "New Semiconductors and Epitaxial Nanocomposites for Electronic and Optoelectronic Applications." Serbian Ceramic Society Conference – Advanced Ceramics and Applications VI. Belgrade, Serbia. (*invited* September 2017)
2. **J. M. O. Zide**. "Band Engineering of Metal/Semiconductor Nanocomposites for Longer Wavelength High Performance Terahertz Photoconductive Switches." SPIE Optics and Photonics. San Diego, California. (*invited* August 2017).
3. **J. M. O. Zide**. "Lanthanide mononictide nanoparticles within III-V semiconductors for photoconductive switches and other terahertz devices." SPIE Commercial + Scientific Sensing and Imaging. Anaheim, California. (2017).
4. (*Keynote*) **J. M. O. Zide**. "Novel Semiconductor and Epitaxial Nanocomposite Materials for Electronic and Photonic Applications: The Science and Engineering Views." International Symposium on Advanced Materials, Islamabad, Pakistan. (2015).
5. **J. M. O. Zide**. "Photon Upconversion for Efficient Solar Energy Conversion" International Symposium on Advanced Materials, Islamabad, Pakistan. (2015).

6. J. M. O. Zide, “Peter Mark Memorial Lecture: Novel Semiconductor and Epitaxial Nanocomposite Materials for Electronic and Photonic Applications” AVS 61 Symposium, Baltimore, Maryland (2014).
7. (*Keynote*) J. M. O. Zide. “New Materials and Device Designs for Solar and Thermoelectric Energy Conversion.” International Conference on Renewable Energy Resources, Bahawalpur, Pakistan. (2014).
8. J. M. O. Zide, M. F. Doty, Y. Zhong, D. G. Sellers, E. Chen, J. Zhang. “Upconversion as a viable route to increased efficiency solar energy conversion.” International Conference on Renewable Energy Resources, Bahawalpur, Pakistan. (2014).
9. J. M. O. Zide, M. F. Doty, Y. Zhong, D. G. Sellers, E. Chen, J. Zhang. “Upconversion as a viable route to increased efficiency solar energy conversion.” Solar Workshop: Terawatt Challenge!?, Newark, DE, (2014).
10. J. M. O. Zide, Y. Zhong, P. B. Dongmo. “Electronic, optical, and thermal properties of MBE-grown InGaBiAs on InP.” 3rd International Workshop on Bismuth-Containing Semiconductors, Victoria, BC, Canada. (2012).
11. L. Cassels, P. Dongmo, A. Ramu, G. Pernot, T. Buehl, A. Gossard, A. Shakouri, C. Palmstrøm, J. Bowers, J. M. O. Zide, “Enhancing Efficiency in Thermoelectrics with MBE-grown Tb(Er)As/InGaAs Nanocomposites,” North American Conference on Molecular Beam Epitaxy, San Diego, CA (2011).
12. J. M. O. Zide, Optical, electrical, and thermal properties of TbAs:(In)GaAs Nanocomposites, Workshop on embedded nanoparticles, Santa Barbara, CA (2011).
13. J. M. O. Zide, “Improved Thermoelectric Performance in Epitaxial Metal/Semiconductor Nanocomposites,” Advanced Concepts in Semiconductor Materials and Devices for Energy Conversion, Beltsville, MD (2010).
14. J. M. O. Zide. “Novel Metal/Semiconductor Nanocomposite and Superlattice Materials and Devices for Thermoelectrics” SPIE – Defense, Security, and Sensing. Orlando, FL (2010).
15. J. M. O. Zide, A. Shakouri, and A. Majumdar. “The Use of Nanoparticle Inclusions to Reduce Thermal Conductivity in Thermoelectrics.” Advances in Peltier Cooling Workshop, Air Force Research Laboratory, Albuquerque, NM (2009).
16. J. M. O. Zide. “Metal/Semiconductor Nanocomposites and Electron Filtering Effects for Thermoelectric Applications.” 8th Pacific Rim Conference on Ceramic and Glass Technology. Vancouver, BC, Canada. (2009).
17. J. M. O. Zide et al. “Optical and terahertz characterization of semimetallic nanoparticles embedded in III-V semiconductors.” Los Alamos/Sandia: Center for Integrated Nanotechnology (CINT) User Workshop. Albuquerque, NM. (2006).

Selected Invited Seminars

1. Delaware State University, 2018.
2. Peking University/Chinese Academy of Sciences Institute of Physics, 2016.
3. Chinese Academy of Sciences: Institute of High Energy Physics, 2016.
4. Chinese Academy of Sciences: Suzhou Institute of Nano-technology, 2016.
5. Tsinghua University, Materials Science Department, 2016.
6. Nanjing University, 2016.
7. City University of New York – Chemistry, Salzburg Lecture, 2016.
8. Franklin & Marshall College – Chemistry and Physics, 2015.
9. Tufts University – Electrical and Computer Engineering, 2013.

10. Pennsylvania State University – Materials Science and Engineering Department, 2013.
11. Princeton University – Princeton Institute for the Science and Technology of Materials, 2013.
12. University of Michigan – Center for Solar and Thermoelectric Energy Conversion, 2013.
13. University of Texas at Austin – Microelectronics Research Center Distinguished Seminar, 2012.
14. University of Virginia – Departments of Physics, Materials, Mechanical Engineering, and Electrical Engineering, 2012.
15. University of Delaware – Electrical and Computer Engineering Department, 2012.
16. Yale University, Electrical and Computer Engineering Department, 2011.
17. University of Maryland, Materials Science and Engineering Department, 2011.
18. National Institute for Standards and Technology, Boulder, CO, 2011.
19. Millersville University – Physics Department, 2009.
20. University of Delaware – Materials Science and Engineering Department, 2009.
21. Army Research Laboratories (Adelphi) – SEDD Group, 2008.
22. University of Delaware – Department of Physics and Astronomy (Condensed Matter Group), 2007.
23. University of Delaware – Electrical and Computer Engineering Department, 2007.
24. University of California, Santa Barbara – Materials Department, 2004.

Teaching

- Spring 2008 – Epitaxy and Band Engineering (ELEG/MSEG 867)
- Fall 2008 – Characterization of Electronic Materials and Devices (ELEG/MSEG 467/667)
- Spring 2009 – Introduction to Materials Science (MSEG 302) co-taught with Opila
- Fall 2009 – Applied Quantum Mechanics I (MSEG 667)
- Spring 2010 – Epitaxy and Band Engineering (MSEG/ELEG 860)
- Fall 2010 – Applied Quantum Mechanics I (MSEG 640)
- Fall 2011 – Applied Quantum Mechanics I (MSEG 640)
- Spring 2012 – Characterization of Electronic Materials and Devices (MSEG/ELEG 467/667)
- Fall 2013 – Applied Quantum Mechanics I (MSEG 640)
- Spring 2013 – Introduction to Materials Science and Engineering (MSEG 302)
- Fall 2013 – Applied Quantum Mechanics I (MSEG 640)
- Spring 2014 – Epitaxy and Band Engineering (MSEG/ELEG 860)
- Fall 2014 – Applied Quantum Mechanics I (MSEG 640)
- Spring 2015 – Solid State Materials II (MSEG 842) co-taught with Doty
- Fall 2015 – Introduction to Materials Science (MSEG 302) co-taught with Johnson, Doty, Chase
- Spring 2016 – Characterization of Electronic Materials and Devices (MSEG467/667)
- Fall 2016 – Nanotech in the News (MSEG 288)
- Spring 2017 – Solid State Materials I (MSEG 841)
- Fall 2017 – Epitaxy and Band Engineering (MSEG 860)
- Spring 2018 – Solid State Materials I (MSEG 841)

Prof. Zide has been nominated twice (2009, 2011) for the UD University Teaching Award and several additional times for the College of Engineering Teaching Award.

Service to Research Community

- Reviewer: *Thin Solid Films*, *Electronics Letters*, *Applied Surface Science*, *Applied Physics Letters*, *Physical Review B*, *ACS Nano*, *Nano Letters*, *Physical Chemistry*

Chemical Physics, Journal of Electronic Materials, Proceedings of the National Academy of Science, Journal of the American Chemical Society, Journal of Crystal Growth, Surface Science, Communications Physics, Nature Materials, Nature Energy, National Science Foundation, American Society for Engineering Education, Department of Energy Office of Science

- Most Valuable Reviewer 2016, *Journal of Vacuum Science and Technology*
- Session Chair and Abstract Sorter: 2008 American Physical Society March Meeting
- Focus Topic Chair and Abstract Sorter: 2012 American Physical Society March Meeting

- Program Committee: 2010-2018 Electronic Materials Conference
 - 2012-present, member of the EMC Committee
 - 2018-present, Treasurer, EMC Committee
 - Host, 2016 EMC (held at UD) and Local Arrangements Chair/Host, 2016 Device Research Conference

- Program Committee: 2010, 2011, 2012, 2017, 2018 North American Conference on Molecular Beam Epitaxy, 2014, 2018 International Conference on Molecular Beam Epitaxy

- Editorial Board member, *Journal of Vacuum Science and Technology*, 2017-present
- Editorial Advisory Board Member, *Applied Surface Science*, 2017-present

- Editor: *Journal of Vacuum Science and Technology B* – Special Issue (Papers from NAMBE), 2011
- Guest Editor: *Journal of Electronic Materials* – Special Issue (Papers from EMC), 2013, 2014, 2015, 2017.
- Guest Editor: *Semiconductor Science and Technology* – Special Issue (Dilute bismides and related materials) 2015.
- Guest Editor: *Journal of Applied Physics* – Special Topic: Highly Mismatched Semiconductors Alloys: from Atoms to Devices, 2018.
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Selected Service to Institution

- A. Graduate Program Director, MSE (2018-present)
- B. Member, University Nanofabrication Facility Advisory Board (2013-present)
- C. Member, University Cleanroom Task Force and several subcommittees (2011-2013)
- D. Member College of Engineering ISEB Cleanroom/Instrumentation Committee (2009-2011)
- E. Senator, University of Delaware Faculty Senate (2014-2018)
- F. Department Representative, College of Engineering Diversity Committee (2012-present)
- G. Co-Chair, College of Engineering Diversity Committee (2013-2014)
- H. Chair, College of Engineering Diversity Committee (2014-2016)
- I. Chair, Clare Boothe Luce Assistant Professor search/hiring committee (2013-2014)
 - a. Mentor to Stephanie Law, CBL Assistant Professor
- J. Member, MSE faculty search/hiring committee (2014-2015, 2017-2018)
- K. Member, MSE Undergraduate Education Exploratory Committee (2010-2011)

- L. Member, MSE Graduate Committee (2014-present)
 - a. Chair (2018-present)
- M. Member, MSE faculty search/hiring committee (2010)
- N. Member, MSE awards committee (2009-present)
- O. Organizer (with Doty, Hu), MSE Seminar Series (2008-2014)
- P. Faculty adviser, MSE Safety Committee (2011-2012)
- Q. Member, Faculty Senate Library Committee (2013-2017)
- R. Member, College of Engineering Elections Committee (2011-2014)
- S. Undergraduate Research Program – Senior Thesis Third Reader (2014-2015)

Graduated Students

(current affiliation)

Doctor of Philosophy

Yujun Zhong '13	Caterpillar (Data Analytics)
Pernell Dongmo '15	Global Foundries (IBM), Vermont
Cory Bomberger '16	Intel Corporation

Masters of Science

Laura (Cassels) Clinger '11	Dupont Corporation
John Petropoulos '11	Apple Computers

Bachelors

Thomas Cristiani '13	University of California, Santa Barbara
Peter Attia '14	Stanford University
Chelsea Shockey '14	Dupont Corporation
Kevin Bichoupan '16	Deloitte Consulting
Ana Haddad '18	ExxonMobil

Current Students

Graduate:

Matthew Lewis, Eric Chen (co-advised with M. Doty), Bo Tew, Jing Zhang, Yuejing (Crystal) Wang, Lauren Nowicki, James Bork

Undergraduate:

Charles Jabbour

Diversity

>50% of the students within the Zide research group have been women or underrepresented minorities.