UC SANTA BARBARA

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Andrew Masuda

A Renewed Focus

For taking novel membrane-based approaches — and new materials to enable them — to change how we purify water, a team including researchers at UC Santa Barbara has received a $12 million grant from the Department of Energy (DOE) through its Energy Frontier Research Center (EFRC) Program. The four-year extension grant is part of DOE's $400 million investment to establish and sustain forty-three EFRCs across the country to accelerate basic science understanding and discovery in energy-related fields.

The Center for Materials for Water and Energy Systems (M-WET), is headquartered in the Cockrell School of Engineering at University of Texas at Austin, and also involves researchers from Lawrence Berkeley National Laboratory (LBNL). Launched with a $10.75 million DOE grant in 2018, it unites experts from three institutions to apply state-of-the-art materials synthesis, characterization and modeling to address basic science knowledge gaps hindering the creation of next-generation polymer membranes to filter chemically contaminated water for re-use.

"Energy and water are inextricably linked, in that the purification of water is undeniably energy intensive, and the production of energy generates uniquely contaminated water. This center brings together the expertise developed over the past decades to make designer polymers with the ability to design scalable membrane separations processes to address this unique challenge," said Rachel Segalman, chair of UCSB's chemical engineering department and an M-WET associate director. "Now that we've established ourselves as a research center, the renewal allows us to evolve, reframe what we are doing and pursue new frontiers of

science to develop impactful water- treatment technologies."

According to Segalman, M-WET will add research thrusts including how to process membranes, with the goal of learning how to design porous materials that are efficient, effective and reproducible on an industrial scale. Ions are the subject of a second new focus, bringing together the ion and battery communities to study ion transport in water. Additional faculty who specialize in those areas, their graduate students and postdoctoral researchers will be involved. The expanded scope promises to speed both the identification and the preparation of new membrane materials with superior properties for energy-efficient recycling, repurposing and purifying of water.

"We will be specifically seeking to understand and exploit the interaction of water and solutes with polymer chemistries to make new, highly efficient membranes," said Segalman. "While this center is focused on fundamental design rules, we anticipate having a major impact both in developing novel membranes and in training a new generation of scientists who bridge polymer and membrane science, chemical engineering and environmental engineering."

M-WET leaders say the center's vision and past contributed to its recent renewal.

"In its first four years, M-WET scientists worked across numerous disciplinary boundaries to address basic science challenges related to water-purification membranes that no one group or discipline could address alone," said Benny Freeman, M-WET director and the William J. (Bill) Murray, Jr. Endowed Chair of Engineering in the McKetta Department of Chemical Engineering at UT Austin.

Freeman added that M-WET produced a substantial body of impactful literature, launched the careers of many early-stage researchers, spawned a startup focused on novel lithium-extraction processes, and used advanced spectroscopy to probe new and fundamental molecular-level properties of membranes.

"Looking toward the future," he said, "we will build upon these successes, discovering fundamental design rules to prepare novel membranes, training the next generation of interdisciplinary scientists in this area, and positively impacting water and energy security for our future."

Established by the Department of Energy's (DOE's) Office of Science in 2009, EFRCs have produced more than ten thousand peer-reviewed scientific publications and

generated hundreds of inventions at various stages of the patent process.

UCSB electrical and computer engineering professor Jon Schuller is part of the Quantum Materials for Energy-Efficient Neuromorphic Computing (Q-MEEN-C) Research Center, which was also selected for a four-year extension by the DOE. Based at UC San Diego, the center seeks to identify, develop, and characterize quantum materials to enable energy-efficient neuromorphic computing, which would make it possible to solve problems in a way that replicates human brains. Chemical engineering professors Susannah Scott, Phillip Christopher and Michael Gordon, meanwhile, are collaborators in the University of Minnesota-led Center for Programmable Energy Catalysis (CPEC), which seeks to “transform how catalysts convert energy-rich molecules to enable a large-scale implementation of sustainable energy.”

About UC Santa Barbara

The University of California, Santa Barbara is a leading research institution that also provides a comprehensive liberal arts learning experience. Our academic community of faculty, students, and staff is characterized by a culture of interdisciplinary collaboration that is responsive to the needs of our multicultural and global society. All of this takes place within a living and learning environment like no other, as we draw inspiration from the beauty and resources of our extraordinary location at the edge of the Pacific Ocean.