

Rahul P Panat

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Lab: <https://advancedmanufacturing.us>

RESEARCH INTERESTS:

- Advanced Additive Manufacturing for
 - Structural Materials
 - Biomedical Devices
- Flexible Microelectronics
- Advanced Energy Materials
- Physical and chemical sensors

EDUCATION:

PhD	Theoretical and Applied Mechanics, University of Illinois, Urbana, IL USA	99-04
MS	Mechanical Engineering, University of Massachusetts at Amherst, MA USA	97-99
BS	Mechanical Engineering, Pune University, India	93-97

WORK EXPERIENCE:

- Aug 2017 – Present: Associate Professor, Department of Mechanical Engineering, Carnegie Mellon University, Pittsburgh PA
- Aug 2014 – July 2017: Associate Professor, School of Mechanical and Materials Engineering, Washington State University (WSU), Pullman WA
- July 2004-July 2014: Senior Engineer/Engineering Manager, Assembly Technology and Test Development, Intel Corporation, Chandler AZ

TEACHING EXPERIENCE:

- Taught courses through Intel University while at Intel
- Project-based courses at CMU have led to students filing invention disclosures of their mechanisms/ designs. In 2019, an entirely new mechanism designed by the students was acquired by a fortune 500 company ([news](#)).
- Innovative projects such as automatic s'mores maker, alexa-integrated voice activated spice rack, automated gantry system, and origami furniture were done by students in my Adv Mech Design class. A video of the students doing this work will be published soon.
- Courses taught at universities
 - 'Design of Machine Elements', spring 2019/20 (CMU)
 - 'Advanced Mechanical Design', fall 2017/2018/2019 (CMU)
 - 'Advanced Fracture Mechanics' in spring 2017 (WSU)
 - 'Design for Machine Components' in fall 2016 (WSU)
 - 'Materials Laboratory' in fall 2016 and spring 2017 (WSU)
 - 'Design for Manufacturing' in spring 2016 (WSU)
 - 'Machine Design' in fall 2015 (WSU)
 - 'Manufacturing Processes' in fall 2014 and spring 2015 (WSU)

PUBLICATIONS:

1. D. Tansel, J. Brenneman, G. Fedder, R. Panat, "Mechanical Characterization of Polydimethylsiloxane (PDMS) Exposed to Thermal Histories up to 300 °C in a Vacuum Environment", **submitted** (2020)

2. Y. Zhu, J. Li, M. S. Saleh, R. Panat, J. Park, "Towards High-Performance Li-ion Batteries via Optimized Three-dimensional Micro-lattice Electrode Architectures", **submitted** (2020)
3. B. Mallesham, F. Manciu, S. Tan, R. Panat, C. V. Ramana, "Insights into the Crystal Chemistry and Phase Stability of Ba(Fe_{0.7}Ta_{0.3})O_{3-δ} Compounds: A Combined Experimental and Rietveld Refinement Analysis", **submitted** (2020)
4. M. Sadeq Saleh, S. M. Ritchie, M. A. Nicholas, R. Bezbaruah, J. W. Reddy, M. Chamanzar, E. A. Yttri, R. P. Panat, "CMU Array: A 3D Nano-Printed, Customizable Ultra-High-Density Microelectrode Array Platform", **in Review** (2019). Preprint available on BioRxiv, doi: <https://doi.org/10.1101/742346>
5. Md T. Rahman, C. H. Cheng, B. Karagoz, M. Renn, M. Schrandt, A. Gellman, and R. Panat, "High Performance Flexible Temperature Sensors via Nanoparticle Printing", **ACS Applied Nano Materials**, Vol. 2, Issue 5, pp. 3280-3291 (2019). [PDF](#)
6. R. Danaei, T. Varghese, M. Ahmadzadeh, J. McCloy, C. Hollar, M. Sadeq Saleh, J. Park, Y. Zhang, R. Panat, "Ultrafast Fabrication of Thermoelectric Films by Pulsed Light Sintering of Colloidal Nanoparticles on Flexible and Rigid Substrates", **Advanced Engineering Materials**, Vol. 21, pp 1800800 (2019). [PDF](#)
7. S. Manandhar, A. Battu, S. Tan, R. Panat, V. Shutthanandan, C. V. Ramana, "Effect of Ti Doping on the Crystallography, Phase, Surface/Interface Structure and Optical Band Gap of Ga₂O₃ Thin Films", **Journal of Materials Science**, 54, pp.11526–11537 (2019). [PDF](#)
8. Y. Arafat, S. T. Sultana, I. Dutta, R. Panat, "Effect of Additives on the Microstructure of Electroplated Tin Films", **Journal of the Electrochemical Society**, 165 (16), D816-D824 (2018). [PDF](#)
9. J. Li, X. Liang, R. Panat, and J. Park, "Enhanced Battery Performance through Three-Dimensional Structured Electrodes: Experimental and Modeling Study" **Journal of the Electrochemical Society**, 165 (14), A3566-A3573 (2018). [PDF](#)
10. R. Panat, J. Park, M. S. Saleh, and J. Li, "3D-Printed Lattice Batteries", **Homeland Defense Information Analysis Center (HDIAC) Journal**, 5 (4), pp. 11 (2018). [PDF](#)
11. M. Sadeq Saleh, Jie Li, Jonghyun Park, and Rahul Panat, "3D Printed Hierarchically-Porous Microlattice Electrode Materials for Exceptionally High Specific Capacity and Areal Capacity Lithium Ion Batteries", **Additive Manufacturing**, Vol.23, pp 70-78 (2018). [PDF](#)
12. M. T. Rahman, R. Moser, H. Zbib, C. V. Ramana, and R. Panat, "3D Printed High Performance High Temperature Sensors", **Journal of Applied Physics**, 123, 024501, (2018). [PDF](#)
13. M. Sadeq Saleh, Mehdi Hamid Vishkasougeh, H. Zbib, and R. Panat, "Polycrystalline Micropillars by a Novel 3-D Printing Method and Their Behavior under Compressive Loads", **Scripta Materialia**, Volume 149, 144–149 (2018). [PDF](#)
14. Y. Arafat, R. Panat, I. Dutta, "Highly Stretchable Metal Films on Polymer Substrates: Mechanics and Mechanisms", **IEEE ITherm2018**, pp. 32-36 (2018) [PDF](#)
15. M. Sadeq Saleh, C. Hu, R. Panat, "Three Dimensional micro-architected materials and devices using nanoparticle assembly by pointwise spatial printing" **Science Advances**, 3, e1601986 (2017). [Link](#)
16. J. Geng, M. T. Rahman, R. Panat, and L. Li, "Self-assembled Axisymmetric Microscale Periodic Wrinkles on Elastomer Fibers", **ASME Journal of Micro and Nano-manufacturing**, Vol. 5, Issue 2, pp. 021006 (2017). [Link](#)
17. M. T. Rahman, J. Gomez, K. Mireles, P. Wo, J. Marcial, M. Kessler, J. McCloy, C. Ramana, and R. Panat, "High temperature physical and chemical stability and oxidation reaction kinetics of Ni-Cr nanoparticles", **Journal of Physical Chemistry – C**, Vol.121 (7), pp. 4018–4028 (2017). [Link](#)
18. J. Li, M. Leu, R. Panat and J. Park, "A hybrid 3-D structured electrode for Lithium-ion batteries via 3D printing", **Materials and Design**, Vol. 119, pp. 417-424 (2017). [Link](#)

19. R. Sun, H. Yang, M. Rock, R. Danaei, R. Panat, M. Kessler, and L. Li, "Manufacturing PDMS Micro Lens Array using Spin Coating under a Multiphase System", **Journal of Micromechanics and Microengineering**, Vol. 27(5), pp.1 (2017). [Link](#)
20. Y. Arafat, I. Dutta, R. Panat, "On the deformation mechanisms and electrical behavior of highly stretchable metallic interconnects on elastomer substrates", **Journal of Applied Physics**, Vol. 120, Issue 11, pp. 115103-1 to 11 (2016). [Link](#)
21. M. T. Rahman, J. McCloy, C. V. Ramana, and R. Panat, "Structure, electrical characteristics and high-temperature stability of Aerosol Jet printed silver nanoparticle films", **Journal of Applied Physics**, Vol. 120, Issue 7, pp. 075305-1 to 11 (2016). [Link](#)
22. B. Paul, R. Panat, C. Mastrangelo, D. Kim, and D. Johnson "Manufacturing of Smart Goods: Current state, future potential and research recommendations" **ASME Journal of Nano and Micro-Manufacturing**, Vol. 4, Issue 4, pp. 044001-1 to 044001-12 (2016). [PDF](#)
23. M. T. Rahman, A. Rahimi, S. Gupta, and R. Panat, "Microscale additive manufacturing and simulations of interdigitated capacitive touch sensors", **Sensors and Actuators A: Physical**, Vol. 248, 94-103 (2016). [Link](#)
24. H. Yang, M. T. Rahman, D. Du, R. Panat, and Y. Lin, "Electrochemical sensors for biological applications using 3-D printed adjustable microelectrode arrays", **Sensors and Actuators B: Chemical**, Vol. 230, 600-606 (2016) [Link](#)
25. Y. Arafat, I. Dutta, R. Panat, "Super-stretchable metallic interconnects on polymer with a linear strain of up to 100%" **Applied Physics Letters**, 107 081906 (2015) [Link](#)
26. M. T. Rahman, L. Renaud, M. Renn, D. Heo, R. Panat, "Aerosol based direct-write micro-additive fabrication method for sub-mm 3-D metal-dielectric structures", **Journal of Micromechanics and Microengineering**, Vol. 25 (10), pp. 107002 (2015) [Link](#)
27. R. Panat, "A model for crack initiation in the Li-ion battery electrodes", **Thin Solid Films**, Vol. 596, pp. 174-178 (2015) [Link](#)
28. Y. Arafat, I. Dutta, R. Panat, "Highly stretchable interconnects for flexible electronics applications" **ASME 2015 International Technical Conference and Exhibition on Packaging and Integration of Electronic and Photonic Microsystems**, Paper No. IPACK2015-48187, pp. V003T03A002 (2015) [Link](#)
29. M. T. Rahman, L. Renaud, M. Renn, D. Heo, R. Panat, "3-D Antenna Structures Using Novel Direct-Write Additive Manufacturing Method", **ASME 2015 International Technical Conference and Exhibition on Packaging and Integration of Electronic and Photonic Microsystems**, Paper No. IPACK2015-48130, pp. V002T02A029 (2015) [Link](#)
30. Z. Song, T. Ma, R Tang, Q. Cheng, X. Wang, D. Krishnaraju, R. Panat, C. K. Chan, H. Yu, and H. Jiang, "Origami Lithium ion batteries", **Nature Communications**, 5:33140 10.1038/ncomms4140, (2014). [Link](#)
31. R. Panat, S. Dattaguru, H. Balkan, Y. Min, H. Seh, X. Zhao, "Mechanical reliability of embedding of components in ultra-high performance microprocessors", **IEEE Transactions on Device and Materials Reliability**, Vol 4 (5), 857 (2014). [Link](#)
32. R. Panat, E. Parks, and J. Wang, "On the effects of triboelectrostatic charging between polymer surfaces in manufacturing and test of integrated circuit packages", **IEEE Transactions on Components, Packaging and Manufacturing** Vol. 4 (5), 943 (2014) [Link](#)
33. R. Panat, V. Dimitrova, S. Selvamundiany, K. Ishiko, and D. Sun, "The application of Lean Six Sigma to the configuration control in Intel's manufacturing R&D environment", **International Journal of Lean Six Sigma**, Vol. 5 (4), 444-459 (2014). Selected by the journal as a 'Highly Commended Paper of 2014'. [Link](#).
34. R. Panat, "On the data and analysis of research output of India and China: India has significantly fallen behind China", **Scientometrics** (Springer), Vol. 100 (2), 471-481 (2014). [Link](#)

35. Y. Min, R. Olmedo, M. Hill, K. Radhakrishnan, K. Aygun, M. Kabiri-badr, R. Panat, S. Dattaguru, and H. Balkan, "Embedded capacitors in the next generation processors", **63rd ECTC Conference, IEEE**, 1225-1229 (2013). [Link](#)
36. N. Raravikar, R. Panat, and S. Jadhav, "A tombstone initiation model for small form factor surface mount passives" **IEEE Transactions on Components, Packaging and Manufacturing**, Vol. 2 (9), 1486-1491 (2012). [Link](#)
37. Li Yan, R. Panat, R. Mulligan, P. Srinath, and A. Raman, "The application of 2D X-ray hot stage in flip chip package failure analysis", **IEEE Transactions on Device and Materials Reliability**, Vol. 11 (1), 141-147 (2011). [Link](#)
38. **R. Panat**, et al "Solving the solder bridging issue in large die processors", **Intel Assembly and Test Technology Journal**, Vol. 13, 249-260 (2010) (Intel's internal confidential journal)
39. H. Balkan, others, **R. Panat**, "Passive technology requirements for future flip-chip packages", **Intel Assembly and Test Technology Journal**, Vol. 11, 405-413 (2008) (Intel's internal confidential journal)
40. R. Panat, K.J. Hsia and D.G. Cahill, "Evolution of surface waviness in thin films via volume and surface diffusion", **Journal of Applied Physics**, 97, 013521 (2005). [Link](#)
41. R. Panat, K.J. Hsia and J. Oldham, "Observation of rumpling instability in thermal barrier systems under isothermal conditions in vacuum", **Philosophical Magazine**, 85 (1), 45-64 (2005). [Link](#)
42. R. Panat and K.J. Hsia, "Experimental investigation of the bond coat rumpling instability under cyclic and isothermal temperature histories in thermal barrier systems," **Proceedings of the Royal Society of London, Series A**, Vol. 460, 1957-1979 (2004). [Link](#)
43. R. Panat, S. Zhang and K.J. Hsia, "Bond coat surface rumpling in thermal barrier coatings" **Acta Materialia**, Vol. 51, 239-249 (2003). [Link](#)
44. S. Zhang, R. Panat and K.J. Hsia, "Influence of surface morphology on the adhesion strength of aluminum/epoxy interfaces", **Journal of Adhesion Science and Technology**, Vol. 17 (12), 1685-1711 (2003). [Link](#)
45. R. Panat, K. Jakus, J.E. Ritter and P. Shah, "Erosion and strength degradation of an elastic modulus graded alumina-glass composite," **Ceramic Engineering and Science Proceedings**, Vol. 21 (3), 635 (2000). [Link](#)
46. J.E. Ritter, K. Jakus, R. Panat, "Impact damage and strength degradation of fused silica," **MRS Symposium Proceedings**, 531, pp. 53 (1998). [Link](#)

PATENTS (Total of 10: 6 issued and 4 applications):

- R. Panat, J. Park, M. S. Saleh, and J. Lie, "Three-dimensional lattice batteries via additive manufacturing" U.S. Patent Application #16/593,622, Oct. 2019
- R. Panat, E. Yttri, and M. S. Saleh, "Three dimensional electrode array", Patent application #PCT/US 2019/016050, Feb. 2019.
- R. Panat and D. Heo, "Three-dimensional sub-mm wavelength sub-THz frequency antennas on flexible and in-situ cured dielectric using printed metal structures", U.S. Patent # 10086432, issued Oct 2018. [PDF](#)
- R. Panat and D. Heo, "Three-dimensional passive components", U.S. Patent #9969001, issued May 2018. [PDF](#)
- T. C. Karni, R. Garg, S. Rastogi, R. Panat, and M. S. Saleh, "Nanowire-Mesh Templated Growth of Out-of-Plane Three-Dimensional Fuzzy Graphene", U.S. Patent Application # WO/2018/195108, April 2018.
- R. Panat and L. Lei, "Low-cost fiber optic sensor for large strain", US Patent #9846276, issued December 2017. [Link](#)
- I. Dutta and R. Panat, "Highly stretchable interconnect devices and systems", US Patent #9770759, issued Sept 2017. [Link](#)

- R. Panat and B. Jaiswal, “Nanowires coated on traces in electronic devices”, US Patent #9627320, issued April 2017. [PDF](#)
- N. Raravikar and R. Panat, “Nanolithographic method of manufacturing an embedded passive device for a microelectronic application, and microelectronic device containing the same”, US Patent #8068328, issued May 2014. [Link](#)
- R. Panat and M. S. Saleh, “Additive manufacturing of porous scaffold structures”, U. S. Patent Application # 14/957,849, filed Dec 2015. [Link](#)

R&D ACCOMPLISHMENTS:

- **2018:** Developed a 3D printing method to create neural probes with high degree of customization and an order of magnitude higher recording density when compared to the current state of the art technologies.
- **2016:** Developed a new fabrication technique for hierarchical 3-D porous materials with structural control over 5 orders of magnitudes in length scales for applications such as energy storage, surface modification, bio-scaffolds/implants, actuation, etc.
- **2013:** Integrated Embedded Array Capacitors (EACs) into ultra-high performance Intel chips. This work significantly impacted high performance chip market by enabling Intel chips to operate efficiently at high frequencies not possible until that time ([paper](#)).
- **2006:** Lead process engineer for a team that developed industry’s first halogen free integrated circuit chip in flash memory packages. The technology was later adopted in logic chips (also at Intel) and by other companies worldwide.
- **2004:** As a PhD student at Illinois, co-developed and validated a model to predict surface evolution of thick coatings at low stress and high temperatures via volume and surface diffusion (with KJ Hsia/DG Cahill) ([paper](#))

RESEARCH FUNDING (\$4.08 million as PI; My share: \$2.07 million since 2015):

- 2020: **Pennsylvania Infrastructure Transportation Authority (PITA)**, “Remote Health Monitoring via 3D Printed Wearable Electronic Decals” \$51,500 **PI: Rahul Panat** (ME) and **co-PI: Gary Fedder** (ECE), CMU. Industry Partner: Highmark Health
- 2019: **NIH R01**, “Customizable, Ultra-high Density Optic Fiber-paired Multielectrode Array by 3D Nanoparticle Printing”, \$1,946,748 **PI: Rahul Panat** (ME) and co-investigator: Eric Yttri (Biological Sciences) at CMU.
- 2019: **DOE-NETL**, “A Novel Access Control Blockchain Paradigm for Cybersecure Sensor Infrastructure in Fossil Power Generation Systems”, \$400,000. **PI: Rahul Panat** (ME); co-PI: Vipul Goyal (Computer Science) at CMU.
- 2019: **Allegheny Health Network research grant** to “3D Printed Electronic Decals for in-situ Monitoring of Cardiac Parameters”, \$70,000. PI: Gary Fedder (ECE); **co-PI: Rahul Panat** (ME), CMU.
- 2019: **Pennsylvania Manufacturing Innovation Program**, “3D Printed Conformal Sensors for In-situ Monitoring of Cracks in Critical Freight Car Components”, \$64,060. **PI: Panat** (ME), CMU
- 2018: **NIH R21**, “Rapid 3-D Nano-Printing to Create Multi-Thousand-Channel Microelectrode Arrays”, \$414,204. **Multiple PIs: Rahul Panat** (ME) and Eric Yttri (Biological Sciences), CMU
- 2018: **David Scaife Foundation**, “Seed Grant for CMU Array: Using Rapid 3D Printing of Metal Nanoparticles to Improve Neuronal Sampling Abilities by an Order of Magnitude”, \$110,000. PI: Eric Yttri (Biological Sciences); **co-PI: Rahul Panat** (ME). My share \$55,000.
- 2018: Equipment grant from CIT (\$50,000) to upgrade the 3D printer by adding multi-material printing capability. **PI: Panat**

- 2017: “A Breakthrough Additive Manufacturing Method for High-Strength Lightweight 3D Micro-Architected Materials” **NSF/CMMI. PI: Rahul Panat**, CMU; co-PI: Prof. Hussein Zbib, WSU. (Total funding : \$309,943; my share: \$209,000).
- 2016: “GOALI/Collaborative Research: Additive Manufacturing of Mechanically Strong and Electrochemically Robust Porous Electrodes for Ultra-High Energy Density Batteries” **NSF/CMMI. PI: Rahul Panat**, WSU; co-PI: Prof. Jonghyun Park, MUST, Rolla; GOALI Partner: Dr. Michael Renn, CTO, Optomec Inc., Minneapolis MN. (Total funding: \$300,000; my share: \$150,000)
- 2015: “Low-Cost, Efficient and Durable High Temperature Wireless Sensors by Direct Write Additive Manufacturing for Application in Fossil Energy Systems”, **DOE/NETL. PI: Rahul Panat**, WSU, and co-PI: Prof. C. V. Ramana, University of Texas, El Paso. (Total funding: \$399,932).
- 2015: “NSF Workshop: Advanced Manufacturing for Smart Goods; Vancouver, Washington, May 2015”, **NSF/CMMI. PI: Brian Paul, co-PI: Rahul Panat**, David Johnson, Christina Mastrangelo, Dae-Wook Kim. (\$33,401)
- 2015: **PI: Rahul Panat**. Grant from the **Washington Research Foundation (WRF)** on, “A low-cost super-stretchable polymer optical fiber strain sensor and Fiber-Bragg-Grating (FBG)”. (\$25,000)
- 2015: **PI: Rahul Panat**. Grant from **WRF** on, “Three dimensional sub-mm wavelength antennas using photonic curing of printed metal nanopowders on flexible substrates” (\$25,000)
- 2014: **PI: Rahul Panat**. Equipment grant from the VCEA (**Northern Trust Program**) to add Laser/UV capability to printed electronics equipment and plasma cleaning equipment (\$39,000)

MEDIA:

2019: Research on securing energy grid with blockchains

CMU News: [DOE Tasks CMU with Securing Energy Grid with Blockchains](#)

Pittsburgh Business Report: [Carnegie Mellon University researchers receive grant to protect electric grid using blockchain](#)

2018: Research on 3D printed batteries highlighted in several tech magazines and popular media

Forbes: [See How This New 3D Printing Method Could Make Your Smartphone Last Longer](#)

Green Car: [CMU-led team develops 3D printing method for exceptionally high capacity batteries](#)

Printed Electronics: [3D printing the next generation of batteries](#)

3D Printing Industry: [3D Printing creates major advance for longer lasting batteries](#)

CMU news: [3D Printing the next generation of batteries](#)

German Media: [New “Aerosol Jet” method relies on 3D printing for electrodes of lithium-ion batteries and promises longer battery life](#)

2017: Research on 3D microarchitectures was highlighted in several tech magazines

WSU News: <https://news.wsu.edu/2017/03/03/novel-3-d-manufacturing/>

German Media: [Huge Nanostructures](#)

I4U News: [Researchers 3D Print Lightweight But Ultra-Strong New Material Like Wood And Bone](#)

Materials Today: [Novel 3D printing method goes up and down the scale](#)

3-D Printing Industry: [“Groundbreaking advance” in nanoparticle 3D printing mimics natural construction in the desert](#)

Science Daily: <https://www.sciencedaily.com/releases/2017/03/170303143221.htm>

Yahoo News: [Scientists create ultra-light, super strong new material based on wood and bone](#)

Physics.org: <https://phys.org/news/2017-03-d-highly-complex-bio-like-materials.html>

2015: Research on stretchable Indium conductors was highlighted in several tech magazines

Robot Magazine: [Indium-Plastic Film Could Lead to Stretchier Skin for Robots](#)

Physics.org: [Researchers create super-stretchable metallic conductors for flexible electronics](#)

Space Daily: [Super-stretchable metallic conductors for flexible electronics](#)

Gizmodo: [A New Stretchable Conductor Can Extend to Twice Its Length](#)

Semiconductor Engineering Mag: [Stretchy Metal](#)

Manufacturing.net: [Study: New Metal Fabric Can Stretch To Double Its Original Size](#)

AWARDS AND HONORS:

- Struminger Teaching Fellowship to develop a blended classroom approach for an industry-oriented design course at CMU, December 2019
- Divisional recognition award at Intel for outstanding efforts in development of new solder paste metallurgy, 2010
- Divisional recognition award at Intel for tape-out and production of Intel's first six core Xeon® server microprocessor, 2008
- Technology and Manufacturing Group (TMG) excellence award for innovation in packaging to achieve \$2.6 billion in package, assembly and test savings, 2008
- Divisional recognition award at Intel for developing manufacturing process for world's first fully green (halogen free and lead free) integrated circuit (IC) chip, 2007
- Lean Six Sigma Green Belt Certification at Intel, 2014
- Henry L. Langhaar Graduate Award, University of Illinois at Urbana, 2004
- Stanley J. Weiss Outstanding Dissertation Award, University of Illinois at Urbana, 2004
- Dissertation Completion Fellowship, University of Illinois at Urbana, 2003 - 04
- Materials Research Society (MRS) Gold Medal, 2002
- Mavis Memorial Fund Scholarship Award, University of Illinois at Urbana, 2002 and 2003
- Research Fellowship, TAM Department, University of Illinois at Urbana, (1999–2000)
- National Merit Scholarship by the Government of India (1991)

CONFERENCES/TALKS (only invited talks included):

1. R. Panat, "Microdroplet-based 3D Nanoparticle Printing: Enabling the Next Generation Brain-Computer Interfaces, Sensors, and Li-ion Batteries", invited seminar in the ME Department at **Massachusetts Institute of Technology, Boston MA**, Oct 2019.
2. R. Panat, "Micro and Nanoscale Additive Manufacturing of Biomedical Devices", invited seminar in the BME Department at **University of Pittsburgh, Pittsburgh PA**, Sept 2019
3. R. Panat, "3D Nanoparticle Printing", **invited distinguished seminar** at the Mechanical Engineering Department, **West Virginia University, Morgantown WV**, Sept 2019
4. R. Panat, "3D Nanoparticle Printing", invited seminar in the Mechanical Engineering Department at **University of Massachusetts, Amherst MA**, Sept 2019
5. R. Panat, "3D Printing at Microscale: Process and Devices", invited seminar in the Physics Department, **Pune University, India**, June 2019
6. R. Panat, "Microarchitected Macrostructures: Bridging the Length Scale Gap via Multi material Nanoparticle Printing", invited seminar at the 2019 Multifunctional 3D Printing Symposium at **Rochester Institute of Technology**, Rochester NY, May 2019
7. R. Panat, "Micro-architected Macrostructures: Bridging the Length Scale Gap via Nanoparticle 3D Printing", invited seminar in the **CEE department at CMU**, April 2019

8. R. Panat, "Low-cost efficient sensor by nanoparticle 3D Printing", invited seminar at the **DOE annual review meeting**, Pittsburgh PA, April 2019
9. R. Panat, Md Taibur Rahman, M. Schrandt; M. Renn; M. S. Saleh, C.-Y. Cheng, C. Ramana, "3D Printed High Performance Sensors", invited seminar at **annual TMS conference**, San Antonio, TX, March 2019
10. R. Panat, Md Taibur Rahman, and C. Ramana, "3D Printed Metal Films", invited seminar at **annual TMS conference**, San Antonio, TX, March 2019
11. R. Panat, "3D nanoparticle Printing for Sensors and Energy Storage Devices", invited seminar at **National Energy Technology Laboratory, DOE**, Pittsburgh PA, Jan 2019
12. R. Panat, "3D printed high temperature sensors", invited seminar at the **NETL/DOE annual review meeting**, Pittsburgh PA, April 2018
13. R. Panat, "3D Micro-Devices Using Nanoparticle Printing", **ECE departmental seminar (invited)** at CMU, Pittsburgh PA, April 2018
14. R. Panat, "Micro and Nanoscale Additive Printing of Electronic Devices", invited seminar at **Intel Corporation, Chandler AZ**, March 2018
15. R. Panat, "The application of 3D printing to advanced packaging technology", invited seminar at the **14th TMS Workshop on Advanced Microelectronic Packaging, Emerging Interconnection Technology, and Pb-free Solder**, TMS Conference, Phoenix, March 2018
16. R. Panat, "Micro and Nanoscale Additive Printing", invited seminar at the Mechanical Engineering Department, **Rutgers University**, February 2018
17. R. Panat, "Micro and Mesoscale Additive Manufacturing", invited seminar at **DSN-I, ECE Department at CMU**, January 2018
18. R. Panat, "Micro and Mesoscale Additive Manufacturing", invited seminar at the **NextManufacturing Center, CMU**, October 2017
19. R. Panat "Microscale 3D Printing", invited seminar at the **NEET conference** in University of Texas at El Paso, TX, May 2017
20. Md Taibur Rahman and R. Panat, "3D Printed High Temperature Sensors", invited seminar at the **NETL/DOE annual review meeting**, April 2017
21. Md Taibur Rahman, S. Saleh, C. V. Ramana, A. Rahimi, S. Gupta, R. Panat, "Printed Nanoparticle Films for Electronic Applications", invited seminar at the **annual TMS conference**, San Diego CA, February 2017
22. R. Panat, "3D Printed Microelectronics", invited seminar at the Mechanical, Industrial, and Manufacturing Engineering Department, **Oregon State University, Corvallis, OR**, Nov 2016.
23. R. Panat, "3D Printing at Microscales", invited seminar at the **Air Force Research Laboratory, Dayton, OH**, June 2016
24. R. Panat, "Printed and Flexible Microelectronics Manufacturing for Smart Devices and Systems", invited seminar at the **NextManufacturing center at CMU**, April 2016
25. R. Panat, "Some Problems in Flexible and Printed Electronics and Flexible Li-ion Batteries", invited seminar at the **Sharp Labs, Camas, WA**, June 2015
26. R. Panat, "On the Surface Evolution in Stressed Films: From Metal Films at High Temperature to Electrode Films in LiBs", invited seminar at the **42nd ICMCTF** (International Conference of Metallurgical Coatings and Thin Films) in San Diego, CA, April 2015
27. R. Panat, "On the Integration of Microelectronic Devices on Rigid and Flexible Platforms", invited seminar at the ME Department, **University of Washington, Seattle, WA**, April 2015

28. Department Seminar “Printed and Flexible Microelectronics Manufacturing for Smart Devices and Systems” at the School of Mechanical and Materials Engineering, WSU, Nov 2015
29. Two presentations at the ASME InterPACK Conference, San Francisco, CA, July 2015
30. R. Panat, “Energy Storage Devices for Ultra-High-Performance Microprocessors and Flexible Electronic Devices”, invited seminar at the NSF PERM seminar series, **University of Texas at El Paso, El Paso TX**, June 2014
31. R. Panat, “Mechanics of Microelectronic Packaging”, invited seminar at the Mechanical and Aerospace Seminar Series, **Arizona State University, Tempe AZ**, Aug 2010
32. R. Panat, “Bond coat surface rumpling in thermal barrier coatings”, invited seminar in the Physics department, **Pune University, India**, June 2005
33. R. Panat, “Bond coat surface rumpling in thermal barrier coatings”, invited seminar in the CEE department, **Cornell University, Ithaca NY**, June 2004
34. “Bond coat surface rumpling in thermal barrier coatings”, talk at MRS, Boston, MA (Dec. 2002) – **won MRS gold medal for this presentation ([link](#))**.
35. “Bond coat surface rumpling in thermal barrier coatings”, Materials Interest Group seminar given at the Department of Mechanical Engineering, UIUC, Urbana, IL (Oct. 2003)

SERVICE AND OUTREACH:

- **Member, Carnegie Mellon Faculty Senate** (2019- present)
- Faculty search committee member, ME department, CMU (2018-present)
- **Chair of CMU Mechanical Engineering PhD qualifiers** (2019-present). In this role, I am responsible for managing quals for all the incoming ME PhD students.
- **Graduate Education Committee (GEC) Member**, ME Department, CMU, 2018-present
- **Undergraduate Education Committee (UEC)**, ME Department, CMU 2017 – 2018
- Guest Editor, IEEE CPMT, since June 2019
- Co-organizer of a workshop on Smart Goods Manufacturing, sponsored by the CMMI division of NSF, 2015
- Faculty search committee chair, School of MME, WSU, 2015. Hired 2 tenure track assistant professors in the areas of robotics and energy.
- Faculty mentor for Louis Stokes Alliance for Minority Participation (LSAMP) at WSU
- Symposium chair at the 2015 ASME Applied Mechanics and Materials Conference, Seattle, WA (session: Mechanics of Materials in Energy Technologies), July 2015.
- Proposal reviewer for NSERC (Natural Sciences and Engineering Research Council of Canada), Ottawa, Canada, 2015
- NSF panelist (CMMI division), 2006
- Reviewer for many journals such as Sci Advances, Adv Funct Mater, IEEE Adv Mat Tech, Transactions on Advanced Packaging, IEEE Transactions on Device and Materials Reliability, Journal of Materials Sciences and Engineering A, and Journal of Engineering Tribology

STUDENT ADVISING:

Eight PhD students (3 completed, 5 current), 5 MS students (4 completed), 3 UG students (3 past).

Current PhD Students:

Jacob Brenneman
Sandra Ritchie
Mert Aslanoglu
Sanjida Jahan
Chunshan Hu

Current Postdocs:

Dr. Azahar Ali
Dr. Bin Yuan
Dr. M. Sadeq Saleh

Current MS Students:

Mrunal Vaze

Past Students:

Md. Taibur Rahman (PhD, 2017): Now R&D Engineer, Intel Coporation, Chandler AZ
Yeesir Arafat (PhD, 2019): Now R&D Engineer, Intel Corporation, Chandler AZ
M. Sadeq Saleh (PhD, 2019): Postdoc at CMU

Roosbeh Danaie (MS, 2017): Now R&D Engineer, Intel Coporation, Chandler AZ USA
Chunshan Hu (MS, 2017): Joined my group back as a PhD student in 2020
Russell Moser (MS, 2017): Now Engineer at Janickie Industries, Seattle WA USA
Chih-Yang Cheng (MS, 2019): Now at TDK Invensys, Boston MA USA

Riddhiman Bezbaruah (BS, 2019): MS student at CMU
Edward Houlthas (BS, 2018): Now at Epic Software, Madison, WI USA
Dylan Lew (Research Intern, 2019): BS student at CMU
Misganaw Demissie (Summer intern, 2016): Now pursuing PhD at Ohio State Univ