Jonathan B. Boreyko

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Nanofabrication Research Laboratory
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Education

Duke University, Durham, NC	Mechanical Engineering	Ph.D., 2012
Trinity College, Hartford, CT	Mechanical Engineering	B.Sc. Hons, 2007
	Physics	B.Sc. Hons, 2007

Professional Experience

2012–present	Postdoctoral Research Associate, Center for Nanophase Materials Sciences, Oak Ridge National Laboratory
2007–2012	Graduate Research Assistant, Ph.D. Program, Duke University

Professional and Synergistic Activities

2010	Chairperson, 3rd Annual Retreat for Duke University's Department of Mechanical Engineering and Materials Science (MEMS)
2009–2010	Teaching Assistant, ME126L Fluid Mechanics, Prof. Pei Zhong (2009); ME150L Heat and Mass Transfer, Prof. Chuan-Hua Chen (2010)

Honors and Awards

2011	First Place Poster Award, Gordon Research Conference on Microfluidics
2011	Second Place Poster Award, MRS/ASM/AVS-NC Meeting
2011	Second Place Poster Award, 4th Annual Duke MEMS Retreat
2010	Second Place Poster Award, Faraday Discussion 146 on Wetting Dynamics
2010	Invited Speaker, Faraday Discussion Graduate Research Seminar
2010	NSF Travel Fellowship, Faraday Discussion Graduate Research Seminar
2009	Gallery of Fluid Motion Winner, 62nd Annual APS DFD Meeting
2009	National Finalist, Collegiate Inventors Competition
2009	Honorable Mention, NSF Graduate Research Fellowship Program
2009	Best Oral Presentation Award, 2nd Annual Duke MEMS Retreat
2008	First Place Poster Award, 1st Annual Duke MEMS Retreat
2007–2011	James B. Duke Fellowship, Duke University
2007–2008	Pratt-Gardner Fellowship, Duke University

Publications

Full publication list follows CV.

Research Synopsis

1. *Synthetic biology enabled by microfluidics.*
   We are interested in experimentally characterizing biochemical reactions that occur inside of cells by utilizing a bottom-up approach known as synthetic biology. Intracellular macromolecules will be encapsulated *in vitro* inside of femtoliter sized water droplets, which serve as substitutes for the cellular membrane. These droplets will then be fused together in an oil microchannel to controllably study dynamic microcompartmentation and the effects of macromolecular crowding and confinement on biochemical reactions.

2. *Spontaneously jumping condensate on superhydrophobic surfaces.*
   A new mechanism was discovered for liquid transport: powered by surface tension, microscopic dew forming on a superhydrophobic surface will spontaneously jump out-of-plane off the surface upon coalescence with neighboring drops. This novel and effective form of continuous dropwise condensation is of interest for phase-change heat transfer applications and for enabling anti-dew and anti-frost surfaces.

3. *Thermal diodes.*
   We utilized parallel superhydrophobic and superhydrophilic surfaces separated by an insulating gasket to invent a new type of phase-change thermal diode for asymmetric heat transfer. This planar phase-change thermal diode is over 100 times more thermally conductive in the forward mode compared to the reverse mode, and operates independently of gravity and orientation. Planar thermal diodes are of interest for more efficient solar energy harvesting and for the thermal regulation of buildings.

Graduate and Postdoctoral Advisors

Postdoctoral Advisor: Pat Collier (Oak Ridge National Laboratory)
Graduate Advisor: Chuan-Hua Chen (Duke University)

PUBLICATIONS

Jonathan B. Boreyko, Ph.D.
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Journal Publications

1. J.B. Boreyko, Y. Zhao, and C.H. Chen, "Planar jumping-drop thermal diodes," *Applied Physics Letters* **99**, 234105 (2011).
   [Featured in *Mechanical Engineering*: "Jumping Droplets Make a Heat Trap."]

2. J.B. Boreyko, C.H. Baker, C.R. Poley, and C.H. Chen, "Wetting and Dewetting Transitions on Hierarchical Superhydrophobic Surfaces," *Langmuir* **27**, 7502 (2011).

3. J.B. Boreyko and C.H. Chen, "Self-propelled jumping drops on superhydrophobic surfaces," *Physics of Fluids* **22,** 091110 (2010).

4. J.B. Boreyko and C.H. Chen, "Self-Propelled Dropwise Condensate on Superhydrophobic Surfaces," *Physical Review Letters* **103,** 184501 (2009).
   [Editor's Choice in *Science*: "Up, Up and Away" **326,** 917 (2009)]
   [Featured on *Discovery Channel (Canada)*: Super Slo-Mo Tuesdays, Nov. 3]

5. J.B. Boreyko and C.H. Chen, "Restoring Superhydrophobicity of Lotus Leaves with Vibration-Induced Dewetting," *Physical Review Letters* **103,** 174502 (2009).
   [Cover story of Volume 103, Issue 17]
   [Featured in Oct. 27th *NY Times*: "Vibrations Keep Water Out of Lotus Leaves"]

Conference Proceedings:

1. Y. Zhao, J.B. Boreyko, M.H. Chiang, C.H. Baker, C.H. Chen, "Beetle inspired electrospray vapor chamber," *ASME Micro/Nanoscale Heat & Mass Transfer International Conference*, Shanghai, China, #18498 (2009).

Patents and Applications:

1. C.H. Chen, J.B. Boreyko, and Y. Zhao, "Thermal diode device and methods," *US Publication No. 2012/0012804* (published 2012).
   [National Finalist in the 2009 Collegiate Inventors Competition]