

EVELYN N. WANG, PH.D.

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EDUCATION

- Stanford University**, Stanford, CA 2002-2006
Ph.D. in Mechanical Engineering, January 2006
National Defense Science and Engineering Graduate Research Fellow
Thesis: Characterization of Microfabricated Two-Phase Heat Sinks for IC Cooling Applications
Advisors: Thomas W. Kenny and Kenneth E. Goodson
- Stanford University**, Stanford, CA 2000-2001
M.S. in Mechanical Engineering, December 2001
National Defense Science and Engineering Graduate Research Fellow
- Massachusetts Institute of Technology**, Cambridge, MA 1996-2000
B.S. in Mechanical Engineering, June 2000

RESEARCH EXPERIENCE

- Massachusetts Institute of Technology**, Cambridge, MA August 2006-present
Visiting Assistant Professor, Department of Mechanical Engineering
(Tenure-track Assistant Professor appointment begins July 2007)

Research interests include MEMS/NEMS design and sensing, optical diagnostics, systems integration, and numerical modeling; thermal management for electronic systems; micro-/nano-scale two-phase transport, heat transfer, and phase-change; MEMS-based cell diagnostics and manipulation; bio-inspired micro-/nano-systems.

- Bell Laboratories**, Murray Hill, NJ February 2006-present
Postdoctoral Researcher

Current project focuses on the development of a rapid mixing device using superhydrophobic nanostructured surfaces for accelerated immunoassays. Specific tasks include:

- Investigation of the mechanisms for hydrophilicity-hydrophobicity transition and induced rapid mixing using infrared thermometry, high-speed imaging, and particle diagnostics.
- Model development to predict thermal and hydrodynamic behavior of sample drop and underlying substrate during transition and mixing.
- Demonstration of rapid mixing with DNA hybridization and Enzyme-Linked Immunosorbent Assay (ELISA).

- Stanford University**, Stanford, CA March 2001-January 2006
Graduate Research Assistant

Investigated heat transfer and flow characteristics of two-phase heat sinks for IC chip cooling.

- Designed, microfabricated, and tested silicon-based heat sinks with integrated heaters and doped sensors; projects included both *microjet* impingement and *microchannel* cooling methods.
- Investigated boiling flow characteristics using epi-fluorescence microscopy.
- Developed analysis for heat transfer characteristics and compared results with experimental data.

Developed hybrid methodology for bubble geometry and three-dimensional flow field reconstruction.

- Obtained flow field around nucleating bubble using micron-resolution particle image velocimetry (μ PIV).
- Combined μ PIV data with numerical simulation to reconstruct bubble geometry and three-dimensional flow field in two-phase microchannels.

Developed force analysis for nucleating bubbles during boiling incipience in microchannels based on the above methodology.

Lawrence Livermore National Laboratory, Livermore, CA

June-August 1999

Summer Engineering Intern

Designed and tested a LabView driver to control the kicker pulser power source used in the ETAII linear accelerator.

Calculated and analyzed electron beam trajectories at a split junction area of the linear accelerator.

TRW Inc., RF Products Center, Redondo Beach, CA

January 1999, June-August 1998

Research Engineer

Researched and analyzed deep levels in high electron mobility transistors with the effects of strain and the presence of an AlGaAs buffer.

Robocon International Design Competition, Sao Paulo, Brazil

July 1998

Competitor

One out of six students to represent the United States. Designed and constructed robotic devices in a team of six multi-national students.

TRW Inc., RF Products Center, Redondo Beach, CA

June-August 1997

Summer Technical Assistant

Gathered data from DC testing of electronic devices used for satellite communication systems.

TEACHING & MENTORING EXPERIENCE

Stanford University, Stanford, CA

January 2002-present

Research Mentor

Mentored and guided M.S. and Ph.D. students in research projects. Students include Roger Flynn, Emily Reinhart, Minhwan Lee, Sara Shaughnessy, Margaret Hollendoner, Andrew Graham, Jim Cybulski, and Yoonjin Won.

Stanford University, Stanford, CA

April 2004

Graduate Teaching Assistant

Led students in the design and fabrication of piezoresistive cantilevers for *ME342 MEMS Design*.

Massachusetts Institute of Technology, Cambridge, MA

February-May 1998

Undergraduate Teaching Assistant

Led class lectures and lab sessions for *2.002 Mechanics and Materials II* with 60 students.

Performed aluminum, polycarbonate, and PMMA material testing with INSTRON, stress and strain analysis with finite element program ABAQUS, and machined materials for tension and compression tests.

JOURNAL PUBLICATIONS

E.N. Wang, S. Devasenathipathy, H. Lin, C.H. Hidrovo, J.G. Santiago, K.E. Goodson, T.W. Kenny. "A Hybrid Method for Bubble Reconstruction in Two-Phase Microchannels," *Experiments in Fluids*, 2006, 40 (6), p.847-858.

E.N. Wang, L. Zhang, L. Jiang, J.-M. Koo, J.G. Maveety, E.A. Sanchez, K.E. Goodson, T.W. Kenny. "Micromachined Jets for Liquid Impingement Cooling of VLSI Chips," *Journal of MicroElectroMechanical Systems*, 2004, 13(5), p.833-842.

E.N. Wang, S. Devasenathipathy, J.G. Santiago, K.E. Goodson, T.W. Kenny. "Nucleation and Growth of Vapor Bubbles in a Heated Silicon Microchannel," *Journal of Heat Transfer*, 2004, 128(4), p.497.

L. Zhang, E.N. Wang, K.E. Goodson, T.W. Kenny. "Phase Change Phenomena in Silicon Microchannels," *International Journal of Heat and Mass Transfer*, 2005, 48(8), p.1572-1582.

T.W. Kenny, K.E. Goodson, J.G. Santiago, E. Wang, J.-M. Koo, L. Jiang, L. Zhang, D.W. Fogg, S. Yao, K. Rose, R. Flynn, C.-H. Cheng, C.H. Hidrovo. "Advanced Cooling Technologies for Microprocessors," *International Journal of High Speed Electronics and Systems*, 2006, 16(1), p. 301-313.

C.H. Hidrovo, T.A. Kramer, E.N. Wang, S. Vigneron, J.E. Steinbrenner, J.-M. Koo, F.-M. Wang, D.W. Fogg, R.D. Flynn, E.S. Lee, C.-H. Cheng, T.W. Kenny, J.K. Eaton, K.E. Goodson. "Two-Phase Microfluidics for Semiconductor Circuits and Fuel Cells," *Heat Transfer Engineering*, 2006, 27(4), p.53-63.

A. Balandin, K.L.Wang., S. Cai., R. Li, C.R. Viswanathan, E.N. Wang, M. Wojtowicz. "Investigation of Flicker Noise Level and Deep Levels in AlGaIn/GaN Heterostructure Field Effect Transistors," *Journal of Electronic Materials*, 2000, 29(3), p.297-301.

CONFERENCE PRESENTATIONS & PROCEEDINGS

E.N. Wang, S. Devasenathipathy, H. Lin, C.H. Hidrovo, J.G. Santiago, K.E. Goodson, T.W. Kenny. "A Bubble Reconstruction Method for Two-Phase Microchannel Flows," *58th Meeting of American Physical Society/Division of Fluid Dynamics (APS/DFD)*, Chicago, IL, November 20-22, 2005.

E.N. Wang, S. Devasenathipathy, H. Lin, C.H. Hidrovo, J.G. Santiago, K.E. Goodson, T.W. Kenny. "Bubble Geometry Reconstruction for Force Estimations in Two-Phase Microchannel Flows," *Physics and Chemistry of Microfluidics - Gordon Research Conference*, Oxford, England, August 21-26, 2005.

C.H. Hidrovo, T.A. Kramer, E.N. Wang, S. Vigneron, J.E. Steinbrenner, J.-M. Koo, F.-M. Wang, D.W. Fogg, R.D. Flynn, E.S. Lee, C.-H. Cheng, T.W. Kenny, J.K. Eaton, K.E. Goodson. "Two-Phase Microfluidics for Semiconductor Circuits and Fuel Cells," *3rd International Conference on Microchannels and Minichannels*, Toronto, Canada, June 13-15, 2005.

R. Flynn, T.A. Kramer, J.-M. Koo, D.W. Fogg, C.-H. Cheng, E.N. Wang, K.E. Goodson. "Convective Boiling in Silicon Microchannels with Localized Heating and Thermometry," *3rd International Conference on Microchannels and Minichannels*, Toronto, Canada, June 13-15, 2005.

E.N. Wang, J.G. Santiago, K.E. Goodson, T.W. Kenny. "Microjet Impingement Cooling with Phase Change," *Proceedings of the ASME International Mechanical Engineering Congress & Exposition*, Anaheim, CA, November 13-19, 2004, IMECE2004-62176.

T.A. Kramer, R.D. Flynn, D.W. Fogg, E.N. Wang, C.H. Hidrovo, R.S. Prasher, D.S. Chau, S. Narasimhan, K.E. Goodson. "Microchannel Experimental Structure for Measuring Temperature Fields During Convective Boiling," *Proceedings of the ASME International Mechanical Engineering Congress & Exposition*, Anaheim, CA, November 13-19, 2004, IMECE2004-61936.

E.N. Wang, S. Devasenathipathy, C.H. Hidrovo, D.W. Fogg, J.-M. Koo, J.G. Santiago, K.E. Goodson, T.W. Kenny. "Liquid Velocity Fields in Two-Phase Microchannel Convection," *Proceedings of 3rd International Symposium on Two-Phase Flow Modelling and Experimentation*, Pisa, Italy, September 22-24, 2004.

E.N. Wang, S. Devasenathipathy, C.H. Hidrovo, D.W. Fogg, J.-M. Koo, J.G. Santiago, K.E. Goodson, T.W. Kenny. "A Quantitative Understanding of Transient Bubble Growth in Microchannels using μ PIV," *Proceedings of Hilton Head 2004: Solid-State Sensors & Actuator Workshop*, Hilton Head, SC, June 6-10, 2004.

E.N. Wang, S. Devasenathipathy, J.G. Santiago, K.E. Goodson, T.W. Kenny. "Nucleation and Growth of Vapor Bubbles in a Heated Silicon Microchannel," *ASME International Mechanical Engineering Congress & Exposition*, Washington, D.C., Nov. 15-21, 2003.

J. Burney, T. Bay, P. Brink, B. Cabrera, P. Castle, R. Romani, A. Tomada, S. Nam, A. Miller, J. Martinis, E.N. Wang, T. Kenny, B. Young. "Development and Characterization of a TES Optical Imaging Array for Astrophysics Applications," *Proceedings of 10th International Workshop on Low Temperature Detectors*, Genoa, Italy, July 7-11, 2003.

K.E. Goodson, L. Jiang, S. Sinha, E. Pop, S. Im, D. Fletcher, W. King, J.-M. Koo, E.N. Wang. "Microscale Thermal Engineering of Electronics Systems," *Proceedings of Rohsenow Symposium on Future Trends of Heat Transfer*, Cambridge, MA, May 16, 2003.

L. Jiang, J. Koo, A. Bari, E.N. Wang, L. Zhang, R.S. Prasher, J.G. Maveety, T.W. Kenny, J.G. Santiago, K.E. Goodson. "Cross-Linked Microchannels for VLSI Hotspot Cooling," *Proceedings of the ASME International Mechanical Engineering Congress & Exposition*, New Orleans, LA, Nov. 17-22, 2002, MEMS-1, IMECE2002-39238.

J. Koo, S. Im, E. Cho, R.S. Prasher, E.N. Wang, L. Jiang, A. Bari, D. Champion, D. Fogg, M. Kim, T.W. Kenny, J.G. Santiago, K.E. Goodson. "VLSI Hotspot Cooling Using Two-Phase Microchannel Convection," *Proceedings of the ASME International Mechanical Engineering Congress & Exposition*, New Orleans, LA, Nov. 17-22, 2002, PID-1A, IMECE2002-39585.

E.N. Wang, L. Zhang, L. Jiang, J.-M. Koo, J.G. Maveety, E.A. Sanchez, K.E. Goodson, T.W. Kenny. "Micromachined Jet Arrays for Liquid Impingement Cooling of VLSI Chips," *Proceedings of Hilton Head 2002: Solid-State Sensors & Actuator Workshop*, Hilton Head, SC, June 2-6, 2002.

J. Koo, L. Jiang, A. Bari, L. Zhang, E.N. Wang, T.W. Kenny, J.G. Santiago, K.E. Goodson. "Convective Boiling in Microchannel Heat Sinks with Spatially-Varying Heat Flux," *Proceedings of IITHERM*, San Diego, CA, May 30 - June 1, 2002, pp. 341-346.

L. Zhang, E.N. Wang, J.-M. Koo, L. Jiang, K.E. Goodson, J.G. Santiago, T.W. Kenny. "Enhanced Nucleate Boiling in Microchannels," *Proceedings of 15th IEEE MEMS Workshop*, Las Vegas, Nevada, Jan. 20-24, 2002.

L. Zhang, E.N. Wang, J.D. Koch, J.T. Liu, J.-M. Koo, L. Jiang, K.E. Goodson, J.G. Santiago, T.W. Kenny. "Microscale Liquid Impingement Cooling," *Proceedings of the ASME International Mechanical Engineering Congress & Exposition*, New York City, New York, Nov. 11-16, 2001.

E.N. Wang, M. Wojtowicz, D. Streit. "Traps in Pseudomorphic Single and Double Heterostructure InGaAs/AlGaAs/GaAs HEMTs Measured by Deep Level Current and Capacitance Transient Spectroscopy," *Electronic Materials Conference*, Santa Barbara, CA, July 2, 1999.

A. Balandin, K.L. Wang, S. Cai, R. Li, C.R. Viswanathan, E.N. Wang, M. Wojtowicz. "Correlation Between Material Quality and Low-frequency Noise Level in GaN Heterostructure Field Effect Transistors," *Electronic Materials Conference*, Santa Barbara, CA, July 1, 1999.

TECHNICAL BRIEF

K. E. Goodson, J.G. Santiago, T.W. Kenny, L. Jiang, S. Zeng, J.-M. Koo, L. Zhang, S. Yao, E.N. Wang, "Electroosmotic microchannel cooling system for microprocessors," *Electronics Cooling*, 2002, **8**, pp. 46-47.

PATENTS

K.E. Goodson, D.E. Huber, L. Jiang, T.W. Kenny, J-M Koo, J.C. Mikkelsen, J.G. Santiago, E.N. Wang, S. Zheng, L. Zhang, D. Laser, C.-H. Chen. "Electroosmotic Microchannel Cooling System," U.S. Patent No. 6,942,018, September 13, 2005.

REVIEWER

Sensors and Actuators A, 2006

ASME Summer Heat Transfer Conference, 2005

Journal of Fluid Mechanics (Co-reviewed with Prof. Juan Santiago), 2004

3rd International Symposium on Two-Phase Flow Modelling and Experimentation, 2004

INVITED PRESENTATIONS

University of California, Los Angeles, CA 2006

Massachusetts Institute of Technology, Cambridge, MA, 2006

University of Illinois, Urbana-Champaign, IL, 2006

University of California, Riverside, CA, 2006

University of Washington, Seattle, Washington, 2006

Fluid Mechanics Seminar, UC Berkeley, CA, 2006

Bell Labs, Lucent Technologies, Murray Hill, NJ, 2005

Sandia National Laboratory, Livermore, CA, 2005
Intel Corporation, Portland, OR, 2005
Bay Area MEMS Journal Club, Palo Alto, CA 2004
Thermoscience Division Seminar, Stanford University, 2002, 2004
Mechanical Engineering ME201 Dim Sum, Stanford University, 2003, 2005
Thermal and Fluid Sciences Affiliates and Sponsors Conference, Stanford University, 2001

ACADEMIC SERVICE

Stanford Energy Sciences and System Search Committee, 2005
Stanford Mechanical Engineering Women's Recruitment, 2005
Stanford Design Division Student Representative, 2004-2005
Stanford Building Emergency Response Team, 2003-2006
Stanford Mechanical Engineering Research Lab Clean Room Committee, 2003-2006
MIT Educational Counselor, 2000-present

HONORS & AWARDS

Honorable Mention for Physics and Chemistry of Microfluidics-Gordon Research Conference poster, 2005
ASME Heat Transfer Photogallery Finalist, 2004
National Defense Science and Engineering Graduate Fellowship, 2000
National Science Foundation Graduate Fellowship, 2000
MIT Presidential Fellowship, 2000
4th place winner in MIT 2.007 Engineering Design Competition, 1998
ASME Frank William and Dorothy Given Miller Scholarship, 1999
TRW AAP Engineering and Science Scholarships, 1997, 1998, 1999
CESASC Mr. and Mrs. John Tu Scholarship, 1999
President Chao Nee Memorial Scholarship, 1999
CESASC Mrs. Edna and Dr. Yu-Shan Han Memorial Scholarship, 1998
AMP Inc. Award, Department of Mechanical Engineering, MIT, 1998
Member of Tau Beta Pi Engineering Honor Society
Member of Pi Tau Sigma Mechanical Engineering Honor Society

PROFESSIONAL SOCIETIES

Society of Women Engineers (SWE)
American Society of Mechanical Engineers (ASME)
American Physical Society (APS)
American String Teachers Association (ASTA)