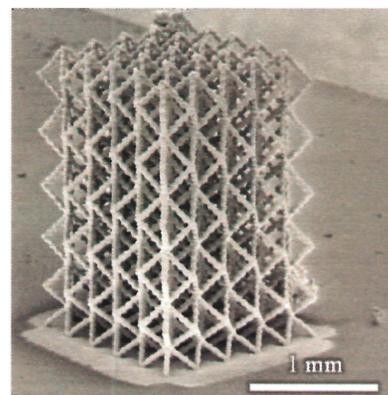


MATERIALS SCIENCE AND ENGINEERING (MS&E) SEMINAR SERIES**Friday September 6, 2019 at 3:00pm in room ESB 207****3D Nanoparticle Printing: Bridging the Length-Scale Gap****Rahul Panat, Associate Professor, Department of Mechanical Engineering,
Carnegie Mellon University**

Advances in microelectronics manufacturing can be utilized to enable next generation devices in several critical areas. Printed electronics is one such microfabrication method that allows rapid changes to design, use of a large number of functional materials, and novel device geometries. Printed electronics, however, has been largely confined to 2D structures on 2D or 3D substrate surfaces. In this work, we extend nanoparticle printing into three dimensions, where controlled condensation and solvent evaporation is used to realize a new class of three-dimensional (3D) micro-architected materials *without any support materials*. A precise arrangement of nanoparticles in 3-D space is achieved to fabricate structures such as highly intricate 3-D microlattices, pillars, and spirals. Theories of dropwise condensation and evaporation are developed and validated through experiments.

We then use this printing method to realize Brain-Computer Interface (BMI) devices having a recording density of > 5000 sites/cm², which is an order of magnitude higher than conventional lithographic methods.

Further, the method enables an on-demand, study-specific prototyping and manufacture of BMI electrode configurations in a few hours. We also show highly sensitive strain, temperature, and touch sensors via printing. Lastly, we show that the printed 3D microlattice structures can be used as Li-ion batteries with 2x areal density compared to block electrodes.



Bio: Dr. Rahul Panat received his MS in ME from the UMass Amherst and PhD in Theoretical and Applied Mechanics from the University of Illinois at Urbana-Champaign. After PhD, Dr. Panat worked at Intel Corporation in the area of microprocessor manufacturing R&D from 2004-2014. At Intel, Dr. Panat led a team of engineers that developed the manufacturing process for world's first halogen-free IC chip. He decided to go back to academia and joined Washington State University (WSU) in fall 2014 before moving to CMU in fall 2017. He works in the areas of additive manufacturing, stretchable electronics, and Li-ion batteries. His research is funded by NIH, DOE, and NSF. He recently received an NIH R01 award as a PI to explore 3D printed brain-machine interfaces. Dr. Panat is a recipient of several awards, including MRS gold medal and an award at Intel for his work on the halogen-free chip.



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