

# Tyler Ray, PhD

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## EDUCATION

### University of California, Santa Barbara, Santa Barbara, CA

Doctor of Philosophy (Ph.D.) in Mechanical Engineering

Sep 2010 – Dec 2015

Dissertation: Gold Nanoparticle Characterization: Improved Methods for Measuring Nanoparticle Surface Properties and Colloidal Stability

### University of South Carolina, Columbia, SC

Master of Science (M.S.) in Mechanical Engineering

May 2008 – May 2010

Thesis: Electric Field Manipulation of Gold Nanorods: Characterization of Far-Field Alignment and Spatial Positioning Through Optical Response Imaging Techniques

Bachelor of Science (B.S.) in Mechanical Engineering

Aug 2004 – May 2008

Graduated with Honors from the University of South Carolina Honors College

Magna Cum Laude

## RESEARCH EXPERIENCE

### Postdoctoral Research Fellow

Sep 2016 –

Center for Bio-Integrated Electronics at the Simpson Querrey Institute for BioNanotechnology and the Department of Material Science and Engineering, Northwestern University

*Professor John A. Rogers*

- Designed and developed the first epidermal, non-invasive, wireless MEMS-based device for the verification of ventriculoperitoneal shunt performance via thermal anisotropy measurements. *Project awarded a 2018 Dixon Translational Research Grant for \$35k from Northwestern Memorial Foundation.*

- Developed epidermal microfluidic platform for the collection and analysis of sweat for cystic fibrosis diagnostics using the principles of soft mechanics to integrate a conformal, flexible microfluidic device intimately to the skin.

- Trainee in the TL1 Multidisciplinary Training Program in Child and Adolescent Health at Northwestern University as part of the NUCATS Clinical and Translational Sciences Institute.

- Mentored 7 undergraduate students and 1 medical student.

- *Work featured by Dr. Whitney Lowe on the Rachel Ray show (2016), at South by Southwest (SXSW) 2017 in partnership with the National Kidney Foundation, the Museum of Modern Art in New York City as part of the exhibit "Is Fashion Modern?" (2017), demoed and worn by Bill Gates (2017).*

### Postdoctoral Research Fellow

Oct 2015 – Sep 2016

Materials Department, University of California, Santa Barbara

*Professor Matthew Begley*

- Established acoustic focusing as a method for the alignment of anisotropic particles for the deposition of two-phase materials with ordered microstructures. Demonstrated, for the first time, the directed assembly of anisotropic particles via acoustic forces in flow.

- Characterized additively manufactured titanium truss structures for defect analysis modeling.

- Mentored 2 undergraduate researchers.

### Doctoral Projects

Sep 2010 – Sep 2015

Department of Mechanical Engineering, University of California, Santa Barbara

*Professor Sumita Pennathur*

- Established a new method for characterizing nanoparticle colloidal stability in response to environmental factors based upon absorbance spectroscopy. This method provides a quantitative method to compare to previous stability studies found in literature.

- Developed method to characterize nanoparticle surface properties using microfluidics with greater accuracy than gold standard techniques using microfluidic capillary electrophoresis.

- Mentored 2 undergraduate researchers and 1 high school student.

### Research Projects

Oct 2011 – Oct 2015

Materials Department, University of California Santa Barbara

*Professor Matthew Begley*

- Synthesized a composite polymer / magnetic material for use as a novel, non-contact oscillating pump for microfluidic circuits.

- Developed a method to align and spatially manipulate anisotropic particles in microfluidic channels via acoustic fields. Demonstrated the efficacy of this method in increasing the solid volume-fraction of a printed two-phase composite.

- Demonstrated a novel DNA purification device for forensic applications via acoustic forces.

## Research Projects

Oct 2011 – Dec 2014

Department of Physics, University of California Santa Barbara

Professor Andrew Cleland

- Developed an aggregation-based biodiagnostic platform for the real-time detection of targets of interest using plasmonic nanoparticles.

## Masters Thesis

Aug 2008 – Sep 2010

Department of Mechanical Engineering and Physics, University of South Carolina

Professors Sarah Baxter and Thomas Crawford

- Built a Total Internal Reflection Microscope to measure the alignment of gold nanorods via dielectrophoresis.
- Developed a statistical method using darkfield microscopy to analyze degree of gold nanorod alignment.
- Implemented a Kelvin Probe microscopy system on an Atomic Force Microscope to improve images of both gold nanorods and magnetic nanoparticles.

## PATENT APPLICATIONS

U.S. Provisional Patent Application 62/514,515. “Thin, Soft, Skin-Mounted Microfluidic Networks for Detection and Analysis of Targets of Interest in Sweat.” **T. Ray**, J. A. Rogers. 2017.

U.S. Provisional Patent Application 62/141,053. “System and method for tunable patterning and assembly of particles via acoustophoresis.” R. Collino, **T. Ray**, M. Begley. 2015.

## PUBLICATIONS

A. Bandodkar, P. Gutruf, J. Choi, J. Leshock, K. Lee, Y. Sekine, **T. Ray**, A. Verrillo, V. Murthi, W. Jeang, S. Krishnan, J.A. Rogers, “A soft, battery-free, wearable microfluidic hybrid device for simultaneous electrochemical and colorimetric sweat sensing,” *in preparation*.

P. Gutruf, V. Krishnamurthi, A. Vazquez-Guardado, A. Banks, C. Haney, E. Waters, I. Kandela, **T. Ray**, J. Leshock, D. Chandra, J.A. Rogers, “Advanced, Fully Implantable Optoelectronic Systems for Battery-free, Multimodal Operation in Neuroscience Research,” *submitted*.

R. Collino, **T. Ray**, L. Friedrich, J. Cornell, C. Meinhart, M. Begley, “Scaling relationships for acoustic control of two-phase microstructures during extrusion printing,” *Materials Research Letters*, *accepted*.

S. Kim, Y. Zhang, S. Won, A. Bandodkar, Y. Sekine, Y. Xue, D. Ostojich, J. Koo, S. Harshman, J. Martin, J. Park, **T. Ray**, K. Crawford, J. Yoon, J. Kim, K. Lee, J. Choi, R. Pitsch, C. Grigsby, A. Strang, Y. Chen, S. Xue, J. Kim, A. Koh, J. Ha, Y. Huang, S. Kim, J.A. Rogers, “Super-absorbent polymer valves and colorimetric chemistries for time-sequenced discrete sampling and chloride analysis of sweat via skin-mounted soft microfluidics,” *Small*, *accepted*.

L. Friedrich, R. Collino, **T. Ray**, M. Begley, “Acoustic control of microstructures during direct ink writing of two-phase materials,” *Sensors and Actuators A: Physical*, 2017, 268, 213-221.

J. Choi, Y. Xue, W. Xia, **T. Ray**, J. Reeder, A. Bandodkar, D. Kang, S. Xu, Y. Huang, J. A. Rogers, “Soft, skin-mounted microfluidic systems for measuring secretory fluidic pressures generated at the surface of the skin by eccrine sweat glands,” *Lab on a Chip*, 2017, 17, 2572-2580.

R. Collino, **T. Ray**, R. Flemming, J. Cornell, B. Compton, M. Begley, “Deposition of ordered two-phase materials using microfluidic print nozzles with acoustic focusing,” *Extreme Mechanics Letters*, 2016, 8, 96-106.

N. Rajan, S. Rajauria, **T. Ray**, S. Pennathur, A. Cleland, “Multiplexed Serum Protein Quantification using an Aggregation Assay Platform Based on an Electrical Microfluidic Nanoparticle Analyzer,” *Biosensors and Bioelectronics*, 2016, 77, 1062-1069.

R. Collino, **T. Ray**, R. Flemming, C. Sasaki, H. Haj-Hariri, M. Begley, “Acoustic field controlled patterning and assembly of anisotropic particles,” *Extreme Mechanics Letters*, 2015, 5, 37-46.

**T. R. Ray**, B. Lettiere, J. de Rutte, S. Pennathur, “Quantitative Characterization of the Colloidal Stability of Metallic Nanoparticles using UV-Vis Absorbance Spectroscopy,” *Langmuir*, 2015, 31, 3577–3586.

**T. R. Ray**, C. J. Murphy, S. Baxter, “Diffusion Linked Solidification Model of Axisymmetric Growth of Gold Nanorods,” in *Advances in Mathematical Modeling and Experimental Methods for Materials and Structures*, 2009, 199-210.

R. Mahtab, S. M. Sealy, S. E. Hunyadi, B. Kinard, **T. Ray**, C. J. Murphy, “Influence of the Nature of Quantum Dot Surface Cations on Interactions with DNA,” *Journal of Inorganic Biochemistry* 2007, 101, 559-564.

**INVITED TALKS** “Epifluidic Tattoos: Skin-Like, Wearable Microfluidic Devices for Sweat-Based Diagnostics” **T.R. Ray**, 2017 *Controversies in Nephrology*, National Kidney Foundation of Illinois, Chicago, Illinois May 2017

**SELECTED TALKS** “Dynamic Microstructural Control in Printable Colloidal Structures via Acoustic Focusing.” D. Melchert, L. Friedrich, R. Collino, **T.R. Ray**, M. Begley, D. Gianola, 2018 *TMS Annual Meeting & Exhibition*, Phoenix, AZ accepted

“Acoustic Focusing for Bulk Assembly of Colloidal Solids from Nanoscale Building Blocks.” **T.R. Ray**, R. Collino, L. Friedrich, M. Begley, 2017 *TMS Annual Meeting & Exhibition*, San Diego, CA Mar 2017

“Field-Assisted 3D-Printing of Aligned Composites” **T.R. Ray**, R. Collino, L. Friedrich, J. Cornell, M. Begley, *XXIV ICTAM*, Montreal, Canada Aug 2016

(Invited) “Scaling Relationships Describing Microfluidic Acoustic Nozzles for 3D-Printing” R. Collino, **T.R. Ray**, L. Friedrich, J. Cornell, M. Begley, *XXIV ICTAM*, Montreal, Canada Aug 2016

“A Microfluidic-based Separation Device for the Accurate Characterization of Metallic Nanoparticles.” **T.R. Ray**, S. Pennathur, 27th *International Symposium on MicroScale Bioseparations and Analyses*, Geneva, Switzerland Feb 2012

“Gold Nanorods: Exploration of the Growth Mechanism through Cellular Automata Modeling” **T.R. Ray**, S. Baxter, *University of South Carolina Discovery Day*, Columbia, SC Apr 2008  
Awarded Best Oral Presentation

**POSTERS** “Thin, Soft, Skin-Mounted Microfluidic Networks for the Diagnosis of Cystic Fibrosis.” **T.R. Ray**, J. A. Rogers, *Gordon Conference on the Physics & Chemistry of Microfluidics* Jun 2017

“Acoustic control of two-phase microstructures during extrusion printing with microfluidic nozzles.” R. Collino, L. Friedrich, **T.R. Ray**, J. Cornell, C. Meinhart, M. R. Begley, *Gordon Conference on the Physics & Chemistry of Microfluidics* Jun 2017

“Acoustically Enhanced Aggregation: a Microfluidic Assay Platform for Point-of-Care Diagnostics.” **T.R. Ray**, R. R. Collino, M. R. Begley, *Gordon Conference on the Physics & Chemistry of Microfluidics* Jun 2015

“Microchannel Acoustophoresis for Particle Manipulation and Deposition.” R. R. Collino, **T.R. Ray**, R. C. Fleming, C. H. Sasaki, H. Haj-Hariri, M. R. Begley, *Gordon Conference on the Physics & Chemistry of Microfluidics* Jun 2015

“Detection of Pathogenic Bacteria in Whole Blood using Microfluidics-Based Plasmonic Biosensing for Rapid Point-of-Care Diagnostics.” **T.R. Ray**, S. Pennathur, *Gordon Conference on the Physics & Chemistry of Microfluidics* Jun 2013

“Nanofluidic-based Characterization of Gold Nanoparticles.” **T.R. Ray**, S. Pennathur, *Gordon Conference on the Physics & Chemistry of Microfluidics* Jun 2011

“Force Handles for Alignment of Metallic Nanoparticles” **T.R. Ray**, T.M. Crawford, and S. Baxter, *Materials Research Society Fall Meeting*, Boston, MA Nov 2009

**HONORS** Simpson Querrey Institute for BioNanotechnology Gallery Competition – Third Place 2017  
Selected as a member of the TL1 Multidisciplinary Training Program in Child and Adolescent Health at Northwestern University 2017  
Mechanical Engineering Grad Slam – First Place 2015  
Gordon Research Seminar on Microfluidics  
Elected Co-Chair (2015), Discussion Leader (2013, 2015)

Honorable Mention in the 2nd Annual Art of Science Competition, UCSB	2015
Institute for Collaborative Biotechnology Graduate Fellow	2014–2015
Best TA Award in Mechanical Engineering	2014
UCSB Excellence Fellowship in Mechanical Engineering	2012
California NanoSystems Institute Graduate Research Fellow	2010 – 2015
University of California Regents Special Fellow	2010 – 2015
National Defense Science and Engineering Graduate Fellow	2008 – 2010
National Science Foundation Graduate Fellowship Honorable Mention	2008, 2009
Engineer in Training	2008
Caroliniana Award for Excellence in Student Leadership and Service Recipient	2008
Outstanding Senior in Mechanical Engineering, University of South Carolina	2008
Barry M. Goldwater National Scholarship for Science and Engineering Honorable Mention	2007
Magellan Scholar Fellowship for independent undergraduate research	2007
Robert McNair Scholarship Recipient Awarded to top 25 out-of-state undergraduate students at the University of South Carolina	2004–2008
Eagle Scout	2001

#### TEACHING

##### **University of California, Santa Barbara**

Lecturing - Laboratory Classes: Introduction to Fabrication Methods Spring 2013, 2014

- Instructed 20–25 students in a weekly lab section on cleanroom fabrication techniques
- Designed three labs to teach basic cleanroom fabrication processes using research-relevant MEMS devices
- Mentored teaching experience, 4 opportunities to lecture (full-length) in the main section

##### **University of South Carolina**

Lecturing - Numerical Methods Fall 2009

- Instructed 75 students in a weekly lab section on programming techniques in MathCad
- Prepared course material to supplement and reinforce concepts taught in the primary section
- Mentored teaching experience, opportunities to lecture in the main section

#### ASSOCIATIONS

Tau Beta Pi, Omicron Delta Kappa, Pi Tau Sigma, Pi Mu Epsilon, American Society of Mechanical Engineers, Materials Research Society

**TECHNICAL  
EXPERTISE**

*Cleanroom fabrication* experience (10 years) using lithography (multi-mask contact, stepper), deposition (e-beam, sputter, atomic layer deposition, chemical vapor deposition), etching (chlorine / fluorine chemistries in reactive ion etching, deep-reactive ion etching of silicon, metal-assisted chemical etching, wet-chemistry etching), wafer-to-wafer bonding (fusion, low-temperature, and anodic), and extensive process engineering in both process optimization and process development.

*Soft materials processing* including soft lithography, molding in both silicon and SU-8, development of materials for use in microfluidics applications, and rapid prototyping technologies (such as laser cutting). Extensive experience in nanofluidics and microfluidics techniques including acoustophoresis, dielectrophoresis, droplets and separation technologies.

*Characterization* experience using spectroscopic techniques (UV-Vis, fluorescence), light scattering techniques (dynamic light scattering, zeta potential), electron microscopy (transmission electron microscopy, scanning electron microscopy), tensile / compression / fatigue testing, digital image correlation (VIC2D/VIC3D), electronic testing, optical microscopy, atomic force microscopy.

*Additive manufacturing* experience in use of fused deposition modeling (extrusion) and scanning laser sintering (resin) technologies in addition to bespoke processes. Additional experience in characterization of titanium printed (e-beam, Arcam) parts.

**SERVICE**

Reviewer – <i>Analytica Chimica Acta</i>	2016–
Organized the 2017 Gordon Research Seminar on Microfluidics	2015–2017
Appointed by the Chancellor to the <i>Coordinating Committee on Budget Strategy</i>	2013–2015
Graduate Student Representative on the <i>Student Fee Advisory Committee</i>	2012–2015
Administered \$350,000 annual budget, \$8.1 million reserve account	