CHEMICAL & BIOMEDICAL ENGINEERING SEMINAR ANNOUNCEMENT

Turning Plastic Waste into Useful Chemicals: A Molecular-Level Approach to a Global Problem

Tridip Das, PhD
Computational Materials Scientist
California Institute of Technology

Friday, Feb. 13
11:00 a.m.
COE B135

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Tridip Das is a computational materials scientist at Caltech, specializing in quantum mechanics, molecular dynamics, and machine learning applications for sustainable technologies. He holds a bachelor's in chemical engineering from Jadavpur University and M. Tech. in chemical engineering from IIT Kharagpur. Tridip earned his Ph.D. also in Chemical Engineering from Michigan State University.

Before joining Caltech in 2021, he held research and engineering roles at Intel Corporation and other leading organizations. At Caltech, Tridip has made significant contributions to solid-state battery research, particularly in the development of novel electrolytes and the study of ionic diffusion mechanisms. His work also spans computational investigations into CO2 reduction reactions (CO2RR), hydrogen evolution (HER), oxygen evolution (OER), and polymer upcycling—advancing the frontiers of energy storage and sustainable materials.

Beyond his research, Tridip is deeply committed to education and mentorship, and actively engages with the broader scientific community through K-12 learning and collaborative initiatives. Outside the lab, he is passionate about playing the tabla and soccer, balancing his scientific pursuits with artistic and athletic expression.

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Every year, we produce hundreds of millions of tons of plastic, much of it is single use plastic: used just once and then thrown away. These materials have persisted in the environment for decades, resisting degradation and overwhelming recycling systems that are often energy-intensive and yield lower-quality products. As a result, plastics accumulate in landfills, oceans, and even our food systems, posing both environmental and health challenges.

My research takes a different approach to this problem. Instead of focusing on traditional recycling, I explore how we can transform plastics into smaller, valuable chemical building blocks that serve as precursors for fuels, new materials, or even pharmaceuticals. To achieve this, I use advanced molecular simulations to understand how plastics behave and decompose at the atomic level.

Specifically, my work focuses on common plastics like - polyethylene, polypropylene, and PVC; used widely in packaging, containers, and medical products. I simulate how these polymers break down when exposed to plasma, a high-energy, "cold lightning" state of matter capable of driving chemical reactions without extreme heat.