**nbende@mail.pse.umass.edu**

**http://nakulbende.com**

**Nakul Bende**

# EDUCATION

**PhD:** Polymer Science and Engineering, University of Massachusetts Amherst Expected: Nov., 2016

Academic Advisor: Prof. Ryan C. Hayward GPA: 3.8

Thesis: Fabrication and mechanics of shape-programmable systems.

**MS:**

Polymer Science and Engineering, University of Massachusetts Amherst 2011 – 2012

**Masters and Bachelors of Technology:**

Polymer Science and Technology, Indian Institute of Technology Roorkee (IIT-R), India 2006 – 2011

Academic Advisor: Prof. Yuvraj S. Negi

Thesis: Effect of polyhedral oligomeric silsesquioxane on poly(ether ether ketone) coatings

(at Department of Polymer Engineering, University of Akron, in collaboration with Prof. Sadhan C. Jana)

# RESEARCH EXPERIENCE

# Graduate research assistant: with Ryan Hayward, UMass Amherst August 2011 - present

* Studying the fundamental mechanics behind multi-stability in corrugated drinking straws to program re-configurable structures with nearly continuous mechanical stability, for application in robotic limbs, medical tubing and mass transport ducts
* Derived a geometric design rule for controlling snap-through instabilities of elastic shells for robust design of rapid actuators by studying the intricate effect of geometry on mechanics of elastic shells using experiments and numerical simulations
* Synthesized temperature-responsive, photo-crosslinkable poly(*N*-isopropyl acrylamide) copolymers for patterning a hydrogel sheet with inhomogeneous growth for controlled 3D buckling upon swelling; utilized this growth-induced mechanism for validating its mathematical equivalence with cut-and-glue construction to enable fabrication of complex 3D geometries
* Developed a protocol for patterning an arbitrary number of swelling levels using grayscale projection photolithography by controlling a digital micro-mirror device (DMD) to photo-pattern hydrogels with smooth curvature gradients for applications such as micro-lens arrays
* Controlling Gaussian and mean curvature simultaneously by patterning in-plane and through-thickness cross-linking density in a multi-layer hydrogel system
* Analyzing the effect of periodic anisotropy on self-assembly by capillary interactions on air-water interface by dynamically tracking the interaction of fabricated elastic anisotropic particles

# Masters research assistant: IIT Roorkee, University of Akron 2010-2011

* Optimized surface properties and solvent casting of PEEK hybrid composite using different POSS systems for high performance coatings

# Research Intern: Max Planck Institute for Polymer Science, Mainz, Germany May – Aug, 2010

* Developed a new technique for studying dynamics of phase transitions in binary or ternary oil-water mixtures based on fluctuations in contact angle

# Industrial Intern: Machino Polymers Limited (R&D and QA), Gurgaon, India May - Aug 2009

* Utilized residence time distribution of poly(propylene) – poly(ethylene) block copolymer composite in an industrial extruder to improve mechanical properties and processability by optimizing formulations with different peroxide concentrations to tune chain scission versus cross-linking of polymer chains

1. old(2015) *Proceedings of the National Academy of Sciences*
2. (2014)

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1. J-H. Na, N. P. Bende, J. Bae, C. D. Santangelo, and R. C. Hayward, “Grayscale gel lithography for programmed buckling of non-Euclidean hydrogel plates”, (2016) *Soft Matter,* doi: 10.1039/c6sm00714g
2. Y. Zhou, A. W. Hauser, N. P. Bende, M. G. Kuzyk, R. C. Hayward “Waveguiding microactuators based on a photothermally responsive nanocomposite hydrogel”, (2016) *Advance Functional Materials,* 10.1002/adfm.201601569
3. E. Esmizadeh, M. Moghri, M. R. Saeb, M. M. Nia, N. Nobakht, N. P. Bende, "Application of Taguchi approach in describing the mechanical properties and thermal decomposition behavior of poly (vinyl chloride)/clay nanocomposites: Highlighting the Role of organic modifier", (2014) *Journal of Vinyl and Additive Technology*, doi: 10.1002/vnl.21395

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1. J. Bae, N. P. Bende, A. A. Evans, J-H. Na, C. D. Santangelo, R. C. Hayward, “Programmable and reversible assembly of soft capillary multipoles”, *In preparation*

# SELECTED PRESENTATIONS

* “How do bendy straws bend? A study of re-configurability of multi-stable corrugated shells” Oral presentation, *American Physical Society*, March Meeting, Baltimore, MD 2016
* “Geometrically controlled snapping transitions in shells with curved creases”, Poster, *Center for UMass/Industry Research on Polymers*, Polymer event, Amherst, MA 2015
* “Folding of non-Euclidean curved shells” Oral presentation, , 2015
* “Snap-through folding of non-Euclidean polymer shells”, Poster, , 2015
* “Catastrophic Success: Snap-through folding of curved shells”, **Invited talk**, *Program in Polymers and Soft Matter at MIT,* Fall Seminar Series, Massachusetts Institute of Technology, Cambridge, MA 2014
* “Fundamental rules for folding elastic non-Euclidean shells”, Poster, *EFRI-FEST: Workshop on Foldable, Buildable, Responsive Materials*, University of Pennsylvania, PA 2014
* “Snap-through folding of non-Euclidean polymer shells”, Poster, 2014
* “Comparative study of ‘vis-breaking’ in poly(propylene)-poly(ethylene) block copolymer and blends, study of residence time distribution using a twin screw extruder”, Poster, 2010
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# TEACHING EXPERIENCE

* TA for graduate level Mechanical testing lab (PSE 602) entailing lectures on stress-strain relationships, rubber elasticity and a weekly lab on mechanical testing, UMass Amherst Fall 2014
* Mentored 7 undergraduate students (3 current students) 2013 – present
* TA for undergraduate level course entitled "Macromolecular Chemistry", IIT Roorkee, India Fall 2011

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# AWARDS, HONORS

* Honorable mention for poster, MIT Polymer Day 2015

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* 2014
* Travel grant, Polymer Science and Engineering, UMass Amherst 2014
* Secured All-India Rank 15th in Graduate Aptitude Test, conducted by IITs (among ~ 100, 000 candidates) 2010

# PROFESSIONAL ACTIVITIES

* Peer review activities, Journal for Applied Polymer Science 2014 – present
* Member, American Physical Society 2014 - present
* Member, Material Research Society 2014 - present
* Member, Society for automotive engineers, IIT Roorkee chapter 2006-2008

# OUTREACH, LEADERSHIP ACTIVITIES

* Od at UMass
* Developed and organized new outreach programs for K-12 schools, the Museum of Science Boston 2012-present
* Taught science courses to children in under-privileged areas, National Service Scheme, India 2006-2009
* Elected Graduate Student Senator, UMass Amherst 2014-present
* Elected Treasurer, Indian Student Association (Graduate Student Organization), UMass Amherst 2012-2013
* Certified Scuba Diver, Project Deep (NAUI), UMass Amherst 2014
* Maintain a repository (git) for lab automation projects using open hardware microelectronics, Internet of things