Materials Science and Engineering Department

Fall Seminar Series

Programming and probing the self-assembly of intrinsically-disordered proteins

Prof. Felipe Quiroz
Biomedical Engineering
Georgia Institute of Technology
Emory University

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Intrinsically-disordered proteins (IDPs) recently emerged as major drivers of self-assembly in nature. Mechanistically, their stimuli-responsive solubility in aqueous solutions is governed by liquid-liquid phase separation (LLPS) dynamics. Intracellularly, for example, phase-separated IDP-assemblies orchestrate wide-ranging cellular mechanisms, from genome organization to cell division. These bioinspired insights suggest that IDPs are outstanding building blocks to engineer self-assembling "smart" materials. *In this talk, I will present our progress toward programming and probing the LLPS behaviors of intrinsically-disordered proteins (IDPs), demonstrating their utility as self-assembling nanomaterials*. I will highlight our two main approaches: (1) the engineering of lower and upper critical solution temperature (LCST and UCST, respectively) LLPS behavior in IDP polymers (*Nature Materials* 2015, *Science Advances* 2019); and (2) the development of biomolecular sensors to probe the material properties of intracellular IDP-assemblies (*Science* 2020). Dwelling in materials engineering, I will discuss how the syntax and architecture of IDP polymers control their ability to access complex (e.g., band pass, with dual LCST/UCST) and non-equilibrium LLPS behaviors. As an example, these advances enabled the engineering of LCST-exhibiting IDPs that form nanorods with superb stability. Overall, my twofold goal is to inspire the materials science and engineering community to mine IDP self-assembly, and, conversely, to invite materials science rigor to the probing of IDP-assemblies. The growing focus on IDPs and their LLPS behaviors offers fruitful ground for exploration of fundamental and applied materials engineering research.

Felipe G. Quiroz is Assistant Professor of Biomedical Engineering at Georgia Institute of Technology and Emory University. Dr. Quiroz and his team mine protein self-assembly in engineered and biological material systems. He holds a Career Award at the Scientific Interface from Burroughs Wellcome Fund.

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Email: kn52@drexel.edu
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