



# MATERIALS SCIENCE and ENGINEERING SEMINAR



**Dr. Andrea Carlini**

*Chemistry & Biochemistry*

**University of California Santa Barbara**

**Optically- and Structurally-Responsive Polymers for  
Oxidative Stress**

## **Abstract**

Polymeric materials offer unique opportunities to translate molecular-scale chemical events into functional responses across larger length and time scales. Our group develops responsive materials in which macromolecular architecture couples molecular recognition with optical and structural responses. By controlling the placement and organization of responsive motifs within polymeric systems, we seek to amplify molecular-level reactions into adaptive behaviors that operate across space, time, and scale. In this talk, I will describe our efforts to apply this framework to peroxynitrite ( $\text{ONOO}^-$ ), a highly reactive marker and mediator of oxidative stress. Conventional small-molecule peroxynitrite-responsive probes provide rapid fluorogenic detection but are limited by diffusion, transient signals, and single-use reactivity. To overcome these limitations, we incorporate benzopyrylium-based activity sensors into well-defined polymer architectures using ring-opening metathesis polymerization (ROMP). Polymerization provides control over probe localization, persistence, and signal integration while retaining a fluorogenic response to peroxynitrite. We further investigate how peroxynitrite recognition can drive changes in polymer structure and assembly, coupling optical reporting with material adaptation. Together, these systems establish design principles for extending molecular sensing through polymer architecture, with the goal of mapping peroxynitrite dynamics during oxidative stress and transitions between apoptotic and necrotic cell death.

## **BIOGRAPHY**

Andrea S. Carlini holds a B.S. in Chemistry and Biological Sciences from Virginia Tech. She completed her Ph.D. research on "Dynamic Biosynthetic Polymers for Myocardial Tissue Engineering" at the University of California San Diego, supported by an NSF GRFP Fellowship under the mentorship of Prof. Nathan C. Gianneschi. Following her doctoral studies, she pursued postdoctoral research with Prof. John A. Rogers at the Querrey Simpson Institute for Bioelectronics (QSIB). In 2022, Dr. Carlini joined the faculty at the University of California Santa Barbara as an Assistant Professor of Biomaterials in the Department of Chemistry & Biochemistry. She holds an affiliate position within the Interdisciplinary Quantitative Biosciences (IQB) Program and the Center for Polymers and Organic Solids (CPOS). The Carlini Group develops structurally dynamic biomaterials for biomedical applications. Her research has been recognized with an NSF CAREER Award, the Harold J. Plous Award, and a Hellman Family Faculty Fellowship.

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