

Curriculum Vitae  
James R. Doyle  
January 2022

## Education

Undergraduate: B.S. (Major: Physics Minor: Chemistry) May 1981  
University of Michigan-Dearborn MI 48128

Graduate: Ph.D. (Physics) August 1989  
Joint Institute for Laboratory Astrophysics (JILA)  
University of Colorado-Boulder CO 80309  
Thesis adviser: Alan Gallagher  
Thesis title: *Deposition Kinetics of Hydrogenated Amorphous Silicon and Silicon-Germanium Thin Films*

## Academic Appointments

2005  
To present Professor of Physics  
Macalester College, St. Paul, MN 55105

1998  
to 2005 Associate Professor of Physics  
Macalester College, St. Paul, MN 55105

1992  
to 1998: Assistant Professor of Physics  
Macalester College, St. Paul, MN 55105

1989  
to 1992 Postdoctoral research associate, Department of Materials Science and  
Engineering, University of Illinois, Urbana IL (supervisor: John R. Abelson)

## Research Interests

General areas of interest: Energy technology, materials science, computational methods and simulations, chemical physics, plasma physics, biophysics, ecology, electronics.

Specific areas of interest: Modelling of electrical grid load balance and storage; demand response modelling and hardware implementation; Deposition and characterization of materials used in photovoltaics; Deposition and characterization of materials used for water hydrolysis; Deposition and characterization of biomaterials. Fundamental chemical and physical processes in plasma-enhanced chemical vapor deposition and physical vapor deposition; Thin film deposition and characterization; Non-equilibrium chemical kinetics; Computational simulations in ecology; Theory and simulation of excitable biological membranes;

### Current projects:

- Simulations of grid load balancing and storage with high penetration of wind and solar energy
- Computer Simulation of sputter deposition processes (in collaboration with Professor Keith Kuwata, Department of Chemistry, Macalester College)

- Computer simulation of invasive and native species competition at the Ordway Field Station (in collaboration with Dr. Michael Anderson, Department of Biology, Macalester College)
- Stochastic effects in neuron action potentials
- Deposition of nickel-based films for hydrogen production by water electrolysis

### **Publications (Macalester undergraduate student co-authors are denoted by \*)**

37. Nicholas Moore\* and James R. Doyle *Storage Considerations for High Grid Penetration of Wind and Solar Power with Added Baseload Power*. International Conference on Environmental Science and Green Technology (ICESGT) 15th Mar 2020, Agra, India *Conference paper*.
36. Hannah Johlas\*, Shelby Witherby\*, and James R. Doyle *Storage requirements for high grid penetration of wind and solar power for the MISO region of North America: A case study* Renewable Energy 146, 1315-1324 (2020). *Journal Article*
35. Abigail Cotter\*, Alexander Stowell\*, John Carlson\*, and James R. Doyle *A mass spectrometric method for estimating dissociation rates in hydrogen discharge plasma*, Journal of Vacuum Science and Technology A 36, 031304 (2018). *Journal Article*
34. James R. Doyle and Hannah Johlas\*. *Energy Storage Considerations for High Renewable Power Penetration: A Case Study*. in: SenGupta S., Zobaa A., Sherpa K., Bhoi A. (eds) *Advances in Smart Grid and Renewable Energy*. Lecture Notes in Electrical Engineering, vol 435. Springer, Singapore (2018). *Conference paper*.
33. James R. Doyle and Hannah Johlas\* *Strategies for the reduction of energy storage capacity for high penetration of wind and solar power* in Sustainable and Renewable Energy Engineering (ICSREE), (2017) 2nd International Conference, Hiroshima, Japan (IEEE, 2017). *Conference paper*.
32. Samuel J. Levang\* and James R. Doyle, *Properties of Hydrogenated Amorphous Silicon-Germanium Alloys Deposited by Dual Target Reactive Magnetron Sputtering*, Proceedings of the Materials Research Society Amorphous and Polycrystalline Thin-Film Silicon Science and Technology –2012 Volume 1426, 2102 (2012). *Conference paper*.
31. T. Kaufman-Osborne\*, K. M. Pollock\*, J. Hiltrop\*, K. Braam\*, S. Fazzio\*, and J. R. Doyle, *The effects of temperature and near-substrate plasma density on the structural and electrical properties of dc sputtered germanium thin films*, Thin Solid Films **520**, 1866 (2012). *Journal Article*
30. K. M. Pollock\*, T. Kaufman-Osborn\*, J. Hiltrop\*, and J. R. Doyle, *Effect of Near-Substrate Plasma Density in the Reactive Magnetron Sputter Deposition of Hydrogenated Amorphous Germanium*, Journal of Vacuum Science and Technology A **29**, 051301, (2011). *Journal Article*
29. I. T. Martin, C.W. Teplin, J. R. Doyle, H. M. Branz, and P. Stradins, *Physics and Chemistry of hot-wire chemical vapor deposition from silane: measuring and modeling the silicon epitaxy deposition rate*, Journal of Applied Physics **107**, 054906 (2010). *Journal Article*
28. J.P. Craddock, D.H. Malone, J. Magloughlin, A.L. Cook, M.E. Rieser, and J.R. Doyle, *Dynamics of the emplacement of the Heart Mountain allochthon at White Mountain: Constraints from calcite twinning strains, anisotropy of magnetic susceptibility, and thermodynamic calculations*, Bulletin of the Geological Society of America **121**, 919 (2009). *Journal Article*

27. J. R. Doyle, Y. Xu, R. Reedy, H. M. Branz and A. H. Mahan, *Film stoichiometry and gas dissociation kinetics in hot-wire chemical vapor deposition of a-SiGe:H*, Thin Solid Films, **516**, 526 (2008). *Journal Article*
26. N. W. Schmidt\*, T. S. Totushek\*, W. A. Kimes\*, D. R. Callender\*, and J. R. Doyle, *The effects of substrate temperature and near-substrate plasma density on the properties of dc magnetron sputtered aluminum doped zinc oxide*, Journal of Applied Physics, **94**, 5514- 5521, (2003). *Journal Article*
25. K. T. Kuwata, R.I. Erickson\*, and J.R. Doyle, *A comparative study of interatomic potentials for copper and aluminum gas phase sputter atom transport simulations*, Nuclear Instruments and Methods in Physics Research B, **201**, 566 – 570, (2003). *Journal Article*
24. J.R. Doyle and G.J. Feng *Effects of surface topography on oxide deposition rates using TEOS/O<sub>2</sub> chemistry*, Journal of Vacuum Science and Technology B, **17**, 2147-2152 (1999). *Journal Article*
23. J.R. Doyle, *Chemical kinetics in low pressure acetylene rf glow discharges*, Journal of Applied Physics vol **82**, pp 4763 - 4771 (1997). *Journal Article*
22. D.J. Dagle\*, C.M. Mallouris\* and J.R. Doyle, *Radical and film growth kinetics in methane rf glow discharges*, Journal of Applied Physics vol **79**, pp 8735 - 8747 (1996). *Journal Article*
21. J.R. Doyle, A. Nurrudin, and J.R. Abelson, *Effect of anode bias on plasma confinement in dc magnetron discharges*, Journal of Vacuum Science and Technology, vol. **A12**, pp 886-888 (1994). *Journal Article*
20. A. Nurrudin, J.R. Doyle, and J.R. Abelson, *Macro-trench studies of the surface reaction probability in a-Si:H deposition*, Journal of Applied Physics vol. **76**, pp 3123-3129 (1994). *Journal Article*
19. J.R. Abelson, L.M. Mandrell, and J.R. Doyle, *Hydrogen release kinetics from the a-Si:H surface during reactive magnetron sputter deposition*, Journal of Applied Physics vol. **76**, pp. 1856 - 1870 (1994). *Journal Article*
18. A.M. Myers, J.R. Doyle, and D.N. Ruzic, *Monte Carlo simulations of sputter atom transport in low pressure sputtering: the effects of interaction potential, sputter distribution, and system geometry*, Journal of Applied Physics **72**, 3064 (1992). *Journal Article*
17. J.R. Doyle, D.A. Doughty, and A. Gallagher, *Plasma Chemistry in Disilane Discharges*, Journal of Applied Physics **71**, 4771 (1992). *Journal Article*
16. J.R. Doyle, D.A. Doughty, and A. Gallagher, *Plasma chemistry in silane/germane and disilane/germane mixtures*, Journal of Applied Physics. **71**, 4727 (1992). *Journal Article*
15. J.R. Doyle, D.A. Doughty, and A. Gallagher, *Germane discharge chemistry*, Journal of Applied Physics **69**, 4169 (1991). *Journal Article*
14. A. Nurrudin, J.R. Doyle, and J.R. Abelson, *Macro-trench studies of surface reaction probability during a-Si:H growth* in Amorphous Silicon Technology 1992 ed. M.

Thompson et al. (Mat. Res. Soc. Symp. Proceedings. Vol. 258), p. 33. *Conference paper*.

13. A.M. Myers, J.R. Doyle, J.R. Abelson, and D.N. Ruzic, *Monte Carlo simulations of magnetron sputtering particle transport*, J. Vac. Sci. Technol. **A9**, 614 (1991). *Journal Article*

12. J.R. Doyle, N. Maley, and J.R. Abelson, *Light induced changes in photocarrier transport in magnetron sputtered a-Si:H*, in "Amorphous silicon Materials and Solar Cells" AIP conference Proceedings 234 (Denver, CO 1991), pp. 248-255. *Conference paper*.

11. J.R. Doyle, N. Maley, J.R. Abelson, *Schottky barriers on magnetron sputtered a-Si:H: depletion width effects on photocarrier collection vs bandgap and light soaking*, in "Amorphous Silicon Technology 1991" ed. A. Madan et al. (Mat. Res. Soc. Symp. Proceedings. Vol. 219), p 111. *Conference paper*.

10. A.M. Myers, J.R. Doyle, G. J. Feng, N. Maley, D.L. Ruzic, and J.R. Abelson, *Energetic Particle Fluxes in magnetron sputter deposition of a-Si:H*, J. Non-Crys. Sol. 137&138, 783 (1991) *Journal Article*

9. J.R. Abelson, N. Maley, J.R. Doyle, G.F. Feng, M. Fitzner, M. Katiyar, L. Mandrell, A.M. Myers, A. Nuruddin, D.N. Ruzic, and S. Yang, *In-situ measurements of hydrogen flux, surface coverage, incorporation and deposition during magnetron sputter-deposition of a-Si:H*, in Amorphous Silicon Technology 1991 (Mat. Res. Soc. Symp. Proc. Vol. 219), p. 619. *Conference paper*.

8. A.M. Myers, D.N. Ruzic, N. Maley, J. Doyle, and J.R. Abelson, *Energy Resolved Mass Spectrometry of the a-Si:D Growth Species During dc Magnetron Sputtering*, in Amorphous Silicon Technology 1990, ed. A. Madan et al. (Mat. Res. Soc. Symp. Proc. Vol. 192), p 595. *Conference paper*.

7. J.R. Abelson, L. Mandrell, J. Doyle, A.M. Myers, and N. Maley *Isotopic Hydrogen Exchange Studies of the a-Si:H Surface During Growth*, J. Non-Crystalline Solids 114, 184 (1989) *Journal Article*

6. J.R. Doyle, D.A. Doughty, and A. Gallagher, *Silane dissociation products in deposition discharges*, Journal of Applied Physics. **68**, 4375 (1990). *Journal Article*

5. D.A. Doughty, J.R. Doyle, G.H. Lin, and A. Gallagher, *Surface reaction probability of film producing radicals in silane glow discharges*, Journal of Applied Physics **67**, 6220 (1990). *Journal Article*

4. J.R. Abelson, J.R. Doyle, L. Mandrell, A.M. Myers, and N. Maley, *Surface hydrogen release during the growth of a-Si:H by reactive magnetron sputtering*, Journal of Vacuum Science and Technology A, **8** 1364 (1990). *Journal Article*

3. A. Gallagher, J. Doyle, and D. Doughty, *Plasma chemistry in silane and silane-disilane discharge deposition* in Amorphous Silicon Technology 1989 (Mat. Res. Soc. Symp. Proc. Vol. 149), pp. 23-31. *Conference paper*.

2. J.R. Doyle, R. Robertson, G.H. Lin, M.Z. He, and A. Gallagher, *Production of high quality amorphous silicon films by evaporative silane surface decomposition*, Journal of Applied Physics **64**, 3215 (1988). *Journal Article*

1. G.H. Lin, J.R. Doyle, M. He, and A. Gallagher, *Argon sputtering analysis of the growing surface of hydrogenated amorphous silicon films*, Journal of Applied Physics **64**, 188 (1988). *Journal Article*

**Presentations at Professional Meetings without Conference Proceedings (presenters underlined, Macalester undergraduate co-authors denoted by \*)**

James R. Doyle and Hannah Johlas\* *Strategies for the reduction of energy storage capacity for high penetration of wind and solar power*” contributed talk at the Sustainable and Renewable Energy Engineering Conference (ICSREE), 2017 2nd International Conference, Hiroshima, Japan.

Yifei Sun\*, Nadia Foo Kune\*, and James R. Doyle, *Deposition Kinetics of Zinc Oxide Thin Films by Magnetron Sputtering*, poster presentation at the Materials Research Society Spring 2017 Meeting, Phoenix, AZ.

Samuel J. Levang\* and James R. Doyle, *Properties of Hydrogenated Amorphous Silicon-Germanium Alloys Deposited by Dual Target Reactive Magnetron Sputtering* poster presentation at the Materials Research Society Spring 2012 Meeting, San Francisco.

K. Braam\*, M. Kyslinger\*, and J. R. Doyle, *Structural and electrical characterization of rf magnetron sputtered aluminum-doped zinc oxide*, poster presentation at the American Vacuum Society National Meeting 2009, San Jose, CA.

K. M. Pollock\*, J. Hiltrop\*, and J. R. Doyle. *Plasma characterization of an unbalanced magnetron sputter deposition system*, poster presentation at the American Vacuum Society National Meeting 2009, San Jose, CA.

Kristin Pollock\*, Tobin Kaufman-Osborn\*, Jonas Hiltrop\*, Kyle Braam\*, Steven Fazzio\*, and James R. Doyle, *Substrate ion flux effects in the reactive magnetron sputtering of hydrogenated amorphous germanium*, poster presentation at the Materials Research Society Spring 2007 Meeting, San Francisco.

J. R. Doyle , Y. Xu, R. Reedy, H. M. Branz, and A. H. Mahan, *Film Stoichiometry and Gas Phase Chemistry in HW-CVD of a-SiGe:H*, Contributed talk to the 4<sup>th</sup> International Conference on HWCVD Process, October 2006, Takayama, Japan.

J. R. Doyle , Y. Xu, R. Reedy, H. M. Branz, and A. H. Mahan, *Film Stoichiometry and Gas Phase Chemistry in HW-CVD of a-SiGe:*, poster presentation at the Materials Research Society Spring 2006 Meeting, San Francisco.

J.R. Doyle, *Near-substrate plasma effects on the properties of dc magnetron sputtered aluminum doped zinc oxide*, poster presentation at the Materials Research Society Spring 2004 Meeting, San Francisco.

J.R. Doyle F. Mohammed\*, A Pontarelli\*, and S. Bokhari\*, *Photoelectronic Properties of n-ZnO:Al/p-Si Heterojunctions*, poster presentation at the American Vacuum Society 50<sup>th</sup> International Symposium, Baltimore Md, November, 2003.

J.R. Doyle N. Schmidt\*, T. Totushek\*, W. Kimes\*, *The Effects of Substrate Temperature and Ion Flux on the Opto-electronic Properties of dc Magnetron Sputtered Aluminum-doped Zinc Oxide*, poster presentation at the American Vacuum Society 49<sup>th</sup> International Symposium, November, 2002.

J.R. Doyle, D. Cole\*, B. Magocsi\*, *Deposition kinetics in methane rf glow discharges: a combined experimental and modeling study*, contributed talk presented at the 45<sup>th</sup> National Symposium of the American Vacuum Society, Boston, MA, October 2000.

R. Erickson\* and J.R. Doyle, *Energy and angular distributions of deposition flux in magnetron sputtering systems*, poster presentation at the 45<sup>th</sup> National Symposium of the American Vacuum Society, Boston, MA, October 2000.

J.R. Doyle, *Plasma chemistry in acetylene rf glow discharges*, poster presentation at the 44<sup>th</sup> National Symposium of the American Vacuum Society, San Jose CA, October 1997.

J. Hart Shafer\*, M. Mahala\*, D. J. Dagle\*, and J. R. Doyle *Ion bombardment effects on dc magnetron sputtered ZnO thin films*, poster presentation at the 44<sup>th</sup> National Symposium of the American Vacuum Society, San Jose CA, October 1997.

G.J. Feng and J.R. Doyle, *Effects of surface topography in plasma-enhanced silicon dioxide deposition from TEOS* poster presentation at the 44<sup>th</sup> National Meeting of the American Vacuum Society San Jose, CA October 1997.

J. R. Doyle, *Fundamental Kinetics in Thin Film Deposition: PACVD of Diamond-like Carbon and Reactive Magnetron Sputter Deposition of ZnO*, invited talk given to Thin Film Chapter at 3M Corporate Research, St. Paul, August 1997.

J.R. Doyle, D.J. Dagle\*, and C.Z. Mallouris\*, *Radical and film growth kinetics in methane discharges*, contributed talk given at the 43<sup>rd</sup> National Symposium of the American Vacuum Society, Philadelphia, 1996.

J.R. Doyle, D.J. Dagle\*, and C.Z. Mallouris\*, *A Model for Radical Chemistry in Methane Discharges*, poster presentation at the 46<sup>th</sup> Gaseous Electronics Conference, Montreal, 1993.

J.R. Doyle, N. Maley, and J.R. Abelson, *Light induced changes in photocarrier transport in magnetron sputtered a-Si:H*, presentation at the Amorphous Silicon Materials and Solar Denver, CO 1991.

J.R. Doyle, N. Maley, J.R. Abelson, *Schottky barriers on magnetron sputtered a-Si:H: depletion width effects on photocarrier collection vs bandgap and light soaking*, Materials Research Society Spring Meeting April 1991.

## **External Grants Received**

National Science Foundation Research in Undergraduate Institution (NSF-RUI) \$216,335 (2005-2008)  
*Fundamental Studies of a-Ge:H and a-SiGe:H by Reactive Sputter Deposition*

National Science Foundation Research in Undergraduate Institution (NSF-RUI) \$222, 567 (1999-2002)  
*Fundamental Studies of Zinc Oxide Deposition by Reactive Sputter Deposition*

NSF Instrumentation and Laboratory Improvement (with J. Heyman) Grant \$50,300 (1998 – 2000) *Microelectronics in the Undergraduate Physics Laboratory*

NSF Instrumentation and Laboratory Improvement (with K. Wirth and T. Varberg) Grant \$22,538 (1995-1997) *x-ray Diffraction: A Common Interdisciplinary Experience for Geology, Chemistry, and Physics Students*

NSF Instrumentation and Laboratory Improvement (ILI) Grant \$38,460 (1993-1995) *Semiconductor Characterization in Undergraduate Physics*

Petroleum Research Fund Type G Grant \$20,000 (1993-1995) *Mass Spectrometric Studies of Methane Glow Discharge Reaction Kinetics*

### **Macalester Honors Theses Supervised as Primary Advisor**

Yifei Sun, *Strategies for Increasing Deployment of Photovoltaics in Developing Countries: Reducing the Cost of Technology and Lowering Implementation Barriers* (2017).

Samuel Levang, *Properties of Hydrogenated Amorphous Silicon-Germanium Alloys Deposited by Dual Target Reactive Magnetron Sputtering* (2012).

Jonas Hiltrop, *Particle-in-Cell and Monte Carlo Modeling of Plasma Probe Characteristics* (2008).

Kyle Braam, *The Effect of Nitrogen and Oxygen on the Growth of rf-Sputtered ZnO Films* (2008).

Hallie Boyer *Photoconductivity in Amorphous Silicon Germanium Alloys at Low Temperature* (2008).

Trevor David Rhone, *Electrical Transport Properties of Ultra-thin Gold Films* (2005).

Evan Acharya, *Field Programmable Gate Array Implementation of Artificial Neural Networks* (2004).

Fitih Mohammed, *Fabrication and Characterization of ZnO/p-Si Heterojunction Solar Cells* (2003).

Erik Hoffman, *Synchronization in Coupled Chaotic Circuits* (2002).

Rachel Erickson, *A Monte Carlo Simulation of Sputter Transport Deposition* (2001).

Mark Hassan, *Electrodeposited CuInSe<sub>2</sub> for Photovoltaic Applications* (2000)

Douglas Cole, *A Study of the Diffusion-Reaction Problem in Methane Glow Discharge Plasmas* (2000).

Boris Magosci, *Particle in a Cell / Monte Carlo Simulation of Plasmas* (1999).

Justin Johnson, *A Computational Investigation of Ion-dipole Reaction Kinetics* (1999).

Patricia Cleary, *The Electrodeposition of ZnS Thin Films on Indium-Tin Oxide Coated Glass Substrates* (1998).

Amanda VanderVenter, *Chemical Deposition of Semiconducting Thin Films for Photovoltaic Applications* (1996).

Daryl Dagel, *Opto-electronic Properties of dc Magnetron Sputtered a-Ge:H Thin Films* (1996).

## **Courses Taught (Macalester)**

### Standard Curriculum

Science of Renewable Energy (Physics 130; cross-listed as Environmental Studies 130)

Principles of Physics I (Physics 226)

Principles of Physics II (Physics 227)

Modern Physics (Physics 331)

Digital Electronics (Physics 340; cross-listed as Computer Science 340)

Laboratory Instrumentation (Physics 348)

Energy and Sustainable Design (Physics 350; cross-listed as Environmental Studies 350)

Electromagnetic Theory I (Physics 443)

Electromagnetic Theory II (Physics 444)

Mechanics (Physics 460)

Statistical Mechanics (Physics 468)

Quantum Mechanics (Physics 481)

### Special Topics Courses

The Physics of Sustainable Design (Physics 194; cross-listed as Environmental Studies 194)

Biomechanics (Physics 194)

Biophysics (Physics 394)

Analog Electronics (Physics 394)

Semiconductor Device Physics (Physics 494)

Chemical Physics (Physics 494; cross-listed as Chemistry 494)

Condensed Matter Physics (Physics 494)



*Independent Studies supervised*

Solar Cell Device Physics, Fluid Mechanics, Plasma Physics, Geophysics, Oceanography, and many miscellaneous research projects.

**Awards**

Janet Andersen Lecture Award (Midstates Consortium for Math and Science) 2020

Educator of the Year Community Recognition Award (Macalester College) 2020

**Major College Committee Service**

Faculty Personnel Committee (elected, chair AY 2021-2022) Spring 2021-Fall 2022

Social Responsibility Committee (appointed, chair) 2017 – 2018

Macalester Affirmative Action Committee (appointed) 2006 - 2018

NTT Personnel Committee (appointed) 2017

NTT Personnel Committee (appointed) 2016

Faculty Personnel Committee (elected, chair Spring 2010) 2008 - 2010

Faculty Personnel Committee (elected) 2003- 2005

Chair, Department of Physics and Astronomy (appointed) 1999 - 2005

Information Services Advisory Committee (appointed, chair) 2001-2002

Benefits Committee (appointed) Spring 1998.

Curriculum Committee (appointed) Spring 1998.