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EDUCATION

Northwestern University, Evanston, IL

2007 – 2013

Ph.D., Physical Chemistry

Dissertation: “Charge-Transfer Oligomers and Polymers for Organic Photovoltaics: Structure, dynamics, and their implications for solar devices”

University of Washington, Seattle, WA

2002 – 2007

BS, Chemistry and BA, English (with honors)

RESEARCH EXPERIENCE

US Naval Research Laboratory, Washington, DC

August, 2018 - present

ASEE fellow, Electronics Science and Technology Division

- Using DNA nanotechnology to produce chromophore networks with well-defined orientations and positions, in order to induce synchronized environmental perturbations for prolonged quantum coherence. These are probed using 2D electronic spectroscopy.
- Using machine-learning methods to develop quantitative models that predict energy transfer efficiencies in chromophore-decorated DNA-origami scaffolds.
- Modeling energy transfer rates in cascading, DNA-scaffolded multi-chromophore relays.

The University of Chicago, Chicago, IL

2013 - July, 2018

Postdoctoral fellow, Department of Chemistry and The James Franck Institute

PI: Greg S. Engel

- Developed a time-ordered, time-domain vibrational technique based on 2D electronic spectroscopy, and used it to observe interexcitonic vibrational correlations in a photosynthetic pigment-protein complex. These correlations can extend coherence lifetimes.
- Developed a method to obtain highly resolved 2D electronic spectra, revealing the overlapping peak positions of feature-rich spectra.
- Developed a combined 2D spectroscopy and machine-learning approach to calculate Hamiltonians in the site basis for biological systems.
- Built an experiment to measure the transient material response to Laguerre-Gaussian “twisted light,” and used it to measure how the response in semiconductors depends on the light’s orbital angular momentum. These dynamics can be understood and optimized to create solid-state detectors for this quantum number in light. Helped conceive of, design, and obtain funding (\$3 million, see Grants section) for the project.

Northwestern University, Evanston, IL

2007 – 2013

and concurrently at **Argonne National Laboratory, Lemont, IL**

2010 – 2013

Graduate researcher, Department of Chemistry and ANSER Center

PI: Lin X. Chen

- Studied intramolecular and intermolecular exciton dissociation in alternating copolymers, identifying trends between intramolecular polymer processes and corresponding bulk heterojunction device efficiencies. These studies explained high power conversion efficiencies in organic photovoltaic devices employing alternating copolymers.
- Examined aggregate morphologies in neat and bulk heterojunction alternating copolymer films using grazing incidence wide/small angle X-ray scattering, demonstrating correlations between π - π stacking distances and bulk heterojunction device fill factor.
- Studied spontaneous self-assembly behavior in spin-coated photovoltaic oligomer systems depending on monomer length, using grazing incidence wide/small angle X-ray scattering and atomic force microscopy.
- Characterized anisotropic absorption behavior of organic donor-acceptor co-crystals as a function of modular chromophore species.

GRANTS

“Transcribing Quantum Information using Quantum Dynamics of Coherent Materials”

(PI: Engel)

10/1/2014 - 9/30/2019

Agency: Vannevar Bush Faculty Fellowship

Total costs: \$3,000,000 (all to U. Chicago, PI: Engel)

Contribution: Helped conceive of and design the project, and helped write the proposal.

FELLOWSHIPS

ASEE Fellowship (August, 2018-present)

Argonne Graduate Fellowship (2010-2012)

TALKS

11. **Rolczynski, B. S.** and Engel, G. S. “Correlated Protein Environments Prolong Quantum Coherence.” US Naval Research Laboratory, Washington, DC 5/3/18.

10. **Rolczynski, B. S.** and Engel, G. S. “Correlated Protein Environments Drive Prolonged Quantum Coherence.” Washington University in St. Louis, St. Louis, MO 11/30/17.

9. **Rolczynski, B. S.** and Engel, G. S. “Correlated Motion for Prolonged Quantum Coherences in a Photosynthetic Protein.” Invited talk, Loyola University, Chicago, IL, 4/20/17.

8. **Rolczynski, B. S.**; Navotnaya, P.; Engel, G. S. “Driving delocalized dynamics using the orbital angular momentum of light.” ACS Meeting, San Francisco, CA, 4/5/17.
7. **Rolczynski, B. S.**; Yeh, S.; Navotnaya, P.; Ashraf, K.; Gardiner, A.; Cogdell, R.; Engel, G. S. “Resolving the detailed 2D spectral structure of the Fenna-Matthews-Olson complex.” ACS Meeting, San Francisco, CA. 4/5/17.
6. **Rolczynski, B. S.**; Zheng, H.; Singh, V.; Navotnaya, P.; Caram, J.; Ashraf, K.; Gardiner, A.; Cogdell, R.; Engel, G. S. “Correlated vibrational motion in the Fenna-Matthews-Olson complex.” ACS Meeting, San Francisco, CA. 4/2/17.
5. **Rolczynski, B. S.** and Engel, G. S. “Correlated exciton environments in the Fenna-Matthews-Olson complex.” Photosynthesis conference, Marshall, IN, 11/5/16.
4. **Rolczynski, B. S.** and Engel, G. S. “Transcribing light’s orbital angular momentum to materials.” Spinov VI, Chicago, IL, 10/17/16.
3. **Rolczynski, B. S.** and Engel, G. S. “Long-lived coherences through correlated environments.” ACS Meeting, Philadelphia, PA, 8/22/16.
2. **Rolczynski, B. S.** and Engel, G. S. “How Long Does a CdSe Quantum Dot Remember Its Excitation Energy?” Nanotalk Symposium, Chicago, IL, 2/25/14.
1. **Rolczynski, B. S.** and Chen, L. X. “The role of tuning push-pull interactions in small optical gap copolymers.” Gordon Research Seminar, Easton, MA, 7/10/11.

PUBLICATIONS

[Google Scholar link](#)

- **Rolczynski, B. S.**; Yeh, S.-H.; Navotnaya, P.; Lloyd, L. T.; Ginzburg, A. R.; Zheng, H.; Allodi, M. A.; Otto, J. P.; Ashraf, K.; Gardiner, A. T.; Cogdell, R. J.; Kais, S.; Engel, G. S. Measuring the Excitonic Structure of the Fenna-Matthews-Olson Complex Using High-Resolution 2D Spectroscopy. *In review*.

25. Allodi, M. A.; Otto, J. P.; Sohail, S. H.; Saer, R. G.; Wood, R. E.; **Rolczynski, B. S.**; Massey, S. C.; Ting, P.-C.; Blankenship, R. E.; Engel, G. S. Reactive oxygen species affect ultrafast exciton transport in photosynthetic pigment-protein complexes. *J. Phys. Chem. Lett.* 2018, 9, 89-95.

24. **Rolczynski, B. S.**; Zheng, H.; Singh, V. P.; Navotnaya, P.; Ginzburg, A. R.; Caram, J. R.; Ashraf, K.; Gardiner, A. T.; Yeh, S.-H.; Kais, S.; Cogdell, R. J.; Engel, G. S. Correlated Protein Environments Drive Quantum Coherence Lifetimes in Photosynthetic Pigment-Protein Complexes. *Chem* 2018, 4, 138-149.

*Highlighted in a Preview. (Maiuri, M.; Scholes, G. 2D Spectroscopy Helps Visualize the Influence of Spectral Motion on Chromophore Response. *Chem* 2018, 4, 20-21.)

23. **Rolczynski, B. S.**; Navotnaya, P.; Sussman, H. R.; Engel, G. S. Cysteine-mediated mechanism disrupts energy transfer to prevent photooxidation. *Proc. Nat. Acad. Sci.* 2016. 113(31), 8562. *commentary

22. Flanagan, M. L.; Long, P. D.; Dahlberg, P. D.; **Rolczynski, B. S.**; Massey, S. C.; Engel, G. S. Mutations to R. sphaeroides Reaction Center Perturb Energy Levels and Vibronic Coupling but Not Observed Energy Transfer Rates. *J. Phys. Chem. A.* 2016. 120(9), 1479.

21. Cho, S.; **Rolczynski, B. S.**; Xu, T.; Yu, L.; Chen, L. X. Solution Phase Exciton Diffusion Dynamics of a Charge-Transfer Copolymer PTB7 and Homopolymer P3HT. *J. Phys. Chem. B.* 2015, 119(24), 7447.

20. Blackburn, A. K.; Sue, A. C.-H.; Shveyd, A. K.; Cao, D.; Tayi, A.; Narayanan, A.; **Rolczynski, B. S.**; Sarko, J. M.; Bozdemir, O. A.; Wakabayashi, R.; Lehrman, J. A.; Chen, L. X.; Nassar, M. S.; Stupp, S. I.; Stoddart, J. F. Lock-arm supramolecular ordering: A molecular construction set for cocrystallizing organic charge transfer complexes. *J. Am. Chem. Soc.* 2014, 136, 17224.

19. **Rolczynski, B. S.**; Szarko, J. M.; Son, H. J.; Yu, L.; Chen, L. X. Effects of Exciton Polarity in Charge Transfer Polymer/PCBM Bulk Heterojunction Films. *J. Phys. Chem. Lett.* 2014, 5(11), 1856.

18. Szarko, J. M.; **Rolczynski, B. S.**; Lou, S. J.; Xu, T.; Strzalka, J.; Marks, T. J.; Yu, L.; Chen, L. X. Photovoltaic Function and Exciton/Charge Transfer Dynamics in a Highly Efficient Semiconducting Copolymer. *Adv. Funct. Mater.* 2014, 24(1), 10.

*Over 100 citations.

17. Zheng, H.; Caram, J. R.; Dahlberg, P. D.; **Rolczynski, B. S.**; Viswanathan, S.; Dolzhnikov, D. S.; Khadivi, A.; Talapin, D. V.; Engel, G. S. Dispersion-free continuum two-dimensional electronic

spectrometer. *Applied Optics* 2014, 53(9), 1909.

16. Caram, J. R.; Zheng, H.; Dahlberg, P. D.; **Rolczynski, B. S.**; Griffin, G. B.; Dolzhenkov, D. S.; Talapin, D. V.; Engel, G. S. Exploring size and state dynamics in CdSe quantum dots using two-dimensional electronic spectroscopy. *J. Chem. Phys.* 2014, 140(8), 084701.

15. Griffin, G. B.; Lundin, P. M.; **Rolczynski, B. S.**; Linkin, A.; McGillicuddy, R. D.; Bao, Z.; Engel, G. S. Ultrafast energy transfer from rigid, branched side-chains into a conjugated, alternating copolymer. *J. Chem. Phys.* 2014, 140(3), 034903.

14. Caram, J. R.; Zheng, H.; Dahlberg, P. D.; **Rolczynski, B. S.**; Griffin, G. B.; Fidler, A. F.; Dolzhenkov, D. S.; Talapin, D. V.; Engel, G. S. Persistent Interexcitonic Quantum Coherence in CdSe Quantum Dots. *J. Phys. Chem. Lett.* 2014, 5(1), 196.

13. Singh, V. P.; Fidler, A. F.; **Rolczynski, B. S.**; Engel, G. S. Independent phasing of rephasing and non-rephasing electronic spectra. *J. Chem. Phys.* 2013, 139(8), 084201.

12. Tayi, A. S.; Shveyd, A. K.; Sue, C.-H.; Szarko, J. M.; **Rolczynski, B. S.**; Sarjeant, A. A.; Stern, C. L.; Cao, D.; Paxton, W. F.; Wu, W.; Dey, S. K.; Fahrenbach, A. C.; Guest, J.; Mohseni, H.; Chen, L. X.; Wang, K. L.; Stoddart, J. F.; Stupp, S. I. Room Temperature Ferroelectricity in Supramolecular Networks of Charge Transfer Complexes. *Nature* 2012, 488, 485.

*Over 250 citations.

11. **Rolczynski, B. S.**; Szarko, J. M.; Son, H. J.; Liang, Y.; Yu, L.; Chen, L. X. Ultrafast Intramolecular Exciton Splitting Dynamics in Isolated Low-Band-Gap Polymers and Their Implications on Photovoltaic Materials Design. *J. Am. Chem. Soc.* 2012, 134, 9, 4142.

*Over 100 citations.

10. Gothard, N. A.; Mara, M. W.; Huang, J.; Szarko, J. M.; **Rolczynski, B. S.**; Lockard, J. V.; Chen, L. X. Strong Steric Hindrance Effect on Excited State Structural Dynamics of Cu(I) Diimine Complexes. *J. Phys. Chem. A* 2012, 116, 9, 1984.

9. Carsten, B.; Szarko, J. M.; Son, H. J.; Wang, W.; Lu, L.; He, F.; **Rolczynski, B. S.**; Lou, S. J.; Chen, L. X.; Yu, L. Examining the Effect of the Dipole Moment on Charge Separation in Donor-Acceptor Polymers for Organic Photovoltaic Applications. *J. Am. Chem. Soc.* 2011, 133, 50, 20468.

*Over 250 citations.

8. Murray, I. P.; Lou, S. J.; Cote, L. J.; Loser, S.; Kadleck, C. J.; Xu, T.; Szarko, J. M.; **Rolczynski, B. S.**; Johns, J. E.; Huang, J.; Yu, L.; Chen, L. X.; Marks, T. J.; Hersam, M. C. Graphene Oxide

Interlayers for Robust, High-Efficiency Organic Photovoltaics. J. Phys. Chem. Lett. 2011, 2, 3006.

*Over 150 citations.

7. Szarko, J. M.; Guo, J.; **Rolczynski, B. S.**; Chen, L. X. Nanoscale structure, dynamics and power conversion efficiency correlations in small molecule and oligomer-based photovoltaic devices. Nano Rev. 2011, 2, 7249.

6. Szarko, J. M.; Guo, J.; **Rolczynski, B. S.**; Chen, L. X. Current trends in the optimization of low band gap polymers in bulk heterojunction photovoltaic devices. J. Mater. Chem. 2011, 21, 22, 7849.

5. **Rolczynski, B. S.**; Szarko, J. M.; Lee, B.; Strzalka, J.; Guo, J.; Liang, Y.; Yu, L.; Chen, L. X. Length-dependent self-assembly of oligothiophene derivatives in thin films. J. Mater. Res. 2011, 26, 296.

4. Szarko, J. M.; **Rolczynski, B. S.**; Guo, J.; Liang, Y.; He, F.; Mara, M. W.; Yu, L.; Chen, L. X. Electronic Processes in Conjugated Diblock Oligomers Mimicking Low Band-Gap Polymers: Experimental and Theoretical Spectral Analysis. J. Phys. Chem. B 2010, 114, 14505.

3. Szarko, J. M.; Guo, J.; Liang, Y.; Lee, B.; **Rolczynski, B. S.**; Strzalka, J.; Xu, T.; Loser, S.; Marks, T. J.; Yu, L.; Chen, L. X. When Function Follows Form: Effects of Donor Copolymer Side Chains on Film Morphology and BHJ Solar Cell Performance. Adv. Mater. 2010, 22, 48, 5468.

*Over 300 citations.

2. Guo, J.; Liang, Y.; Szarko, J.; Lee, B.; Son, H. J.; **Rolczynski, B. S.**; Yu, L.; Chen, L. X. Structure, Dynamics, and Power Conversion Efficiency Correlations in a New Low Bandgap Polymer:PCBM Solar Cell. J. Phys. Chem. B 2010, 114, 2, 742.

*Over 150 citations.

1. Szarko, J.; Guo, J.; Liang, Y.; **Rolczynski, B.**; Yu, L.; Chen, L. X. The electron and energy transfer between oligothiophenes and thieno[3,4-b]thiophene units. Proc. of SPIE 2008, 7034, 703403.

TEACHING

The University of Chicago, Chicago, IL

Research mentor

Graduate Students: Polina Navotnaya, John Otto, Hallie Sussman, Curtis Peterson,
Ryan Mensson

Undergraduates: Alan Ginzburg, Matthew Talaga, Jonathan Michelson, Gillian Shen

Guest lecture

Wave Mechanics and Spectroscopy

Fall 2015

Northwestern University, Evanston, IL

Research mentor

Graduate Student: Sam Eaton

Undergraduate: Julie Bloom

Super TA, General Physical Chemistry

Spring 2008, Spring 2009

Instructor, Gateway Science Workshop

an honors Chemistry program for undergraduates

Spring 2008, Spring 2009

TA, Advanced Undergraduate Laboratory

Summer 2009

TA, General Inorganic Chemistry

Winter 2008

TA, General Chemistry

Fall 2007

SERVICE

Reviewer

ACS Energy Letters