

Introduction

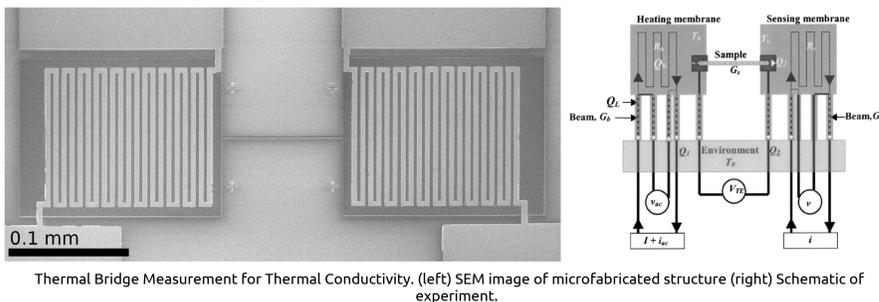
The nanoscale Thermal Energy Laboratory is focused on the study of thermal energy transport, conversion and storage in nanostructured materials. The lab is interested in the study of fundamental behavior as well as applications using both computational and experimental methods.

Methods

Experimental

The nanoscale Thermal Energy Laboratory uses bulk and micro/nanoscale experimental measurement techniques.

- Bulk thermal characterization methods for thermal conductivity, thermal contact conductance, thermal diffusivity, thermal expansion, melting temperature, latent heat of fusion and heat capacity
- Micro/nanoscale thermal characterization methods for direct thermal conductivity measurements using thermal bridge and 3ω techniques.
- Additional resources for micro/nanofabrication and thermal characterization are available through the Nanoscale Device Laboratories and the Multiscale Thermophysics Lab, respectively, at Utah State University

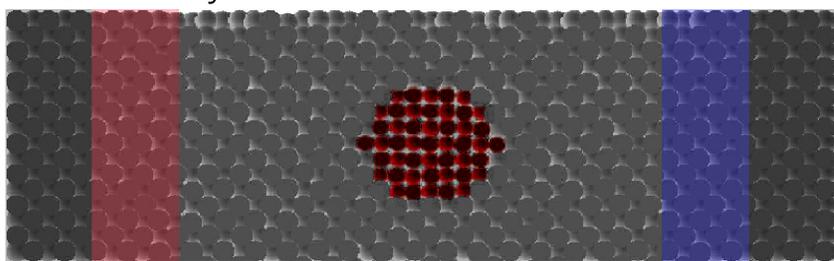


Thermal Bridge Measurement for Thermal Conductivity. (left) SEM image of microfabricated structure (right) Schematic of experiment.

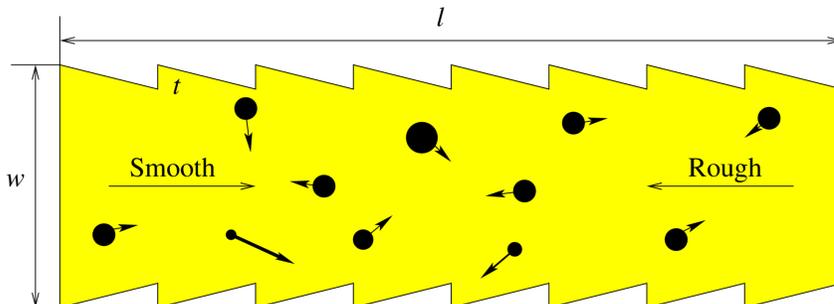
Computational

The nanoscale Thermal Energy Laboratory mainly uses two computational methods.

- Molecular Dynamics Simulations for determining the thermal conductivity of nanostructured materials and the phonon transmission rates through nanocrystalline materials and at interfaces.
- Monte Carlo Simulations for studying phonon and photon transport in nanostructured systems



Computational domain for Molecular Dynamics simulations

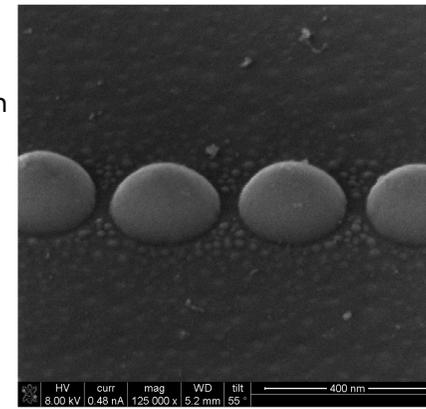


Computational domain for Monte Carlo simulations

Thermoelectric Energy Conversion

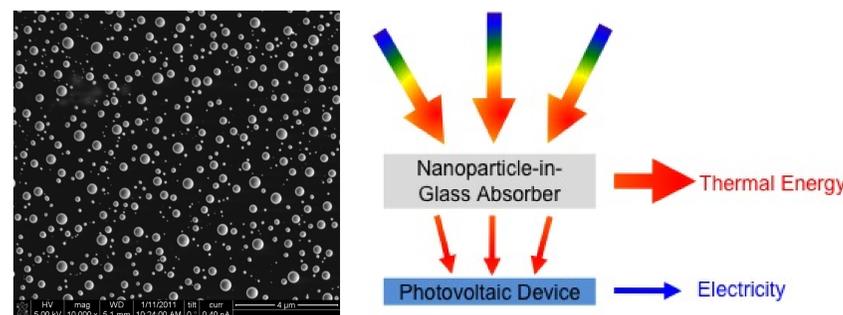
Our focus is to develop low cost, high efficiency thermoelectric materials using scalable and implementable manufacturing techniques.

(right) SEM image of a Si/NiSi nanocomposite array to be characterized using the thermal bridge technique.



Hybrid Solar/Thermal Energy Conversion

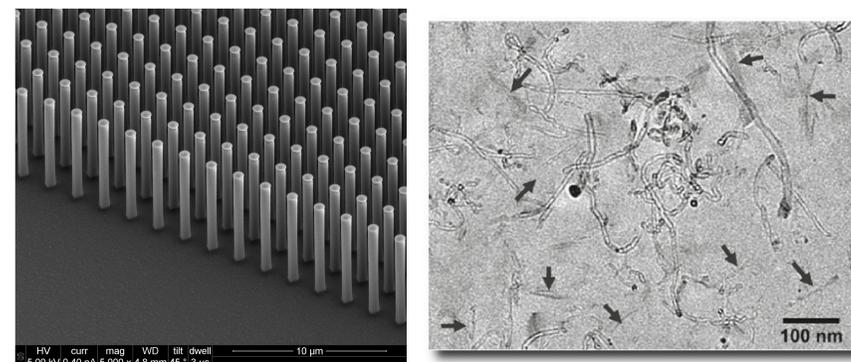
Our goal is to develop "nanoparticle-in-glass" solar/thermal absorbers to remove and utilize wavelengths of light from the sun that are not desired for photovoltaic devices – effectively harnessing more energy from the sun and protecting the photovoltaic from excess heating.



(left) SEM of fabricated "nanoparticle-in-glass" absorber (right) Schematic of the hybrid solar/thermal energy conversion system.

Phase Change Materials for Thermal Management and Storage

Our aim is to develop nanoenhanced phase change materials for applications in thermal management of portable electronics and li-ion batteries as well as for thermal energy storage. Our main focus is to improve the thermal conductivity and long term stability of existing phase change materials with the addition of small fractions of thermally conductive nanomaterials.

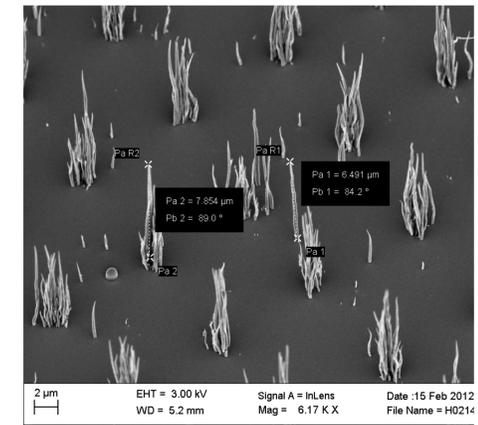


(left) SEM of vertically aligned nanowires grown on a Si substrate (right) SEM of CNTs in a polymer matrix.

Thermal Interface Materials

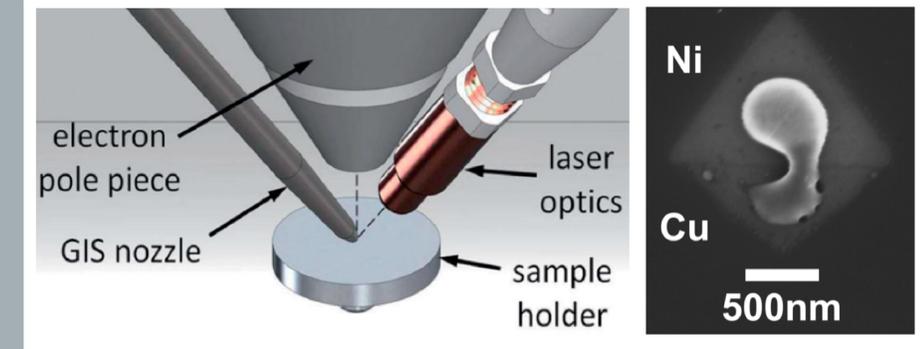
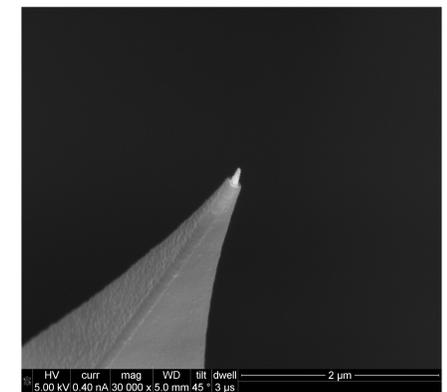
Our goal is to develop thermally conductive polymer-based thermal interface materials to meet the demands of the microelectronics industry in transferring heat from the electronic package to the heat sink.

(right) SEM image of vertically aligned carbon nanofibers to be embedded in a PDMS film.



Nanoscale Thermal Property Measurement

Our focus is on developing new and more accurate methods for thermal property measurement including (right) scanning thermal microscopy for nanoscale thermal property resolution (below) in-situ methods for temperature measurement in an SEM system and (below right) nanoscale thermocouples for high resolution, on chip temperature measurement.



Research Positions

The nanoscale Thermal Energy Lab at Utah University currently has openings for undergraduate, Masters and PhD research assistants. We are seeking motivated to solve current and future thermal management and energy issues. If you are interested in learning more about the research opportunities please email your resume or CV to Prof. Nick Roberts (nick.roberts@usu.edu).

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