Thomas J. Barrett

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Education

2024 Ph.D. Mechanical Engineering, Materials Science
Northeastern University

2019 M.S. Mechanical Engineering, Mechanics and Design
Northeastern University

2016 B.S. Mechanical Engineering
University of Rochester

Research Interests

Multiscale modeling of polymer nanocomposites for high performance materials.

Sustainable polymer production and fiber development.

Microplastic pollution and nanotoxicity.

Polymer discovery through Machine Learning.

Inverse design of polymeric systems and composites.

Research Experience

Northeastern University MINUS Lab

Graduate Research Assistant
Advisor: Prof. Marilyn L. Minus
Dissertation: Multiscale modeling of semi-crystalline polymer nanocomposites

Northeastern University Applied (Bio)Mechanics and Tribology Laboratory

Graduate Research Assistant
Advisor: Prof. Sinan Müftü (MEIE) & Prof. Brian Helmuth (Marine Sciences)
Thesis: Effects of solar radiation and surface roughness on surface temperatures of coastal rocks.

Projects

Multiscale modeling of polymer nanocomposites
- Python, LAMMPS, Abaqus

Combined experimental, molecular dynamics, and finite element approach to describing semicrystalline polymer nanocomposite behavior.

Developed methods to determine crystalline regions within molecular dynamic polymer melts to maintain semicrystalline behavior across domains.

Semicrystalline polymer film and fiber fabrication and characterization, primarily focused on Polyvinyl Alcohol and Polyacrylonitrile.

3D Printing of HEC - Algae Biocomposites
- Python, LAMMPS

Collaboration with **Daraio Laboratory at California Institute of Technology** and **MaP+S Group at Harvard University**.

Performed mesoscale dissipative particle dynamics (DPD) simulations to determine reinforcement mechanisms of 3D printed cellulose biocomposites.

Surface Roughness & Thermal Refugia
- MATLAB, COMSOL

International, multi-disciplinary collaboration between **Northeastern University's Mechanical and Industrial Engineering** and **Marine and Environmental Sciences** departments and the **Israeli National Institute of Oceanography, Oceanographic and Limnological Research**.

3D GIS scans of coastal surfaces with 1 cm^2 resolution were converted to $\sim$1 m^3 meshes to determine the relationship between surface roughness and area of thermal refugia for sessile organisms under solar radiation.

Software Packages

MDvoro
- Python, Abaqus

Self-Developed an open-source tool for meshing heterogeneous molecular dynamics volumes for use in Finite Element simulations.

PolyAlign
- Python, LAMMPS

Self-Developed an open-source tool for visualization and analysis of semi-crystalline polymer melts in molecular dynamics.

Performs modified DBSCAN clustering using orientation metrics such as $\langle P_2 \rangle$ to determine crystal regions in polymer melts.

PyFiber
- Python, PyQT

Self-Developed an open-source tool for visualization and analysis of Wide Angle X-Ray Diffraction (WAXD) results using a nodal approach.

Publications

Academic Journals

1. **T.J. Barrett**, M. Li, T. Gouhier, G. Rilov, B. Helmuth, F. Choi, & S. Müftü. Fine-scale spatial heterogeneity dictates temperature extremes on coastal rock surfaces. In preparation.

2. **T.J. Barrett** & M.L. Minus. Benchmarking Nosé-Hoover integration methods for tensile measurements. In preparation.

3. **T.J. Barrett** & M.L. Minus. PolyAlign and MDvoro: Python packages for molecular dynamic polymer characterisation and finite element volume generation. In preparation.

Conferences

Oral Presentation

1. **Barrett, T.J.** & Minus, M.L. A cluster-based approach for identifying and meshing crystalline regions in molecular dynamics simulations. Materials Research Society (MRS) Spring Meeting 2022. Honolulu, Hawaii (USA), May 2022.

Service

Northeastern University College of Engineering Ph.D. Council, **Cofounder**
Mechanical and Industrial Engineering Graduate Student Council, **Advisor**
Mechanical and Industrial Engineering Graduate Mentorship Program, **Mentor**

Professional Memberships

Materials Research Society (MRS)

References

References available upon request.