

*Journal Club Talk arranged on 23 June 2023*

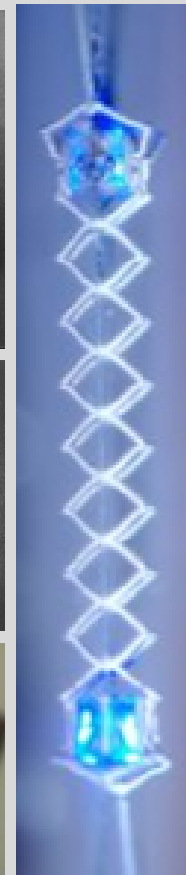
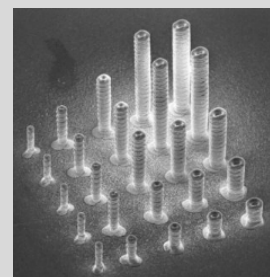
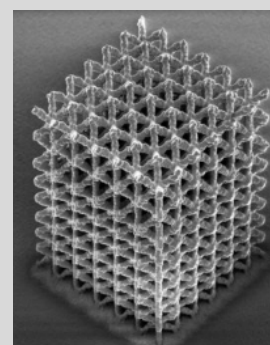


## Nanoparticle 3D Printing for Next Generation Biomedical Devices, Li-ion Batteries, and Robotic Skins

By

**PROF. RAHUL PANAT,  
CARNEGIE MELLON UNIVERSITY,  
PITTSBURGH PA, USA**

**Abstract:** In this research, we develop a nature-inspired droplet-based nanoparticle 3D printing method that creates highly complex three-dimensional architected structures and use them to make new device structures. Fluid dynamics of aerosol microdroplets is used to stack nanoparticles (or 2D nanoflakes) in 3D space without auxiliary support to create such structures. First, this technique is used to realize next generation biomedical devices such as a biosensor that detects COVID-19 antibodies and antigens in 10 seconds. This is the fastest detection time for this biomarker. Second, we use 3D printing to create fully customizable brain-computer interfaces (BCIs) having recording densities of thousands of electrodes/cm<sup>2</sup>, which is 5-10x higher than the current state-of-the-art BCI technologies. The technology is tested by recording the action potentials from the mouse brain. The same technique is also used to create high-capacity Li-ion batteries and thin flexible robotic skins with embedded sensors. The talk will also include our recent research on (i) creating digital twins of the nanoparticle 3D printing process and using AI for the process control, and (ii) use of AI to design and fabricate plate lattice structures for the US Army's combat vehicle program. Lastly, I will include a brief overview of the ME department at CMU and the research opportunities offered by its MS/PhD program.



**Biography:** Prof. Panat is Russell V. Trader Professor of Mechanical Engineering at Carnegie Mellon University (CMU). He is also the Associate Director of Research at the Manufacturing Futures Institute at CMU, which is focused on bringing the latest advances in digital technologies to advanced manufacturing. Prof. Panat completed his PhD in Theoretical and Applied Mechanics from the University of Illinois at Urbana in 2004. He joined Intel Corporation's R&D unit in Chandler, AZ, where he worked for 10 years on microprocessor manufacturing. At Intel, Dr. Panat led a team of engineers that developed the manufacturing process for world's first halogen-free IC chip. He was part of a team that introduced the first Si chip with a billion transistors. He returned to academia in 2014 and joined CMU in fall 2017. His research is focused on microscale 3D printing and its applications to biomedical engineering, stretchable electronics, and Li-ion batteries. His research is funded by NIH, DOE, NSF, US Army, US Air Force, in addition to industry and several foundations. Prof. Panat is recipient of several awards, including MRS gold medal, Mavis Memorial Award, an award at Intel for his work on the halogen-free chip, Struminger Teaching Fellowship, and the Russell V. Trader chair professorship at CMU.

**VENUE: SEMINAR HALL**  
**Time: 11:30 am to 1:00 pm**

**National Centre for Nanosciences and nanotechnology,  
Unviersity of Mumbai, Kalina Campus, Mumbai**