UCLA College | Physical Sciences Chemistry & Biochemistry

Chem 218: Student Exit Seminar

Understanding Charge Transport in Doped Conjugated Polymers: The Roles of Environment, Dopant-Induced Disorder, and Microstructure

By Diego Garcia Vidales
Schwartz Group

Conjugated polymers are electronic materials that combine semiconductor-like behavior with mechanical flexibility, solution processability, and chemical tunability. However, their intrinsically low carrier density and heterogeneous microstructure pose challenges for efficient charge transport. To mitigate the low carrier density, we incorporate carriers via chemical doping into semiconducting polymer thin films. This talk investigates how chemical doping and polymer morphology jointly dictate charge transport across molecular, mesoscale, and macroscopic length scales, with implications for electronic and thermoelectric applications. We characterize the doped films using techniques such as four-point probe conductivity, Seebeck coefficient measurements, Hall effect measurements, X-ray scattering, and spectroscopy. We first study how the hygroscopicity of the counterions in doped polymer thin films can significantly influence electronic transport by enabling water uptake. We show that absorbed moisture introduces trap states and suppresses carrier mobility, underscoring the need to consider environmental stability and dopant chemistry when chemically doping polymer devices. Second, we dope the same polymer with four molecular dopants and find that the choice of dopant affects not only carrier generation but also structural ordering, crystallite connectivity, and Coulomb trapping, leading to distinct charge-transport pathways and thermoelectric performance. Importantly, we show that electrical conduction can be enhanced without sacrificing Seebeck coefficient either by mitigating Coulomb interactions or by activating charge transport through previously amorphous regions. Finally, we isolate the role of the polymer microstructure by tuning the polymer crystallinity by controlling regioregularity. We find that higher intrinsic crystallinity promotes greater polaron delocalization and faster local transport, and that dopant- induced crystallization in amorphous regions can enhance mesoscale connectivity. The combination of high local order and doping-enabled long-range connectivity is essential for maximizing mobility and thermoelectric performance. Overall, this work establishes structure–doping–transport relationships in doped conjugated polymers and highlights design principles for next-generation polymer conductors: choose dopants that both minimize trapping and enable structural reinforcement, and engineer polymer microstructure to balance local order and mesoscale connectivity.

Thursday, November 6th, 2025
12:00 p.m.
Young Hall 4222C

For questions, please contact: letts@g.ucla.edu