Christopher J. Kloxin

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University of Delaware
201 DuPont Hall
Newark, DE 19716

Dept. of Chemical & Biomolecular Engineering
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226 Colburn Laboratory
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Newark, DE 19716

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Education

Ph.D. in Chemical Engineering, 2006
Thesis topic: "Investigating Aqueous PEO-PPO-PEO Triblock Copolymer Dispersion Dynamics with Colloidal Sphere Thermal Motion,"
Advisor: John H. van Zanten
Department of Chemical and Biomolecular Engineering, North Carolina State University, Raleigh, NC

B.S. in Chemical Engineering, 1999
Department of Chemical Engineering, University of Colorado, Boulder, CO

Professional Employment

2014-present	Assistant Professor Department of Materials Science & Engineering and Department of Chemical & Biomolecular Engineering, University of Delaware, Newark, DE
2014-present	Affiliate Professor; Department of Biomedical Engineering
2014-present	Affiliate; Delaware Environmental Institute (DENIN)
2014-present	Faculty, Center for Molecular and Engineering Thermodynamics (CMET)
2011-2014	Research Assistant Professor Department of Materials Science & Engineering and Department of Chemical & Biomolecular Engineering, University of Delaware, Newark, DE
2010	Research Assistant Professor Department of Chemical & Biological Engineering, University of Colorado, Boulder, CO
2006-2009	Post-doctoral Research Associate *Advisor: Christopher N. Bowman* Department of Chemical & Biological Engineering, University of Colorado, Boulder, CO

Teaching Experience

2013-present University of Delaware, Newark, DE
- MSEG 667 – Bio-conjugations and Macromolecular Design (S15)
- MSEG 803 – Equilibria in Material Systems (F15)
- MSEG 667 – Macromolecular- and Bio-conjugations (S15)
- CHEG 345 – Chemical Engineering Lab I (S13, S14)

2011 University of Colorado, Boulder, CO
- CHEN 5383 – Polymer Physics (S11) – Co-instructor, Kristi S. Anseth

Honors and Awards

- McNair Scholars Outstanding Advisor Award 2015
- University of Delaware Research Foundation (UDRF) Award 2012 & 2014
- Outstanding Teaching Assistant, Department of Chemical and Biomolecular Engineering, NCSU 2001
- Outstanding Undergraduate Teaching Assistant, Department of Chemical Engineering, CU 1998 & 1999

Publication Record

Publication Statistics (starting 2008)

Web of Science (1/5/2016): 1094 citations (295 in 2014); h-index, 17; i10-index, 20; i100-index, 3.

Google Scholar (1/5/2016): 1349 citations (310 in 2014); h-index, 19; i10-index, 21; i100-index, 4.

Publication List (* indicates corresponding author)

June 2011-present (University of Delaware)

34. T.F. Scott, J.C. Furgal, & **C.J. Kloxin**, "Expanding the Alternating Propagation–Chain Transfer-Based Polymerization Toolkit: The Iodo–Ene Reaction," *ACS Macro Letters* **4** 1404-1409 (2015) DOI: 10.1021/acsmacrolett.5b00640
33. M.B. Gordon, J.M. French, N.J. Wagner & **C.J. Kloxin***, "Dynamic Bonds in Covalently Crosslinked Polymer Networks for Photoactivated Strengthening and Healing," *Advanced Materials* **27** (48) 8007-8010 (2015) DOI: 10.1002/adma.201503870
32. W. Xi, S. Pattanayak, C. Wang, B. Fairbanks, T. Gong, J. Wagner, **C.J. Kloxin**, & C.N. Bowman, "Clickable Nucleic Acids: Sequence-Controlled Periodic Copolymer/Oligomer Synthesis by Orthogonal Thiol-X Reactions,", *Angewandte Chemie International Edition* **54** (48) 14462-14467 (2015) DOI: 10.1002/anie.201506711
31. Tibbits, A.C.; Mumper, L.E.; **Kloxin, C.J.***; & Yan, Y.S.*, "A Single-Step Monomeric Photo-Polymerization and Crosslinking via Thiol-Ene Reaction for Hydroxide Exchange Membrane Fabrication," *Journal of The Electrochemical Society*. **162** (10) F1206-F1211 (2015) DOI: 10.1149/2.0321510jes
30. Xi, W.; Peng, H.; Aguirre-Soto, A.; **Kloxin, C.J.**; Stansbury, J.; & Bowman, C.N., "Spatial and Temporal Control of Thiol-Michael Addition via Photo-caged Superbase in Photopatterning and Two-stage Polymer Networks Formation," *Macromolecules* **47** (18) 6159-6165 (2014) DOI: 10.1021/ma501366f.
29. Xi, W.; Scott, T.F.; **Kloxin, C.J.**; & Bowman, C.N., "Click Chemistry in Materials Science," *Advanced Functional Materials* **24** (18) 2572-2590 (2014) [cover] DOI: 10.1002/adfm.201302847
28. Chantani, S.; **Kloxin, C.J.**; & Bowman, C.N., "The power of light in polymer science: photochemical processes to manipulate polymer formation, structure, and properties," *Polymer Chemistry* **5** 2187-2201 (2014) DOI: 10.1039/C3PY01334K.
27. Ma, S.J.; Mannino S.J.; Wagner, N.J.; & **Kloxin**, **C.J.***, "Photodirected Formation and Control of Wrinkles on a Thiol−ene Elastomer," *ACS Macro Letters* **2** 474-477 (2013) DOI: 10.1021/mz400166e.
26. **Kloxin C.J.** & Bowman C.N., "Covalent adaptable networks: smart, reconfigurable and responsive network systems," *Chemical Society Reviews* **42** (17), 7161-7173 (2013) DOI: 10.1039/C3CS60046G.
25. Xi, W.; Krieger, M.; **Kloxin C.J.**; & Bowman, C.N., "A New Photoclick Reaction Strategy: Photo-induced Catalysis of the Thiol-Michael Addition via a Caged Primary Amine," *Chemical Communications* **49** (40) 4504-4506 (2013) DOI: 10.1039/C3CC41123K.
24. Adzima, B.J.; **Kloxin, C.J.**; DeForest, C.A.; Anseth, K.S.; & Bowman, C.N., "Photofixation lithography in Diels—Alder Networks," *Macromolecular Rapid Communications* **33** (24) 2092-2096 (2012) DOI: 10.1002/marc.201200599.

23. Xi, W.; Chen, W.; **Kloxin, C.J**.; & Bowman, C.N., "Nitrogen-centered Nucleophiles Catalyzed Thiol-Vinylsulfone Addition, Another Thiol-ene "Click" Reaction," *ACS Macro Letters* **1** (7) 811-814 (2012) DOI: 10.1021/mz3001918.
22. Park, H.Y.; **Kloxin, C.J.**; Abuelyaman, A.S.; Oxman, J.D.; & Bowman, C.N., "Novel dental restorative materials having low polymerization shrinkage stress via stress relaxation by addition-fragmentation chain transfer," **28** (11) 1113-1119 (2012) *Dental Materials* DOI: 10.1016/j.dental.2012.06.012.
21. Park, H.Y.; **Kloxin, C.J.**; Abuelyaman, A.S.; Oxman, J.D.; & Bowman, C.N., "Stress relaxation via addition-fragmentation chain transfer in high T_g, high conversion methacrylate-based systems," *Macromolecules* **45** (14) 5640-5646 (2012) DOI: 10.1021/ma300228z
20. Park, H.Y.; **Kloxin, C.J.**; Fordney, M.F.; & Bowman, C.N., "Stress reduction and T_g enhancement in ternary thiol–yne–methacrylate systems via addition–fragmentation chain transfer," *Macromolecules* **45** (14) 5647-5652 (2012) DOI: 10.1021/ma300225q
19. Bowman, C.N.; & **Kloxin, C.J.*;** "Covalent Adaptable Networks: Incorporation of Reversible Bond Structures in Crosslinked Polymer Networks," *Angewandte Chemie International Edition* [Highlight], **51** (18) 4272-4274 (2012) DOI: 10.1002/anie.201200708.
18. Koehler, K.C.; Durackova, A.; **Kloxin, C.J.**; & Bowman, C.N., "Kinetic and thermodynamic measurements for the facile property prediction of Diels-Alder-conjugated materials," *AIChE Journal*, (2012) DOI: 10.1002/aic.13733.
17. Park, H.Y.; **Kloxin, C.J.**; Fordney, M.F.; & Bowman, C.N., "Stress Relaxation of Trithiocarbonate-Dimethacrylate-based Dental Composites," *Dental Materials*. **28** (8) 888-893 (2012) DOI: 10.1016/j.dental.2012.04.016.
16. Scott, T.F.; **Kloxin, C.J.**; Forman D.; McLeod, R.R. & Bowman, C.N., "Principles of voxel refinement in optical direct write lithography," *Journal of Materials Chemistry* **21** (37) 14150-14155 (2011) DOI: 10.1039/C1JM11915J.

Prior to June 2011 (NCState or UCBoulder)

15. **Kloxin, C.J.**; Scott, T.F.; Park, H.; & Bowman, C.N., "Mechanophotopatterning on a Photoresponsive Elastomer", *Advanced Materials* **23** (17) 1977-1981 (2011) DOI: 10.1002/adma.201100323 [Frontispiece].
    This work was featured in *Nature* "News and Views" by Prof. Huck **472** (7344) 425 (2011) DOI: 10.1038/472425a.
14. Tanner, S.A.; Amin, S.; **Kloxin, C.J.**; & van Zanten, J.H., "Microviscoelasticity of Soft Repulsive Sphere Dispersions: Tracer Particle Microrheology of Triblock Copolymer Micellar Liquids and Soft Crystals", *Journal of Chemical Physics* **134** (17) 174903 (2011) DOI: 10.1063/1.3578183.
13. Adzima, B.J.; Tao, Y.; **Kloxin, C.J.**; DeForest, C.A.; Anseth, K.S.; & Bowman, C.N., "Spatial and temporal control of the alkyne—azide cycloaddition by photoinitiated Cu(II) reduction", *Nature Chemistry* **3**, 258-261 (2011) DOI: 10.1038/nchem.980.
12. Park, H.Y.; **Kloxin, C.J**; Scott, T.F.; & Bowman, C.N., "Stress relaxation by addition-fragmentation chain transfer in highly crosslinked thiol-yne networks", *Macromolecules* **43** (24) 10188-10190 (2010) DOI: 10.1021/ma1020209.
11. Park, H.Y.; **Kloxin, C.J.**; Scott, T.F.; & Bowman, C.N., "Covalent adaptable networks as dental restorative resins: Stress relaxation by addition-fragmentation chain transfer in allyl sulfide containing resins", *Dental Materials* **26** (10) 1010-1016 (2010) DOI: 10.1016/j.dental.2010.06.007.
10. Kloxin, A.M.; **Kloxin, C.J.**; Bowman, C.N.; & Anseth, K.A., "Mechanical properties of cellularly responsive hydrogels and their experimental determination", *Advanced Materials* **22** (31) 3484-3494 (2010) DOI: 10.1002/adma.200904179.
9. Adzima, B.J.; **Kloxin, C.J.**; & Bowman, C.N., "Externally triggered healing of a thermoreversible covalent network via self-limited hysteresis heating," *Advanced Materials* **22** (25) 2784-2787 (2010) DOI: 10.1002/adma.200904138.
8. **Kloxin, C.J.**; Scott, T.F.; Adzima, B.J.; & Bowman, C.N., "Covalent adaptable networks (CANs): A unique paradigm in crosslinked polymers," *Macromolecules* **43** (6) 2643-2653 (2010) DOI: 10.1021/ma902596s. [Cover]

7. **Kloxin, C.J.** & van Zanten, J.H., "High pressure phase diagram of an aqueous PEO-PPO-PEO triblock copolymer system via probe diffusion measurements" *Macromolecules* **43** (4) 2084-2087 (2010) DOI: 10.1021/ma902571h.
6. **Kloxin, C.J.** & van Zanten, J.H., "Microviscoelasticity of adhesive hard sphere dispersions: Tracer particle microrheology of aqueous Pluronic L64 solutions", *Journal of Chemical Physics* **131** (13) 134904 (2009) DOI: 10.1063/1.3238570.
5. **Kloxin, C.J.**; Scott, T.F.; & Bowman, C.N., "Stress relaxation via addition-fragmentation chain transfer in a thiol-ene photopolymerization," *Macromolecules* **42** (7) 2551-2556 (2009) DOI: 10.1021/ma802771b.
4. Fairbanks, B.D.; Scott, T.F.; **Kloxin, C.J.**; Anseth, K.S.; & Bowman, C.N., "Thiol-yne photopolymerizations: Novel mechanism, kinetics, and step-growth formation of highly cross-linked networks," *Macromolecules* **42** (1), 211-217 (2009) DOI: 10.1021/ma801903w.
3. Scott, T.F.; **Kloxin, C.J.**; Draughon, R.B.; & Bowman, C.N., "Nonclassical dependence of polymerization rate on initiation rate observed in thiol-ene photopolymerizations," *Macromolecules* **41** (9), 2987-2989 (2008) DOI: 10.1021/ma8002505.
2. Bowman, C.N. & **Kloxin, C.J.**, "Toward an enhanced understanding and implementation of photopolymerization reactions," *AIChE Journal* **54** (11), 2774-3037 (2008) DOI: 10.1002/aic.11678 [Cover].
1. Adzima, B.J.; Aguirre, H.A.; **Kloxin, C.J.**; Scott, T.F.; & Bowman, C.N., "Rheological and chemical analysis of reverse gelation in a covalently cross-linked Diels-Alder polymer networks," *Macromolecules* **41** (23), 9112-9117 (2008) DOI: 10.1021/ma801863d.

Book Chapter

1. **Kloxin, C.J.**, "Reversible covalent bond formation as a strategy for healable polymer networks," in the RSC Polymer Chemistry Series entitled, "Healable Polymer Systems", Edited by Wayne Hayes and Barnaby Greenland (2013).

Intellectual Property

- Bowman, C.N.; **Kloxin, C.J.**; Xi, W.; Gong, T. Pattanayak, S., "Thiol-X Click Foldamers for Polymer Affinity and Catalysis Libraries," WO 2015/120290 A2, Filed February 6, 2015.
- Bowman C.N.; **Kloxin, C.J.**; Xi, W., "Click Nucleic Acids (CNAs)," US Patent Application Number: 14/388,748; WO 2013148165 A1; EP 2831277 A1, Filed March 12, 2013.
- Bowman, C.N.; **Kloxin, C.J.**; & Adzima, B.J., "Photoinduced Alkyne—Azide Click Reactions," US Patent Application Number: 13/990, 218, 2011; WO 2012074931.
- Bowman, C.N.; Adzima, B.J.; & **Kloxin, C.J.**, "Radio Frequency Magnetic Field Responsive Polymer Composites," US Patent #9,044,902; Issued June 2, 2015.
- Bowman, C.N.; **Kloxin, C.J.**; & Adzima, B.J., "Novel Thermoreversible Network Scaffolds and Methods of Preparing Same" US Patent #9,012,127; Issued April 21, 2015.
- Bowman C.N.; **Kloxin, C.J.**; Park, H.Y.; Leung, D., "Stress relief for crosslinked polymers," US Patent #8,455,565; Issued November 4, 2014.
- Abuelyaman, A.S.; Oxman J.D.; Yang Y.; Bowman C.N.; Park, H.Y.; & **Kloxin, C.J.**, "Disulfide monomers comprising ethylenically unsaturated groups suitable for dental compositions" US Patent #8,455,565; Issued June 4, 2013.
- Bowman C.N.; Park, H.Y.; **Kloxin, C.J.**; Abuelyaman, A.S.; Oxman J.D.; & Yang Y., "Disulfide monomers comprising ethylenically unsaturated norbornyl groups suitable for dental compositions" US Patent #8,431,626; Issued April 30, 2013.
- Thap, D.; West, P.R.; Gurney, J.A; Kalamen, J.; & **Kloxin, C.J.**, "Photosensitive polymer composition and element containing photosensitive polyamide and mixture of acrylates," US Patent #5,925,498; Issued July 20, 1999.

Invited and Contributed Presentations

June 2011-present

1. "Point and Click Synthesis: The Utilization of Photo-enabled Click Reactions in Polymer Formation and Modification," Delaware ACS Meeting "ChemVets," Wilmington, DE, November 11, 2015. *Invited*.
2. "Point and Click Network Formation," Annual AIChE National Meeting, Salt Lake City, UT, November 9, 2015. *Invited*.
3. "Ion Conductive Network Formation using Photoinitiated Click Reactions," Photopolymerization Fundamentals 2015, Boulder, CO, September 16, 2015. *Invited*.
4. "Point-and-Click Chemistry in Dental Materials," NIST AADR, Gaithersburg, MD, July, 24, 2015. *Invited*.
5. "Photodirected Wrinkling via a Facile Two-stage Polymerization Scheme," Zing 4th Annual Polymer Chemistry Conference, Cancun, MX, December 12, 2014.
6. "Engineering Polymer Networks using a Few Good Reactions," The City College of New York, Department of Chemical Engineering, March 31, 2014. *Invited*.
7. "Mechanopatterned Polymer Networks via Light-Mediated, Chain Transfer Approaches," 21st Biennial Polymer Network Meeting, Jackson Hole, WY, August 14, 2012. *Invited.*
8. "Mechanically Assisted Photolithography," CIMTEC 2012 - 4th International Conference *Smart Materials, Structures and Systems*, Montecatini Terme, Italy, June 10, 2012. *Invited.*
9. "Novel Polymer Networks and Mechanopatterned Materials via Light-mediated, Chain Transfer Approaches," 3M, St. Paul, MN, December 16, 2011. *Invited.*
10. C.J. Kloxin and T.F. Scott, "Recent Developments in APT-Based Polymerization Reactions: The Iodo-Ene Reaction", AIChE National Meeting, Minneapolis, MN, October 2011.
11. "Reversible Covalent Chemistry in Polymer Networks," Dentsply International Inc., Milford, DE, July 29, 2011. *Invited.*

Prior to June 2011

12. "Photochemical and Thermal Covalent Adaptable Networks," Army Research Laboratory, Aberdeen, MD, March 10, 2010. *Invited.*
13. C.J. Kloxin, T.F. Scott, and C.N. Bowman, "Photomediated Thiol-ene Click Chemistry Methodologies for the Synthesis of Controlled Macromolecular Sequences", Australasian Polymer Symposium, Coffs Harbour, Australia, February 2011. *Contributed*.
14. C.J. Kloxin, B.J. Adzima, and C.N. Bowman, "Externally triggered healing of thermoreversible covalent adaptable network via self-limited hysteresis heating", AIChE National Meeting, Salt Lake City, UT, November 2010. *Contributed*.
15. C.J. Kloxin, H.Y. Park, T.F. Scott, and C.N. Bowman, "Reversible Addition-fragmentation Chain Transfer for Low Stress Thiol-ene/-yne Networks", 240th American Chemical Society National Meeting, POLY, Boston, MA, August 2010. *Contributed*.
16. C.J. Kloxin, H.Y. Park, T.F. Scott, and C.N. Bowman, "Addition-fragmentation Chain Transfer in Chemical Networks", Macro2010, 43rd IUPAC World Polymer Congress, Glasgow, UK, July 2010. *Contributed*.
17. C.J. Kloxin, T.F. Scott, and C.N. Bowman, "Photoreversible Covalent Adaptable Networks", 11th Pacific Polymer Conference, Cairns, Australia, December 2009. *Contributed*.
18. C.J. Kloxin, T.F. Scott, and C.N. Bowman, "Photochemical Adaptable Networks", AIChE National Meeting, Nashville, TN, November 2009. *Contributed*.
19. C.J. Kloxin, T.F. Scott, R.B. Draughon, and C.N. Bowman, "Photo-induced stress relaxation in thiol-ene polymer networks", 235th American Chemical Society National Meeting, PMSE, New Orleans, LA, April 2008. *Contributed*.
20. C.J. Kloxin, T.F. Scott, and C.N. Bowman, "Stress relaxation in cross-linked polymers", Materials Research Society Spring Meeting, San Francisco, CA, April 2007. *Contributed*.
21. C.J. Kloxin and J.H. van Zanten, "Probe Diffusion and Microrheology", AIChE National Meeting, San Francisco, CA, March 2003. *Contributed*.

Advising

Current Researchers

Post-doctoral researchers:

- Srimoyee Dasgupta, PhD — October 2015-present
- Dongdong Wu, PhD (co-advise with Pochan) — August 2015-present

PhD students:

- Kaleigh Reno (co-advise with Epps) — CBE, S15-present
- Bryan Sutherland — MSE, F14-present
- Abhishek Shete — MSE, F13-present
- Bassil El-Zaatari — CBE, F13-present
- Melissa B. Gordon (co-advise with Wagner) — CBE, S13-present
- Andrew C. Tibbits (co-advise with Yan) — CBE, F12-present
- Stephen J. Ma (co-advise with Wagner) — CBE, F11-present

Masters students:

- Samhita Kattekola — MEPT, W16-present

Undergraduate Researchers:

- Shea Cole — CBE, W16-present
- Derek Bischoff — CBE, Sum15-present
- Laura Mumper — CBE, Sum14-present
- Stephanie Anderson — CBE, W13-present
- Benjamin J. Carberry — CBE, Sum13-present
- Jonathan H. Galarraga — CBE, Sum13-present
- Justin M. Paloni — CBE, Sum13-present

PhD Committee:

Eric Fowler (MSE), Hang Kuen Lau (MSE), Liang Gong (MSE), Kevin Dicker (MSE), Wenqiong Tang (MSE, 2014), Jeong Jae Wie (CBE, 2012)

Previous Researchers

Post-doctoral Researchers: Jonathan French, PhD (OChem, July 2014-July 2015)

Masters: Stephen Ekatan (MSE, S12-F12)

Undergraduate Researchers: Thomas R. Cristiani (CBE, Sum12-S13); Samantha J. Mannino (CBE, W12-S14); John Affriol (CBE, Sum14),

Service

National Service

MRS National Meeting

- 2013, Organizers of Symposium on: "Point-and-Click Synthesis—Implementations of Click Chemistry in Polymers" (December 1-6, 2013, Boston, MA).
- 2015, Organizer of Symposium on: "Shape Programmable Materials" (November 29-December 4, 2015, Boston, MA).

Organizing committee member for the Polymer Networks Group (PNG2012) international conference (formerly IUPAC). Organized the following sessions: "Reversible Networks", "Biomaterials – Smart & Responsive", and "Smart & Responsive I & II"; chair of "Responsive Gels" plenary session; managed conference web-site (August 12-16, 2012, Jackson Hole, WY).

AIChE National Meeting:

- *Session Chair*:
  - 08A Polymers, Self-healing and Adaptable Materials (October 16-21, 2011, Minneapolis, MN);

  - 08A Polymers, Polymer Thermodynamics I (October 8-November 2, 2012, Pittsburgh, PA);
  - 08A Polymers, Polymer Networks and Gels I (November 17-22, 2013, San Francisco, CA).
- *Area Chair*:
  - 22B Nanobiotechnology, (November 8-13, 2015, Salt Lake City, UT).

CIMTEC ("Smart and Multifunctional Materials, Devices, Structures")

- 2016, International Advisor Board for of "Symposium A: Stimuli Responsive and Multifunctional Polymers: Progress in Materials and Applications," Italy (Andreas Lendlein, Programme Chair)

Coatings Editorial Board (2010-present)

NSF Panelist (2011, 2012, and 2013)

Reviewer for: *ACS Applied Materials and Interfaces, ACS Macro Letters, Advanced Materials, Biomacromolecules, Biomaterials Science, Chemical Sciences, Chemical Communications, European Polymer Journal, Industrial Engineering Chemical Research, Journal of the American Chemical Society*, *Journal of Materials Chemistry A, Journal of Materials Chemistry B, Journal of Nanoparticle Research, Journal of Polymer Science A: Polymer Chemistry, Langmuir, Macromolecular Rapid Communications, Macromolecular Symposia, Macromolecules, Nature Chemistry, Nature Communications, Polymer, Polymer Chemistry, & Soft Matter.*

University

- Junior Faculty Advisory Council of COE (Fall 2014 to present)
- UD Undergraduate Research Program, Senior Thesis Third Reader (2014-5, 2015-6)
- MSE Grad Committee (Fall 2014 to present)
- MSE Departmental Seminar Series Coordinator (Spring 2015 to present)
- CBE Undergraduate Advising (Fall 2014 to Spring 2018)
- MSE Departmental Awards Committee (Spring 2013).
- Discovery Days – Discussing opportunities in CBE to high school students (July, 14, 2012; July 13, 2013; and July 19, 2014).