

**“Understanding and Designing
Complex Materials to Stabilize
Proteins and Enable Supra-Biological
Properties”**

**Wednesday
March 30, 2022
3:30 pm
Wu & Chen Auditorium**



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Abstract

Our group is broadly focused on understanding and controlling the intersection of biology and materials at the molecular level. This intersection is critical in many areas of biotechnology where proteins and enzymes are integrated into or in constant contact with materials, including biocatalysis, tissue engineering, drug delivery, biosensing, and vaccine formulation. In line with this interest, we have developed a novel approach to elucidate the structure and transient behavior of protein molecules at the solution-solid interface based on dynamic single-molecule tracking. This approach, which is uniquely sensitive to structural and interfacial dynamics, includes the use of high throughput tracking of protein molecules by means of internal reflection fluorescence (TIRF) microscopy in combination with intramolecular as well as intermolecular Forster resonance energy transfer (FRET). An important aspect of this approach is the use of bioorthogonal labeling techniques to site-specifically introduce donor and acceptor fluorophores, which allow fluctuations in FRET efficiency to be correlated with changes in protein structure. Notably, in this approach, as many as 10^6 protein molecules are tracked as they adsorb, desorb, diffuse, and simultaneously undergo conformational changes and/or intermolecular associations, permitting the statistical identification of dynamic, spatial, and population heterogeneity. The subsequent correlation of these dynamic behaviors on a molecule-by-molecule basis via large-scale multi-variate analyses, moreover, provides new insights into the connection between interfacial dynamics and protein structure. This talk will specifically focus on the application of this approach to understand the connection between protein dynamics and conformation, and to rationally improve enzyme function.

Bio

Joel Kaar is an Associate Professor in the Chemical and Biological Engineering Department at the University of Colorado, Boulder. Prior to joining the faculty at CU Boulder in 2010, he received his B.S. and P.h.D. under Professor Alan Russell in chemical engineering from the University of Pittsburgh. Additionally, he was a postdoctoral fellow at the Medical Research Council Centre for Protein Engineering in Cambridge, England, in Professor Sir Alan Fersht's group. He has received the US Army Young Investigator (2012), NSF CAREER (2015), CU Department of Chemical & Biological Engineering Outstanding Junior Faculty (2016), CU Provost's Faculty Achievement (2016), and CU Department of Chemical & Biological Engineering Distinguished Faculty (2019) awards.