UC Irvine Samueli
Department of Chemical and Biomolecular Engineering

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Precision Engineering of Macromolecular Systems as Transducer Biomaterials

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Abstract: Signaling in physiological environments relies on ion currents, biomolecular exchange, and other physical cues that are all processed by the cellular machinery to execute a specific response. This presentation will focus on the development of macromolecular organic materials as 'transducer materials'—materials capable of converting external or cell-mediated biophysical cues to stimulatory, regenerative cues or as sensory output signals—for electroactive living systems. Specifically, molecular engineering and fabrication approaches for endowing these systems with the order-dependent ability to convert exogenous optical, electronic, mechanical or chemical cues at the interface with excitable cells will be discussed. Soft lithography, nanoimprinting, surface templating, and light-based micropatterning techniques are leveraged to introduce topographical confinement effects on the self-assembly of optoelectronic peptide units on inorganic lattices or polymeric surfaces, consequently leading to tissue anisotropy. We elucidated the dependence of specificity of these surface-based assembly cues on the molecular design and size of the assembly units, as well as supramolecular distance to surface lattice matching. The peptide-polymer or organic-inorganic hybrid surfaces resulting from the templating process are capable of generating photocurrents upon excitation of the functionalized peptides. Additionally, stabilization of these assemblies on conductive polymer film substrates or as hydrogels can be achieved via surface conjugation chemistries. Through these efforts, we have unraveled new insights on macromolecular assembly on surfaces, as well as how cardiomyocytes perceive the sub-micron dimensionality, local molecular order, and other surface cues from their immediate environment. Lastly, this presentation will cover biohybrid platforms of cardiac and brain models where the sequence-/chemical design-tunable polymeric or supramolecular assembly interface can transduce light to stimulate tissue function or drive spatial heterogeneity of model tissues. Overall, we envision these design-programmable and ordered transducer macromolecular systems towards promoting stem cell-derived cardiomyocyte maturation, facilitating regenerative processes, and advancing the capabilities of engineered tissue constructs for in vitro modeling applications.

Bio: Herdeline Ann M. Ardoña is originally from Valenzuela City, Philippines. She received her B.S. in Chemistry from the University of the Philippines Diliman in 2011, completed her Ph.D. in Chemistry at Johns Hopkins in 2017, and was a postdoctoral researcher at Harvard University as an American Chemical Society (ACS) Irving S. Sigal Postdoctoral Fellow from 2017–2020. Currently, she is an Assistant Professor at the UCI Department of Chemical and Biomolecular Engineering, with joint appointments at the UCI Department of Chemistry and

Department of Biomedical Engineering. She currently serves as a Senior Editor for the ACS journal Langmuir. She is an NSF CAREER Awardee, Hellman Fellow, Kavli Frontiers of Science Fellow, ACS Polymeric Materials Science & Engineering (PMSE) Division Early Investigator Awardee, and named as one of the 2025 Talented 12 by the Chemical & Engineering News (C&EN).

Hosted by: Prof. Vasan Venugopalan