Department of Materials Science and Engineering Seminar Series 2026

Monolayer Amorphous Carbon for Lithium Deposition

Shi Lu

Date and time: 05th March 2026 (Thursday) 3:30pm-5:30pm

Venue: EA-02-14

Abstract

Anode-less lithium metal batteries offer a pathway toward higher energy density for secondary batteries, but practical realization requires improved control over lithium deposition. Morphological instability during plating accelerates interfacial degradation, increases electrolyte consumption, and reduces Coulombic efficiency and cycle life, motivating a fundamental understanding of how interfaces govern lithium nucleation, early growth, and morphology evolution.

This thesis introduces monolayer amorphous carbon (MAC), a disordered sp^2 network, as an atomically thin, structurally well-defined platform to study lithium deposition. Uniform, continuous MAC is synthesized directly on copper, forming a mechanically robust and electrically integrated coating. Combined experimental characterization and atomistic modeling show that disorder produces a spatially continuous landscape of energetically favorable lithium-binding sites across the basal plane, enabling more uniform lithium morphology than graphene-coated copper and bare copper. The post-nucleation early growth regime is shown not to proceed by simple local accumulation. Under sustained lithium plating, size-selective evolution occurs, where a subset of smaller deposits decreases in height while larger deposits grow. Population-level statistics further support redistribution-controlled growth scaling during this stage.

Overall, this work develops a mechanistic framework for atomically thin interfacial coatings in lithium metal systems. It demonstrates that structural disorder can be leveraged as a functional parameter to achieve intrinsic lithiophilicity without chemical doping, and that early-stage lithium growth should be understood as a redistribution-controlled population process. By connecting interfacial structure, electronic properties, and growth dynamics, this thesis provides guidance for the rational design of ultrathin interfacial coatings for lithium deposition.

Biography

Shi Lu is currently a Ph.D. candidate at the MSE department under the supervision of Prof. Barbaros Oezyilmaz. Her research focuses on the synthesis of two-dimensional materials and their applications in energy storage, catalysis, and semiconductor technologies.

Please join us!

HOST: Asst Prof Ahmet Avsar