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James Badham

A new aqueous battery research collaboration to advance clean energy

UC Santa Barbara materials faculty members Raphaële Clément and Ram Seshadri will work with colleagues across the U.S. in one of two U.S. Department of Energy (DOE) Energy Innovation Hub teams funded by a five-year, $125 million grant, “to seed and accelerate next-generation technologies beyond today’s generation of lithium (Li)-ion batteries,” the DOE stated.

The multi-institution teams, one led by Argonne National Laboratory in Illinois, and the other by Stanford University/SLAC, will develop scientific concepts and understanding with an eye to decarbonizing transportation and incorporating clean energy into the electricity grid.

Clément and Seshadri are part of the Aqueous Battery Consortium (ABC) led by Stanford University/SLAC and involving 31 co-principal investigators from 15 institutions in the United States and Canada. The ABC will focus on establishing the scientific foundation for large-scale development and deployment of aqueous batteries for long-duration grid storage technologies, prioritizing the use of Earth-abundant materials to mitigate supply-chain risks.

Rechargeable batteries, such as Li-ion and lead-acid batteries, have had tremendous impact on the nation's economy, but emerging battery technologies will need to be more energy-dense, safer and cheaper. They will also require the ability to be manufactured using a diverse array of inexpensive raw materials.

"The goal of the hub is to provide cheap, sustainable and safe electrical energy storage for the grid using water-based chemistries," said Clément. "A significant challenge to making this a reality is to develop a high-voltage battery in such a way as to prevent water electrolysis — the splitting of water molecules into oxygen and hydrogen gas — which causes the battery to fail. Our specific task within the large team is to use nuclear magnetic resonance spectroscopy (NMR), a technique akin to magnetic resonance imagery (MRI), to better understand and control the reactions taking place during charge and discharge and to identify ways to 'protect' the water molecules by changing the composition of the electrolytic solution. Achieving that would improve the energy density and long-term cycling performance of these aqueous batteries."

"We are excited to expand the portfolio of experimental tools that will be employed to help address the grand challenge of creating aqueous batteries suitable for grid-scale storage," said Seshadri. "We are particularly interested in the use of operando tools that can diagnose materials properties during the process of charging and discharging, for example, by carrying out studies in a scanning electron microscope, making use of the superb shared facilities that are so central to how we work at UCSB."

Among the multiple institutions participating in the two Energy Innovation Hubs are Historically Black Colleges and Universities and other Minority Serving Institutions. The projects provide an outstanding opportunity for workforce development in energy storage research and inclusive research involving diverse individuals from varied institutions.

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