Roman Anufriev

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Research experience

2021 – 2023 · Associate Professor at the University of Tokyo
2018 – 2021 · Project Research Associate at the University of Tokyo
2014 – 2018 · PostDoc at the University of Tokyo
2010 – 2013 · PhD at Lyon Nanotechnology Institute (INL)
2009 – 2010 · Master at Saint Petersburg Academic University

Education

PhD · Institut National des Sciences Appliquées (INSA) de Lyon (2013)
Optical properties of III-V nanowire heterostructures grown on silicon substrates
Supervised by Catherine Bru-Chevallier and Nicolas Chauvin

M.S. · Saint Petersburg Academic University of the Russian Academy of Sciences (2010)
Simulation of Tamm plasmon polaritons in multilayered cylindrical structures
Major: Electronics and microelectronics.
Supervised by Mikhail Kaliteevski

Skills and expertise

- Nanofabrication methods (EB lithography, RIE, PVD, and other clean-room methods)
- Time-domain thermoreflectance (TDTR)
- Brillouin light scattering (BLS) spectroscopy
- Photoluminescence spectroscopy (PL, Micro-PL, PLE, TR-PL)
- Electron and atomic force microscopy (AFM)
- Ray-tracing, FEM, and quantum simulations (Python, Matlab, Comsol, and Nextnano)
- Background in the solid state physics (semiconductor optics, nanoscale heat transport, phononics)
- English (Advanced), French (B2), Polish (Beginner), Russian (Native)

Grants and awards

2020 · Best Review Award from JSPS
2019 · The Junior Prize of the IPPA
$ 2019 · PRESTO JST grant (€ 300 000)
$ 2018 · Kakenhi JSPS grant (€ 23 000)
2017 · JSAP Young Author Award
2016 · Certificate of merit for "Thermal Engineering Best Paper" from the JSME
$ 2016 · Postdoctoral scholarship of the JSPS (€ 20 000)

★ Research highlights

Nanoscale limit of the thermal conductivity in crystalline silicon carbide membranes, nanowires, and phononic crystals

We fabricated single crystalline SiC nanostructures, including nanomembranes, nanowires, and phononic crystals, and systematically studied their thermal properties and phonon mean free path. Our measurements show that the thermal conductivity of nanostructures is several times lower than in bulk and the values scale proportionally to the narrowest dimension of the structures.

Anufriev et al., NPG Asia Materials 14, 35 2022

Ray phononics: thermal guides, emitters, filters, and shields powered by ballistic phonon transport

This conceptual paper introduced ray phononics as an alternative paradigm of heat conduction manipulations. We demonstrated how the directional phonon fluxes occur and how they can be used to create various devices based on ballistic heat conduction. This work is expected to open a new research direction in phononics.

Materials Today Physics 15, 100272, 2020

Quasi-ballistic heat conduction due to Lévy phonon flights in silicon nanowires

In a series of experiments, we demonstrated how ballistic heat conduction gradually occurs in short nanowires as the temperature is decreased. In contrast with the previous observation, this work reveals a gradual transition from diffusive to ballistic behavior and shows realistic limits of non-diffusive transport. Our modeling also reveals that quasi-ballistic heat conduction is caused by Lévy walk of phonons.

ACS Nano 12, 11928, 2018

Heat conduction tuning by wave nature of phonons

Our experiments on ordered and disordered phononic crystals demonstrated that coherent heat conduction occurs only around 4 K and quickly disappears as the temperature is increased. This resulted concluded an almost decade-long debate about the possibility of coherent heat conduction at room temperature.

Science Advances, 3, e1700027, 2017

Heat guiding and focusing using ballistic phonon transport in phononic nanostructures

Our experiments and simulations demonstrated that it is possible to guide and focus heat using ballistic transport of phonons. This work uncovers a mechanism to achieve functionality similar to that of photonic crystals but for heat and without phonon interference.

Nature Communications, 8, 15505, 2017

Academic open-source projects

Monte-Carlo phonon simulator

Free and open-source simulator of phonon and thermal transport in complex 3D geometries.

github.com/anufrievroman/freepaths

Angry Reviewer corrector

Free online English style corrector for academic writing with plugins for LibreOffice and Vim.

AngryReviewer.com

Callaway-Holland model implementation

Python implementation of Callaway-Holland model of thermal transport that supports Si and SiC.

github.com/anufrievroman/Callaway-Holland-model

Patents

発明者：野村政宏、R. Anufriev, A. Ramiere, J. Maire, 出願番号：特願 2017-095459, 発明の名称：熱流方向性制御構造, 出願日： May 12 (2017)

発明者：野村政宏、R. Anufriev, 柳澤亮人, A. George, 出願番号：特願 2017-154070, 発明の名称：熱電変換材料およびその製造方法, 出願日： August 9 (2017)

Book chapter

R. Anufriev and M. Nomura
"Phonon Engineering for Quantum Hybrid Systems,"
Quantum Hybrid Electronics and Materials, 15-24, Springer Nature, 2022.

Journal publications

R. Anufriev, Y. Wu, J. Ordonez-Miranda, M. Nomura
"*Nanoscale limit of the thermal conductivity in crystalline silicon carbide*"
NPG Asia Materials, *14, 35,* 2022

M. Nomura, R. Anufriev, Z. Zhang, J, Maire, Y. Guo, R. Yanagisawa, S. Volz
"Review of thermal transport in phononic crystals"
Materials Today Physics, 22, 100613, 2022

R. Anufriev, J, Maire, M. Nomura
"*Review of coherent phonon and heat transport control in one-dimensional phononic crystals at nanoscale*"
APL Materials 9, 070701, 2021

R. Anufriev, Y. Wu, M. Nomura
"*Ballistic heat conduction in semiconductor nanowires*"
Journal of Applied Physics 130, 070903, 2021

R. Anufriev, C. Glorieux, G. Diebold
"*Advances in photothermal and photoacoustic metrology*"
Journal of Applied Physics 128, 240402, 2020

R. Anufriev, M. Nomura
"*Ray phononics: thermal guides, emitters, filters, and shields powered by ballistic phonon transport*"
Materials Today Physics 15, 100272, 2020

R. Anufriev, S. Tachikawa, S. Gluchko, Y. Nakayama, T. Kawamura, L. Jalabert, M. Nomura
"Cross-plane thermal conductivity in amorphous Si/SiO2 superlattices"
Applied Physics Letters 117, 093103, 2020

Y. Wu, J. Ordonez-Miranda, S. Gluchko, R. Anufriev, DDS. Meneses, L Del Campo, S. Volz, M. Nomura
"*Enhanced thermal conduction by surface phonon-polaritons*"
Science Advances 6 (40), eabb446, 2020

S. Tachikawa, J. Ordonez-Miranda, Y. Wu, L. Jalabert, R. Anufriev, S. Volz, M. Numura
"*High Surface Phonon-Polariton in-Plane Thermal Conductance along Coupled Films*"
Nanomaterials 10 (7), 1383, 2020

X. Huang, D. Ohori, R. Yanagisawa, R. Anufriev, S. Samukawa, M. Nomura
"*Coherent and incoherent impacts of nanopillars on the thermal conductivity in silicon nanomembranes*"
ACS Applied Materials & Interfaces 12 (22), 25478–25483, 2020

R. Anufriev, J. Ordonez-Miranda, M. Nomura
"*Measurement of the phonon mean free path spectrum in silicon membranes at different temperatures using arrays of nanoslits*"
Physical Review B 101, 115301, 2020

N. Okamoto, R. Yanagisawa, R. Anufriev, Md M. Alam, K. Sawano, M. Kurosawa, M. Nomura
"Semiballistic thermal conduction in polycrystalline SiGe nanowires"
Applied Physics Letters 115, 253101, 2019

X. Huang, S. Gluchko, R. Anufriev, S. Volz, M. Nomura
"*Thermal Conductivity Reduction in a Silicon Thin Film with Nanocones"*
ACS applied materials & interfaces 11, 34394-34398, 2019

A. George, R. Yanagisawa, R. Anufriev, J.He, N. Yoshie, N. Tsujii, Q. Guo, T. Mori, S. Volz, M. Nomura
"Thermoelectric Enhancement of Silicon Membranes by Ultrathin Amorphous Films"
ACS Applied Materials & Interfaces, 11, 12027, 2019

R. Anufriev and M. Nomura
"Coherent thermal conduction in silicon nanowires with periodic wings"
Nanomaterials 9, 142, 2019

R. Anufriev, S. Gluchko, S. Volz, M. Nomura
"*Probing ballistic thermal conduction in segmented silicon nanowires*"
Nanoscale 11, 13407, 2019

S. Gluchko, R. Anufriev, R. Yanagisawa, S. Volz, M. Nomura
"On the reduction and rectification of thermal conduction using phononic crystals with pacman-shaped holes"
Applied Physics Letters 114, 023102, 2018

R. Anufriev, S. Gluchko, S. Volz, M. Nomura
"Quasi-ballistic heat conduction due to Lévy phonon flights in silicon nanowires"
ACS Nano 12 (12), 11928, 2018

R. Anufriev and M. Nomura
"*Phonon and heat transport control using pillar-based phononic crystals*"
Science and Technology of Advanced Materials 19, 863, 2018

M. Nomura, J. Shiomi, T. Shiga, and R. Anufriev
"*Thermal phonon engineering by tailored nanostructures*"
Japanese Journal of Applied Physics 57, 080101, 2018

J. Maire, R. Anufriev, T. Hori, J. Shiomi, S. Volz, and M. Nomura
"*Thermal conductivity reduction in silicon fishbone nanowires*"
Scientific Reports 8, 4452, 2018

R. Anufriev, R. Yanagisawa, and M. Nomura
"*Aluminium nanopillars reduce thermal conductivity of silicon nanobeams*"
Nanoscale, 9, 15083, 2017

J. Maire, R. Anufriev, R. Yanagisawa, A. Ramiere, S. Volz and M. Nomura
"Heat conduction tuning by wave nature of phonons"
Science Advances, 3, e1700027, 2017

M. Verdier, R. Anufriev, A. Ramiere, K. Termentzidis, D. Lacroix
"*Thermal conductivity of phononic membranes with aligned and staggered lattices of holes at room and low temperatures*"
Physical Review B, 95, 155432, 2017

R. Anufriev, A. Ramiere, J. Maire and M. Nomura
"Heat guiding and focusing using ballistic phonon transport in phononic nanostructures"
Nature Communications, 8, 15505, 2017

R. Anufriev and M. Nomura
"Heat conduction engineering in pillar-based phononic crystals"
Physical Review B, 95, 155432, 2017

R. Yanagisawa, J. Maire, A. Ramiere, R. Anufriev and M. Nomura
"Impact of limiting dimension on thermal conductivity of one-dimensional silicon phononic crystals"
Applied Physics Letters, 110, 133108, 2017

J. Maire, R. Anufriev and M. Nomura
"Ballistic thermal transport in silicon nanowires"
Scientific Reports, 7, 41794, 2017

R. Anufriev, J. Maire and M. Nomura
"Reduction of thermal conductivity by surface scattering of phonons in silicon periodic nanostructures"
Physical Review B, 93, 045411, 2016

R. Anufriev and M. Nomura
"Reduction of thermal conductance in two-dimensional phononic crystals by coherent phonon scattering"
Physical Review B, 93, 045410, 2016

R. Anufriev and M. Nomura
"Thermal conductance boost in phononic crystal nanostructures"
Physical Review B, 91, 245417, 2015

R. Anufriev, J.B. Barakat, G. Patriarche, X. Letartre, C. Bru-Chevallier, J.C. Harmand, M. Gendry, N. Chauvin
"Optical polarization properties of InAs/InP quantum dot and quantum rod nanowires"
Nanotechnology, 26, 395701, 2015

M. Nomura, Y. Kage, J. Nakagawa, T. Hori, J. Maire, J. Shiomi, R. Anufriev, D. Moser, and O. Paul
"Impeded thermal transport in Si multiscale hierarchical architectures with phononic crystal nanostructures"
Physical Review B, 91, 205422, 2015

R. Anufriev, N. Chauvin, H. Khmissi, K. Naji, G. Patriarche, M. Gendry, and C. Bru-Chevallier
"Piezoelectric effect in InAs/InP quantum rod nanowires"
Applied Physics Letters, 104, 183101, 2014

R. Anufriev, N. Chauvin, H. Khmissi, K. Naji, G. Patriarche, M. Gendry, and C. Bru-Chevallier
"Quantum efficiency of InAs/InP nanowire heterostructures grown on silicon substrates"
Physica Status Solidi (RRL), 7, 878, 2013

R. Anufriev, N. Chauvin, H. Khmissi, K. Naji, J.-B. Barakat, J. Penuelas, G. Patriarche, M. Gendry, and C. Bru-Chevallier
"Polarization properties of single and ensembles of InAs/InP quantum rod nanowires emitting in the telecom wavelengths" Journal of Applied Physics, 113, 193101, 2013

R. Anufriev, N. Chauvin, H. Khmissi, K. Naji, M. Gendry, and C. Bru-Chevallier
"Impact of substrate-induced strain and surface effects on the optical properties of InP nanowires"
Applied Physics Letters, 101, 072101, 2012.

N. Chauvin, M. H. H. Alouane, R. Anufriev, H. Khmissi, K. Naji, G. Patriarche, C. Bru-Chevallier, and M. Gendry
"Growth temperature dependence of exciton lifetime in wurtzite InP nanowires grown on silicon substrates"
Applied Physics Letters, 100, 011906, 2012

C. E. Little, R. Anufriev, I. Iorsh, M. A. Kaliteevski, R. A. Abram, and S. Brand
"Tamm plasmon polaritons in multilayered cylindrical structures"
Physical Review B, 86, 235425, 2012

M. H. H. Alouane, R. Anufriev, N. Chauvin, H. Khmissi, K. Naji, B. Ilahi, H. Maaref, G. Patriarche, M. Gendry, and C. Bru-Chevallier
"Wurtzite InP/InAs/InP core-shell nanowires emitting at telecommunication wavelengths on Si substrate"
Nanotechnology, 22, 405702, 2011

Invited talks

R. Anufriev and M. Nomura
"*Ray phononics: ballistic analogues of thermal phononic devices*"
4th Phonon Engineering Workshop, Tokyo, Japan (2020)

R. Anufriev, S. Gluchko, S. Volz, and M. Nomura,
"*Ballistic heat conduction in semiconductor nanowires*"
International Summer School-Conference "Advanced Problems in Mechanics", St. Petersburg, Russia (2020)

R. Anufriev and M. Nomura
"*Ballistic thermal transport in silicon nanowires*"
Nanowire week, Pisa, Italy (2019)

R. Anufriev and M. Nomura
"*Time-Domain Thermoreflectance for Thermal Characterization of Nanostructures*"
20th International Conference on Photoacoustic and Photothermal Phenomena, Moscow, Russia (2019)

R. Anufriev, R. Yanagisawa, and M. Nomura
"*Surface engineering of nanobeams and nanomembranes for silicon-based thermoelectrics*"
Collaboratie Conference on Materials Research, 312, Seoul, South Korea (2018)

Full list of talks: https://anufrievroman.com/talks