

# Kenneth E. Goodson

Spring 2023

Davies Family Provostial Professor at Stanford University

Senior Associate Dean for Faculty and Academic Affairs in the School of Engineering

Professor of Mechanical Engineering and, by courtesy, of Materials Science and Engineering

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## Overview

Ken Goodson specializes in heat transfer and energy conversion with applications to data centers, electric vehicles, and power electronics. His group has benefitted from decades of funding from NSF, DARPA, DOE, ONR, AFOSR, and semiconductor and transportation companies. His 50+ PhD alums include dozens of faculty at MIT, Stanford, Princeton, UC Berkeley, and other schools as well as senior leadership at ARPA-E, tech firms, and national labs.

## Education

1993	PhD Mechanical Engineering, MIT
1991	MS Mechanical Engineering, MIT
1989	BS Mechanical Engineering, MIT. Tau Beta Pi
1989	BS Humanities, MIT. Phi Beta Kappa, Luis Sudler Prize

## Employment

1994-	Mechanical Engineering Professor, Stanford University
2001-2003	Founder/CTO, Cooligy, supplied heat sinks to Apple, acquired by Emerson, 30 patents
1993-1994	Visiting Scientist, Materials Research, Daimler-Benz AG, Germany

## Stanford Service

2019-	Senior Associate Dean for Faculty & Academic Affairs, Stanford School of Engineering
2013-2019	Department Chair, Mechanical Engineering
2008-2013	Department Vice Chair, Mechanical Engineering
2015-2016	Presidential Search Committee
2006-2014	Chair/CoChair of ME committees: Faculty search, strategic planning, grad admissions

As ME Chair and Vice Chair, Goodson led two strategic plans and directed or launched many hiring actions, recruiting 15 faculty who transformed the department's scholarship and diversity. As SoE Senior Associate Dean, he supports faculty affairs, research resourcing and compliance, COI, and housing assistance.

## Awards & Honors

2020	Member, National Academy of Engineering
2010-2019	Fellow: National Academy of Inventors, AAAS, IEEE, APS, ASME
2020	SRC Aristotle Mentorship Award. SIA University Researcher Award.
2017,2018	Richard Chu Achievement Award, IEEE. InterPACK Achievement Award, IEEE
2016	Charles Russ Richards Memorial Award, ASME
2015	Donald Q. Kern Heat Transfer Award, AIChE
2014	Heat Transfer Memorial Award for Science, ASME. Technical Excellence Award, SRC
2010-	Many named lectures, e.g., Rohsenow (MIT), Hawkins (Purdue), Aisinjoro-Soo (UIUC)
2010	Allan Kraus Thermal Management Medal, ASME
1996-1999	ONR Young Investigator and NSF CAREER Awards
1990,1991	Vocal Fellow, Tanglewood Music Festival, Boston Symphony Orchestra
1989	Luis Sudler Prize for Arts Achievement, MIT
1989	Tau Beta Pi, Phi Beta Kappa, Pi Tau Sigma. ONR Graduate Fellowship

## **Research, Scholarship, & Invention**

Ken Goodson has served as PI for dozens of grants from DARPA, DOE, ARPA-E, NSF, ONR, AFOSR, SRC, & SEMATECH, and contracts with many IC & transportation companies. He has co-authored 250 archival journal articles, 330 conference papers, 13 book chapters, two books, and 35 US patents. In Google Scholar, his work has 42000 citations (h=98). In Web of Knowledge, his work has 23000 citations (h=71).

### **Selected Archival Papers (from 250 total). PhD Students in Bold**

**Kwon, Khan, Perez, Asheghi, Pop**, Goodson, 2021 “Uncovering Thermal and Electrical Properties of Sb<sub>2</sub>Te<sub>3</sub>/GeTe Superlattice Films,” *Nano Letters*, Vol. 21, 5984.

**Sood**, Xiong, Chen, Wang, Selli, Zhang, McClellan, Sun, Donadio, Cui, Pop, Goodson, 2018, "An Electrochemical Thermal Transistor," *Nature Communications*, Vol. 9, 4510.

**Kodama**, Ohnishi, Park, Shiga, Park, Shimada, Shinohara, Shiomi, Goodson, 2017, “Modulation of Thermal and Thermoelectric Transport in Individual Carbon Nanotubes by Fullerene Encapsulation,” *Nature Materials*, Vol. 16, pp. 892-897.

**Palko, Lee, Zhang, Dusseault, Maitra, Won, Agonafer, Moss, Houshmand, Rong, Wilbur**, Rockosi, Mykyta, Resler, Altman, Asheghi, Santiago, Goodson, 2017, “Extreme Two-Phase Cooling from Laser-Etched Diamond and Conformal, Template-Fabricated Microporous Copper,” *Advanced Functional Materials* 27, 1703265.

**Marconnet, Panzer**, and Goodson, K.E., 2013, "Thermal Conduction Phenomena in Carbon Nanotubes and Related Nanostructured Materials," *Reviews of Modern Physics*, Vol. 85, pp. 1295-1326.

**Rowlette**, Kekatpure, **Panzer**, Brongersma, Goodson, 2009, "Nonradiative Recombination in Strongly Interacting Silicon Nanocrystals Embedded in Amorphous Silicon-Oxide Films," *Physical Review B*, Vol. 80, 045314.

**Pop**, Sinha, Goodson, 2006, "Heat Generation and Transport in Nanometer Scale Transistors," *Proceedings of the IEEE*, Vol. 94, pp. 1587-1601.

**Jiang**, Mikkelsen, **Koo**, Huber, Yao, **Zhang, Zhou**, Maveety, Prasher, Santiago, Kenny, Goodson, 2002, "Closed-Loop Electroosmotic Cooling System for VLSI Circuits," *IEEE Proc. Components, Packaging, & Manufacturing Technology* 25, 347. Basis of US patents 6942018, 6991024, 7131486, 7185697, 7334630.

**Ju**, and Goodson, 1999, "Phonon Scattering in Silicon Films of Thickness Below 100 nm," *Applied Physics Letters*, Vol. 74, pp. 3005-3007.

### **Selected Patents (from 35 total)**

US5,843,224, 1998. “Composite structure comprising a semiconductor layer arranged on a diamond or diamond-like layer and process for its production,” Zachai, Gutheit, Goodson (DaimlerBenz AG)

US6,942,018, 2005. “Electroosmotic Microchannel Cooling System”, Goodson, Huber, Jiang, Kenny, Koo, Mikkelsen, Santiago, Wang, Zheng, Zhang, Laser, Chen (Stanford, licensed to Emerson)

US10,784,115, 2020. “Method of Etching Microelectronic Mechanical System Features in a Silicon Wafer,” Zhou, Jung, Dede, Asheghi, Goodson (Stanford & Toyota)

## **Selected Ph.D. Graduates of Goodson Group (from 52 total)**

### **Alumni in Academia (partial list)**

1. Katsuo Kurabayashi, Ph.D. MSE 1998, Professor of Mechanical Engineering, University of Michigan
2. Y. Sungtaek Ju, Ph.D. ME 1999, Professor, Mechanical & Aerospace Engineering Department, UCLA
3. Daniel A. Fletcher, Ph.D. ME 2001, Purnendu Chatterjee Professor, Bioengineering, UC Berkeley
4. William P. King, Ph.D. ME 2002, Ralph Andersen Professor, Mechanical Science & Engineering Department, University of Illinois at Urbana-Champaign (co-advised with Prof. Kenny, Stanford ME)
5. Ankur Jain, Ph.D. ME 2004, Associate Professor, Mechanical Engineering, U. of Texas, Arlington
6. Eric Pop, Ph.D. EE 2005, Pease-Yi Professor, Electrical Engineering Department, Stanford University (Eric was co-advised with Prof. Bob Dutton, Stanford EE)
7. Sanjiv Sinha, Ph.D. ME 2005, Associate Professor, Mechanical Science and Engineering Department, University of Illinois at Urbana-Champaign
8. Xuejiao Hu, Ph.D. ME 2005, Professor, Power and Mechanical Engineering, Wuhan University, China.
9. Evelyn Wang, Ph.D. ME 2006, Professor and Department Head, Mechanical Engineering Department, Massachusetts Institute of Technology (Evelyn was co-advised with Prof. Tom Kenny, Stanford ME).
10. Amy Marconnet, Ph.D. ME 2012, Associate Professor, Mechanical Engineering, Purdue University
11. Saniya Leblanc, Ph.D. ME 2012, Assistant Professor, Mechanical and Aerospace Engineering, George Washington University
12. Xuejiao Hu, Ph.D. ME 2005, Professor, Power and Mechanical Engineering, Wuhan University, China.
13. Sarah Parikh, Ph.D. ME 2011, Associate Professor, Engineering and Physics Department, Foothill College, CA (Sarah was co-advised with Prof. Sheri Sheppard, Stanford ME)
14. Eon Soo Lee, Ph.D. ME 2007, Assistant Professor, Mechanical and Industrial Engineering Department, New Jersey Institute of Technology (Co-advised with Prof. John Eaton, Stanford ME).
15. Yoon-Jin Won, Ph.D. 2010, Assistant Professor, Mechanical Engineering, UC Irvine (Yoon-Jin was co-Advised with Prof. Tom Kenny, Stanford ME)
16. Jae-Ho Lee, Ph.D. ME 2012, Assistant Professor, Mechanical Engineering, UC Irvine
17. Jungwan Cho, Ph.D. ME 2015, Assistant Professor, Kyung Hee University, South Korea
18. Woosung Park, Ph.D. ME 2017, Assistant Professor, Sogang University, South Korea
19. Aditya Sood, Ph.D. MSE 2017, Assistant Professor, Mechanical & Aerospace Eng., Princeton University

### **Alumni with Industry or at National Laboratories (partial list)**

1. Maxat Touzelbaev, Ph.D. ME 1999, Apple, Mountain View
2. Patricia Gharagozloo, Ph.D., ME 2009, Member of Technical Staff, Sandia National Laboratories, Livermore, California.
3. David Fogg, Ph.D. ME 2007, Create Engineering Research and Development
4. Kevin Ness, Ph.D. ME 2007, Member of Technical Staff, Lawrence Livermore National Laboratories
5. Chen Fang, Ph.D. ME 2009, Senior Research Engineer, ExxonMobil, Houston TX
6. Milnes David, Ph.D. ME 2010, IBM Corporation, Poughkeepsie, NY
7. Jeremy Rowlette Ph.D. EE 2010, Senior Electro-Optics Engineer, Daylight Solutions, San Diego, CA
8. Yuan Gao, Ph.D. 2012, Member of Technical Staff, Apple, Mountain View, CA
9. Elah Bozorg-Grayeli, PhD. 2012, Senior Process Engineer, Intel Corporation, Chandler, AZ
10. Shilpi Roi Panzer, PhD. ME 2013, Member of Technical Staff, Exponent Inc., Oakland, CA
11. Michael Barako PhD. ME 2015, Member of Technical Staff, Northrop Grumman, Los Angeles, CA
12. Marc Dunham, Ph.D. ME 2016, Member of Technical Staff, Analog Devices, Santa Clara, CA
13. Ki Wook Jung, Ph.D. ME 2019, Member of Technical Staff, Samsung, South Korea
14. Joseph Katz, Ph.D. EE 2019, Exponent, CA
15. Tanya Liu, Ph.D. 2020, Google, Mountain View, CA
16. Farid Saroush, Ph.D. ME 2022, Apple, Mountain View, CA



## Narrative Bio Sketch

Ken Goodson is the Senior Associate Dean for Faculty & Academic Affairs in the Stanford School of Engineering. As Mechanical Engineering Chair & Vice Chair at Stanford (2008-2019), he led two strategic plans and recruited 15 faculty who transformed the department's scholarship and diversity.

Goodson specializes in heat transfer and energy conversion with applications to electric vehicles, data centers, and power electronics. His group has benefitted from decades of funding from NSF, DARPA, DOE, ARPA-E, ONR, and AFOSR, and has a track record of translating breakthrough thermal science to corporate practice. Under the DARPA ICECool Programs, his team developed a world-record heat sink for power conversion. Goodson has 35 patents, is a Fellow with the National Academy of Inventors, and co-founded Cooligy, which built heat sinks for Apple and was acquired by Emerson.

Goodson's 50+ PhD alums include dozens of faculty at MIT, Stanford, Princeton, UC Berkeley, and other schools as well as senior leadership at ARPA-E, Sandia Labs, and tech companies. He is a member of the National Academy of Engineering and a Fellow with AAAS, ASME, IEEE, and APS. He received the ASME Kraus Medal and Memorial Award, the IEEE Richard Chu Award, the AIChE Kern Award, and the SRC Aristotle Award for mentoring graduate students.

Goodson moonlights as a baritone oratorio soloist with appearances at Davies Symphony Hall and the Bing Concert Hall. He held voice fellowships at the Tanglewood Music Festival and received the Sudler Prize for Arts Achievement. His wife, Laura Dahl, is a concert pianist with the Stanford music faculty.

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Research Group: <https://nanoheat.stanford.edu>

Web of Science <https://www.webofscience.com/wos/author/record/1265334>

Google Scholar: <https://scholar.google.com/citations?user=oUhOkhUAAAAJ&hl=en>