QICHEN SONG

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EDUCATION AND EXPERIENCES

Harvard University **1/2022** — present
Harvard Quantum Initiative Postdoctoral Fellow (Advisor: Jarad A. Mason)
Research: Thermal transport in phase-change inorganic materials

Massachusetts Institute of Technology **9/2015 — 1/2022**
Ph.D. in Mechanical Engineering (Advisor: Gang Chen)
Thesis: Phonon and electron transport through interfaces and disordered structures
S.M. in Mechanical Engineering (Advisor: Gang Chen)
Thesis: *Ab initio* study of electron transport in lead telluride

Huazhong University of Science and Technology **9/2011 — 6/2015**
B.S. *with Honors* in Thermal Energy and Power Engineering (Advisor: Nuo Yang)
Thesis: On the effect of interlayer interaction on the thermal conductivity in folded graphene

RESEARCH INTERESTS

1. Understanding, manipulating, and optimizing the conversion, transfer, and storage of energy in stimuli-responsive and quantum materials.
2. Solid-state cooling systems using novel caloric materials.

Specializations: Transport physics, phase-change materials, laser spectroscopy, first-principles calculations

FUNDING AND AWARDS

Research Grant, Fourier Scientific LLC **2025 —2026**
Project: Non-contact measurement of thermal conductivity and heat capacity in single crystals via optical reflectance
Harvard Quantum Initiative Postdoctoral Prize **2022 — 2025**
Kaufman Teaching Certificate Program **2020**
MIT Quantum Hackathon Creative Award **2020**
Warren M. Rohsenow Fellowship **2015 — 2016**
National Scholarship (three times) **2012** & **2013** & **2014**

PUBLICATIONS

(34) **Qichen Song**, Rui Pan, Jungwoo Shin, Aaron J. Schmidt, Asegun Henry, Hong Lu, Gang Chen*, "Phonon Anderson localization in aperiodic superlattices up to 200 K", *in preparation*

(33) Rahil Ukani, **Qichen Song**, Alex D. Christodoulides, Caleb Stamper; Jinyoung Seo, Yukyung Moon, Dehong Yu, Catherine Thai, Ryan D. McGillicuddy, Jonathan A. Malen*, and Jarad A. Mason*, "The effect of order–disorder transitions on thermal transport in a two-dimensional hybrid perovskite", to be submitted to *J. Am. Chem. Soc.*

(32) Yukyung Moon, **Qichen Song**, Rahil Ukani, and Jarad A. Mason*, "Bidirectional adjustment of thermal conductivity in metal-organic frameworks via gas-host interactions", to be submitted to *J. Am. Chem. Soc.*

(31) Vidhya M. Dev, Kevin Miura, **Qichen Song**, Jason D. Braun, Faith E. Chen, Jinyoung Seo, Daniel W. Laorenza, and Jarad A. Mason*, "Tailoring spin-Crossover transitions in $Fe[HB(tz)_3]_2$ via co-crystallization for ultra-low

temperature barocaloric cooling", to be submitted to *J. Am. Chem. Soc.*, **2025**

(30) Lucy S. Nathwani, Anne Ruperto, Ashvini Vallipuram, Abigail Y. Jiang, Grace A. Pan, Dan Ferenc Segedin, Ari B. Turkiewicz, Charles M. Brooks, Jarad A. Mason*, **Qichen Song***, and Julia A. Mundy*, "Observation of microscopic domain effects in the metal-insulator transition of thin-film $NdNiO_3$", in revision with *Nano Lett.*, **2025** [Manuscript]

(29) **Qichen Song**, Rahil Ukani, Vidhya Dev, Jungwoo Shin, Jinyoung Seo, Hong Ki Kim, Caleb Stamper, Ryan McGillicuddy, Catherine Thai, Dehong Yu, Gang Chen, Jarad A. Mason*, "Reversible regulation of thermal conductivity through spin-crossover transitions", in revision with *Nature Materials*, **2025** [Manuscript] [Supplementary Information] [Code & Data]

(28) **Qichen Song***, Sorren Warkander, Samuel C. Huberman*, "Probing carrier and phonon transport in semiconductors all at once through frequency-domain photoreflectance", *Phys. Rev. Applied*, **2024**, 21, 034044

(27) Lenan Zhang*, Yang Zhong, Xiangyu Li, Ji-Hoon Park, **Qichen Song**, Long Li, Liang Guo, Jing Kong*, and Gang Chen*, "Effect of twist angle on interfacial thermal transport in two-dimensional bilayers", *Nano Lett.*, **2023**, 17, 7790-7796

(26) Ryotaro Okabe[†]*, Abhijatmedhi Chotrattanapituk[†], Artittaya Boonkird, Nina Andrejevic, Xiang Fu, Tommi S. Jaakkola, **Qichen Song**, Thanh Nguyen, Nathan Drucker, Sai Mu, Bolin Liao, Yongqiang Cheng, Mingda Li*, "Virtual node graph neural network for full phonon prediction", *Nat. Comput. Sci.*, **2024**, 4, 522-531

(25) Zhantao Chen*, Xiaozhe Shen*, Nina Andrejevic, Tongtong Liu, Duan Luo, Thanh Nguyen, Nathan C. Drucker, Michael E. Kozina, **Qichen Song**, Chengyun Hua, Gang Chen, Xijie Wang, Jing Kong, Mingda Li*, "Panoramic mapping of phonon transport from ultrafast electron diffraction and scientific machine learning", *Adv. Mater.*, **2022**, 2206997

(24) Yu Dai, Wenjiang Zhou, Hyun-Jung Kim, **Qichen Song**, Xin Qian, Te-Huan Liu*, Ronggui Yang*, "Simultaneous enhancement in electrical conductivity and Seebeck coefficient by single- to double-valley transition in a Dirac-like band", *npj Comput. Mater.*, **2022**, 8, 234

(23) Chaitanya A. Garde[†], Xingxu Yan[†], **Qichen Song**, Jie Li, Lei Gu, Toshihiro Aoki, Sheng-Wei Lee, Gang Chen, Ruiqian Wu, Xiaoqing Pan*, "Nanoscale imaging of phonon dynamics by electron microscopy", *Nature*, **2022**, 606, 292–297

(22) **Qichen Song** and Gang Chen*, "Significant reduction in semiconductor interface resistance via interfacial atomic mixing", *Phys. Rev. B*, **2022**, 105, 195306

(21) Jiawei Zhou*, Hangtian Zhu, **Qichen Song**, Zhiwei Ding, Jun Mao, Zhifeng Ren, Gang Chen*, "Mobility enhancement in heavily doped semiconductors via electron cloaking", *Nat. Commun.*, **2022**, 13, 2482

(20) Lenan Zhang, Yong Zhong, Xin Qian, **Qichen Song**, Jiawei Zhou, Long Li, Liang Guo*, Gang Chen*, and Evelyn N. Wang*, "Toward optimal heat transfer of 2D–3D heterostructures via van der Waals binding effects", *ACS Appl. Mater. Interfaces*, **2021**, 13, 38

(19) **Qichen Song*** and Gang Chen*, "Evaluation of diffuse mismatch model for phonon scattering at disordered interfaces", *Phys. Rev. B*, **2021**, 104, 085310

(18) Chaitanya Gadre, Xingxu Yan, **Qichen Song**, Gang Chen, Xiaoqing Pan, "Phonon reflections from nanostructured interfaces imaged by momentum-averaged and resolved vibrational EELS", *Microsc. Microanal.*, **2021**, 27 (S1), 1204-1206

(17) Thanh Nguyen, Nina Andrejevic, Hoi Chun Po, **Qichen Song**, Yoichiro Tsurimaki, Nathan C. Drucker, Ahmet Alatas, Esen E. Alp, Bogdan M. Leu, Alessandro Cunsolo, Yong Q. Cai, Lijun Wu, Joseph A. Garlow, Yimei Zhu, Hong Lu, Arthur C. Gossar Alexander A. Puretzky, David B. Geohegan, Shengxi Huang*, Mingda Li*, "Signature of many-body localization of phonons in strongly disordered superlattices", *Nano Lett.*, **2021**, 17, 7419–7425

(16) Haozhe Wang, Zhenpeng Yao, Gang Seob Jung, **Qichen Song**, Marek Hempel, Tomas Palacios, Gang Chen, Markus J. Buehler, Alan Aspuru-Guzik, Jing Kong*, "Frank-van der Merwe growth in bilayer graphene", *Matter*, **2021**, 4, 10, 3339-3353

(15) Wuyang Ren†, **Qichen Song**†, Hangtian Zhu, Jun Mao, Li You, Geethal A. Gamage, Jiawei Zhou, Ting Zhou, Jing Jiang, Chao Wang, Jun Luo, Jiang Wu, Zhiming Wang*, Gang Chen*, Zhifeng Ren*, "Intermediate-level doping strategy to simultaneously optimize power factor and phonon thermal conductivity for improving thermoelectric figure of merit", *Mater. Today Phys.*, **2020**, 15, 100250

(14) Qiyang Lu, Samuel Huberman, Hantao Zhang, **Qichen Song**, Jiayue Wang, Gulin Vardar, Adrian Hunt, Iradwikanari Waluyo, Gang Chen* and Bilge Yildiz*, "Bi-directional tuning of thermal transport in $SrCoO_x$ with electrochemically induced phase transitions", *Nat. Mater.*, **2020**, 19, 655–662

(13) Ke Chen†, Bai Song†*, Navaneetha K. Ravichandran, Qiye Zheng, Xi Chen, Hwijong Lee, Haoran Sun, Sheng Li, Geethal A. Gamage, Fei Tian, Zhiwei Ding, **Qichen Song**, Akash Rai, Hanlin Wu, Pawan Koirala, Aaron J. Schmidt, Kenji Watanabe, Bing Lv, Zhifeng Ren, Li Shi, David G. Cahill, Takashi Taniguchi, David Broido* and Gang Chen*, "Ultrahigh thermal conductivity in isotope-enriched cubic boron nitride", *Science*, **2020**, 367, 6477

(12) Chang Liu, **Qichen Song**, Jianan Chen, Xinhao Li, Jingxuan Cai, Zhouguang Lu, Wendi Li, Nicholas X. Fang*, Shien-Ping Feng*, "Electromagnetic and chemical enhancements of surface-enhanced Raman scattering spectra from Cu_2O hexagonal nanoplates", *Adv. Mater. Interfaces*, **2019**, 6, 17, 1900534

(11) Te-Huan Liu, Bai Song, Laureen Meroueh, Zhiwei Ding, **Qichen Song**, Jiawei Zhou, Mingda Li, Gang Chen*, "Simultaneously high electron and hole mobilities in cubic boron-V compounds: BP, BAs and BSb", *Phys. Rev. B: Rapid Communications*, **2018**, 98, 081203

(10) Hangtian Zhu, Jun Mao, Yuwei Li, Jifeng Sun, Yumei Wang, Qing Zhu, Guannan Li, **Qichen Song**, Jiawei Zhou, Yuhao Fu, Ran He, T. Tong, Zihang Liu, Wuyang Ren, Li You, Zhiming Wang, Jun Luo, Andrei Sotnikov, Jiming Bao, Kornelius Nielsch, Gang Chen, David J. Singh* and Zhifeng Ren*, "Discovery of TaFeSb-based half-Heuslers with high thermoelectric performance", *Nat. Commun.*, **2019**, 10, 270

(9) Qian Zhang*, **Qichen. Song**, Xinyu Wang, Jingying Sun, Qing Zhu, Keshab Dahal, Xi Lin, Feng Cao, Jiawei Zhou, Shuo Chen, Gang Chen, Jun Mao*, Zhifeng Ren*, "Deep defect level engineering: a strategy of optimizing the carrier concentration for high thermoelectric performance", *Energy & Environmental Science*, **2018**, 11 (4), 933-940

(8) Jiawei Zhou, Hangtian Zhu, Te-Huan Liu, **Qichen Song**, Ran He, Jun Mao, Zihang Liu, Wuyang Ren, Bolin Liao, David J. Singh, Zhifeng Ren*, Gang Chen*, "Large thermoelectric power factor from crystal symmetry-protected non-bonding orbital in half-Heuslers", *Nat. Commun.*, **2018**, 9, 1721

(7) Te-Huan Liu, Jiawei Zhou, Mingda Li, Zhiwei Ding, **Qichen Song**, Bolin Liao, Liang Fu, Gang Chen*, "Electron mean-free-path filtering in Dirac material for improved thermoelectric performance", *Proc. Natl. Acad. Sci.*, **2018**, 115 (5), 879-884

(6) Mingda Li†*, **Qichen Song**†, Weiwei Zhao, Joseph A. Garlow, Te-Huan Liu, Lijun Wu, Yimei Zhu, Jagadeesh S. Moodera, Moses H. W. Chan, Gang Chen*, and Cui-Zu Chang*, "Dirac-electron-mediated magnetic proximity effect in topological insulator/magnetic insulator heterostructures", *Phys. Rev. B: Rapid Communications*, **2017**, 96, 201301

(5) **Qichen Song**, Te-Huan Liu, Jiawei Zhou, Zhiwei Ding, Gang Chen*, "*Ab initio* study of electron mean free paths and thermoelectric properties of lead telluride", *Mater. Today Phys.*, **2017**, 2, 69-77

(4) Meng An†, **Qichen Song**†, Xiaoxiang Yu, Zelin Jin, Dengke Ma, Baoling Huang, Nuo Yang*, "Generalized two-temperature model for coupled phonons", *Nano Lett.*, **2017**, 17 (9), 5805-5810

(3) Mingda Li*, **Qichen Song**, Te-Huan Liu, Laureen Meroueh, Gerald D. Mahan, Mildred. S. Dresselhaus, Gang Chen*, "Tailoring superconductivity with quantum dislocations", *Nano Lett.*, **2017**, 17 (8), 4604-4610

(2) **Qichen Song**, Jiawei Zhou, Laureen Meroueh, David Broido, Zhifeng Ren, Gang Chen*, "The effect of shallow vs. deep level doping on the performance of thermoelectric materials", *Appl. Phys. Lett.*, **2016**, 109, 263902

(1) **Qichen Song**†, Meng An†, Xiandong Chen, Zhan Peng, Jianfeng Zang, Nuo Yang*, "The adjustable thermal resistor by reversibly folding a graphene sheet", *Nanoscale*, **2016**, 8, 14943-14949

Presentations

(7) Reversible regulation of thermal conductivity with spin state transitions, **2024** MRS Fall Meeting, Boston, Massachusetts

(6) Bridging thermal engineering and chemistry with molecular materials, Meet the New Faculty Candidates Poster Session, **2024** MRS Fall Meeting, Boston, Massachusetts

(5) Study of carrier and thermal transport in semiconductors using frequency domain thermoreflectance, **2023** MRS Spring Meeting, San Francisco, California

(4) Manipulating electron and phonon flow across interfaces using structural randomness, **2023** APS March Meeting, Las Vegas, Nevada

(3) Probing local heating and cooling at interfaces: a non-equilibrium Green's function study, **2018** APS March Meeting, Los Angeles, California

(2) *Ab initio* study of the effect of the grain boundary on electron transport in thermoelectric materials (poster), **2017** MRS Fall Meeting, Boston, Massachusetts

(1) *Ab initio* study of electron transport in lead telluride, **2017** APS March meeting, New Orleans, Louisiana

Services

Session Chair, SF03.19 Emerging Thermal Materials–From Nanoscale Heat Transport, Devices and Applications, to Theories, **2023** MRS Fall Meeting

Journal Reviewer for *PRL*, *PRB*, *PR Applied*, *Sci. Adv.*, *Nano Lett.*, *Adv. Mater.*, *Adv. Funct. Mater.*, *Joule*, *Mater. Today Phys.*, *ACS Appl. Mater. Interfaces*, *Appl. Phys. Lett.*, *J. Phys. Chem. Lett.*, *J. Mater. Chem. C.*, *npj Comput. Mater.*, *IEEE T-DMR*, *IEEE T-TST*

Guest Editor, Special Issue on Atomic Layer Materials and Processes, *Micromachines*

Project Teach with Brighton High School and Dr. Martin Luther King, Jr. School

Teaching

TA for 2.57 Nano-to-Macro Transport Processes, Fall **2019** (overall rating: 6.8 out of 7)

Instructor for Introduction to Pump-Probe Spectroscopy for Study of Thermal Transport in Materials, Independent Activities Period **2022**

Mentoring

Rahil Ukani, Ph.D. candidate (G7) in the Department of Chemistry & Chemical Biology, Harvard University
Diffuson-like heat transport in dynamically disordered chains

Yukyung Moon, Ph.D. candidate (G5) in the Department of Chemistry & Chemical Biology, Harvard University
Bidirectional adjustment of thermal conductivity in metal-organic frameworks via gas-host interactions
Lucy Nathwani, undergraduate researcher (U4) in the Department of Physics, Harvard University
Tuning thermal transport in $NdNiO_3$ thin films with metal-insulator transitions
Ashvini Vallipuram, Ph.D. student (G2) in the Department of Physics, Harvard University
Engineered Thermal transport in V_2O_3 thin films

Courses

MechE (major)
Advanced Fluid Mechanics, General Thermodynamics, Advanced Heat & Mass Transfer, Nano-to-Macro Transport Processes
Physics (minor)
Theory of Solids II, Relativistic Quantum Field Theory I, Relativistic Quantum Field Theory II, Statistical Mechanics I, Statistical Mechanics II
EECS
Applied Quantum & Statistical Physics, Physics for Solid-State Applications, Principles & Applications of Quantum Optics
MSE
Atomistic Computer Modeling of Materials
Math
Mathematical Methods in Nanophotonics, Computational Science & Engineering I

Computer Skills

FORTRAN 90, Python, Qiskit, MATLAB, LaTeX, C++, LabVIEW

References

Gang Chen
Carl Richard Soderberg Professor of Power Engineering of the Department of Mechanical Engineering
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Jarad A. Mason
John L. Loeb Associate Professor of the Natural Sciences of Chemistry & Chemical Biology
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Julia A. Mundy
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mundy@fas.harvard.edu