

Ajay Vallabh, Ph.D.

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Summary Statement

As a mechanical engineering graduate, I bring **six years** of teaching and research expertise in computational modeling and experimental design, particularly in molecular dynamics, material characterization, polymer mechanics, phase separation, and computational fluid dynamics. With experience instructing over 500 students, I am eager to transition into a faculty role, driven by a passion for academia.

Professional Experience

Research Assistant UNH, Durham, NH.

20 hours/week.

Cell growth in elastic network, *Project*

June-23-Present

- * A phase separation model is built for cells with a cross-linked polymer network by using molecular dynamics (MD).
- * Analytical: Analyze data to observe how the stiffness and cross-link density of the polymer network affect cell growth.
- * Guide: As a senior researcher, I also trained two master's and four undergraduate students on MD software (LAMMPS).

Teaching Assistant UNH, Durham, NH.

20 hours/week.

Course

Students

Experimental Measurement and Data Analysis, *ME646*

80

Jan-May-2023

- * Guide UG students to perform static and dynamic experiments based on the concepts of mechanics, thermodynamics, and fluid mechanics with data analysis.

Intro to Engineering Design, *ME441*

75

Aug-Dec-2022

- * Conduct a SOLIDWORKS software lab; facilitate engineering design tutorials.
- * Guide UG student groups for engineering design and manufacturing projects. (Example: water purifier design, flexible furniture design, etc.); lab report grading.

Introduction to Material Science, *ME561* (Two-term)

85

Jan-May-2022
& 2021

- * Conduct recitations to provide conceptual knowledge of material science.
- * Conduct office hours with 85 students on a one-on-one basis to provide feedback.

Intro to Engineering Computing, *IAM550*

85

Aug-Dec-2021

- * Conduct a Matlab lab in four sessions to provide fundamental knowledge of numerical methods such as Gauss elimination, the LU algorithm, etc.

Dynamics, *ME627* (Two-term)

103

Aug-Dec-2020
& 2019

- * Conduct recitations to cover the numerical problems in dynamics.
- * Hold office hours with 103 students on a one-on-one basis to provide feedback.

Heat and Mass Transfer, *ME603*

103

Dec-May-2020

- * Conduct recitations to cover numerical problems of conduction and convection.

Teaching Assistant IIT, Kanpur, UP, India.

20 hours/week, Rs.12400/month.

Numerical Methods, *ESO208*

105

July-Nov-2018

- * Conduct recitations to cover Python-based programming tutorials for algorithms such as Gauss-Seidel, SIMPLE, etc.

Fluid Mechanics, *ME 231*

95

Jan-Apr-2018

- * Elucidate lab manuals to perform fluid mechanics experiments such as measurement of drag, boundary layer flow over a flat plate, etc.

Energy System, *ME301*

95

July-Nov-2017

- * Prepared course work slides (energy conversion calculations for systems such as I.C. engines, solar systems, power plants, etc. from a thermodynamics point of view).

Education

- May-2024 ■ **Ph.D. Mechanical Engineering, University of New Hampshire**, Durham, NH, USA.
Advisor: Prof. John Tsavalas CGPA: 3.72/4.
- June-2019 ■ **M.S. Mechanical Engineering, Indian Institute of Technology Kanpur**, India.
Advisor: Prof. P.S. Ghoshdastidar CGPA: 8.0/10.
- June-2015 ■ **B.Tech. Mechanical Engineering, GLA University**, Mathura, Uttar Pradesh, India.
Advisor: Prof. Kamal Sharma CGPA: 8.67/10

Machine Tool, Spectroscopy, & Microscopy

Deformation-Induced Bonding (DIB), Universal Testing Machine (Instron 5969 UTM), Electric Discharge Machine (EDM), Differential Scanning Calorimeters (DSC), Dynamic Mechanical Analysis (DMA), Discovery Hybrid Rheometer (DHR-3), Elastomer 3580 Film Applicator, Ultraviolet-visible (UV-Vis), Nuclear Magnetic Resonance (NMR), Scanning Electron Microscope (SEM), X-ray diffraction (XRD)

Skills

Languages	■ Strong communication skills in English and Hindi.
Programming Languages	■ C, C++, Python, Fortran, Cmake.
Simulation Packages	■ LAMMPS (GPU,HPC), Marc-Mentat, Abaqus (FEA), SOLID WORKS, CAD..
Computational Packages	■ MATLAB, Maple, Chemsketch, Adobe illustrator, OVITO.
Typesetting Software	■ L ^A T _E X, EXCEL, VIM, MS WORD.
Equipment Software	■ TRIOS (DHR3), BLUEHILL@UNIVERSAL (UTM), Thermal Advantage (DMA)

Coursework

Macromolecular Characterization, Introduction to polymer physics, , Finite Element Method, Machine learning, Numerical Methods, Sobolev space, Continuum Mechanics, Continuum & Plasticity, Viscous Flow Theory, Computational Fluid Dynamics, Hydrodynamic Stability, High Performance Computing, and Turbulence.

Research Publications

Journal Articles

- 1 A. Vallabh and N. Padhye, "A review on polymer bonding through interdiffusion and role of deformation-acceleration," *To be submitted in RCS Advances*,
- 2 A. Vallabh and N. Padhye, "Dilatational-plasticity opens a new mechanistic pathway for macromolecular transport across polymeric interfaces yielding solid-state bonding," *To be submitted in Scientific Report (Submission Id 3535f887-1856-4ef9-8bf2-f028e295d6b0)*, [URL: https://universitysystemnh-my.sharepoint.com/:b:/g/personal/av1110_usnh_edu/EQeCcqg-nLVCh0GCyEOrBtwB8mwI5wQ-cqJi-vNaJAs2-Q?e=sy4qbo](https://universitysystemnh-my.sharepoint.com/:b:/g/personal/av1110_usnh_edu/EQeCcqg-nLVCh0GCyEOrBtwB8mwI5wQ-cqJi-vNaJAs2-Q?e=sy4qbo).
- 3 A. Vallabh and J. Tsavalas, "Role of plasticizers in film formation and deformation-induced bonding of glassy polymers of bidisperse blends," *To be submitted in Macromolecules*, [URL: https://arxiv.org/abs/2405.11362v1](https://arxiv.org/abs/2405.11362v1).
- 4 N. Padhye and A. Vallabh, "Deformation-induced bonding of polymer films below the glass transition temperature," *Journal of Applied Polymer Science*, vol. 138, no. 41, p. 50934, 2021. [DOI: https://doi.org/10.1002/app.50934](https://doi.org/10.1002/app.50934).
- 5 A. Vallabh and P. Ghoshdastidar, "Numerical simulation of heat transfer in laminar natural convection of mixed newtonian-non-newtonian and pure non-newtonian nanofluids in a square enclosure," *Journal of Thermal Science and Engineering Applications*, vol. 13, no. 6, 2021. [DOI: https://doi.org/10.1115/1.4050322](https://doi.org/10.1115/1.4050322).

Conference Proceedings

- 1 A. Vallabh and J. Tsavalas, "Mechanistic pathway of deformation-induced bonding at below-glass transition temperature in solid-state plasticized polymers," Gothenburg, Sweden: Seventh International Symposium Frontiers in Polymer Science, 2023. [URL: https://www.elsevier.com/events/conferences/frontiers-in-polymer-science](https://www.elsevier.com/events/conferences/frontiers-in-polymer-science).

- 2 A. Vallabh and J. Tsavalas, "Role of plasticization in macromolecular transport mechanism of deformation induced bonding (dib) in glassy polymers," Mount Holyoke College, South Hadley, MA, USA: Gordon research conference, 2023.
 URL: <https://www.grc.org/science-of-adhesion-grs-conference/2023/>.
- 3 A. Vallabh and N. Padhye, "Mechanistic origins of low-temperature bonding in solid polymers," Los Angeles, California: 1st International Conference on Polymer Science and Engineering, 2022.
 URL: <https://polymers.unitedscientificgroup.org/2022/>.

Research and Work Experience

Ph.D Research

Sep-2019-Present

Thesis title: *Mechanism of deformation-induced bonding through dilatational plasticity in solid-state polymers.*

- Experiment and Computation research experience in polymer-film bonding with a new, sustainable, deformation-induced bonding (**DIB**) technique, which can impact different applications' fabrication processes in prominent **Multi-Billion \$** fields such as micro-fluidic, aerospace, pharmaceutical, soft robotics, textile, and packaging by transforming these processes into sustainable ones through the physics of DIB. (see **J.Article[1]**)
- Hands-on experience with machine tools, spectroscopy, and microscopy, as mentioned above. For instance, I performed peel and lap shear tests on **UTM** (ASTM D882 standard) to measure the bonding strength. **DSC**, **DMA**, **XRD** tools were used for polymer material characterization. **SEM** was used to confirm the permanent bond fracture of polymer films. (see **J.Article[4]**)
- Established a mechanistic pathway for macromolecular transport in the deformation-induced bonding technique by using the **coarse-grained Kremer Grest model** through molecular dynamic simulations (**LAMMPS**). I individually processed **four TB** of simulation data and discovered various space and time scales for deformation-based polymer dynamics. (see **J.Article[2]**)

Failure analysis of Tripod, Project

Sep-2021-Dec-2021

- Designed 3D model of tripod in SOLIDWORKS.
- Performed **FEA** analysis in SOLIDWORKS software for compressive load failure.

M.S Research

Jan-2017-Aug-2019

Thesis title: *A Numerical Study of Heat Transfer Enhancement in Natural Convection of Newtonian and Non-Newtonian Nanofluids in a Square Enclosure.*

- Developed a solid numerical and mathematical background in computational fluid dynamics (**CFD**) and heat and mass transfer to observe the natural convection phenomenon of non-Newtonian nanofluids in a square enclosure.
- Implemented the stream function vorticity algorithm to solve the non-linear Navier-Stokes equation using C++ code.
- Developed **C++ code**, and used **Paraview** software to observe isotherms and streamlines. (see **J.Article[5]**)

B.Tech Research

Aug-2014-Jul-2015

Bachelor's Project: *Optimization of Process Parameters of EDM for 3-Phase Carbon Fiber Composite Material.*

- Performed an adequate number of experiments on EDM to optimize its parameters such as gap voltage (V_g), pulse on time (T_{on}), pulse off time (T_{off}), tool wear rate (TWR), material removal rate (MRR), etc.
- Both qualitative and quantitative optimization techniques, such as the Pugh rank method and the technique of order preference by similarity to the ideal solution (TOPSIS), were implemented to optimize parameters.

Awards and Scholarships

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| 2023-2024 | ■ Dissertation year fellowship (24600\$) , University of New Hampshire, USA. |
| 2019-2023 | ■ Institute research assistantship , University of New Hampshire, USA. |
| Oct-2022 | ■ Bertram Husch International Scholarship (450\$) , University of New Hampshire. |
| 2017-2019 | ■ Institute research assistantship , Indian Institute of Technology, Kanpur, India. |
| Mar-2016 | ■ GATE 2016 , Secured position among 1.5% of about 0.2 million candidates who appeared for GATE 2016 (Graduate Aptitude Test in Engineering) in India. |