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James Badham

Matthew Helgeson takes neutron scattering to the next level

Matthew Helgeson is good at shooting neutrons through things — so good, in fact, that he was recently named one of eleven fellows in the 2026 cohort of the Neutron Scattering Society of America (NSSA). The UC Santa Barbara chemical engineering professor was recognized for his “research and service to the field of neutron scattering, especially dealing with the thermodynamics and dynamics of soft materials,” and for innovations in that area. He will be formally inducted at the American Conference on Neutron Scattering, to be held this month in Detroit, Michigan.

“We at The Robert Mehrabian College of Engineering (COE) offer Matthew Helgeson warm congratulations on this important and very well-deserved mid-career honor from the Neutron Scattering Society of America,” said Umesh Mishra, dean of the COE at UCSB. “Through his research and the innovations in equipment developed in his lab, he has significantly expanded how neutron-scattering can be used to determine the structure and character of soft materials in both neutral states and when undergoing some kind of force. It is important work, and we are very proud of Matt's leadership in the field.”

"Matt Helgeson has made seminal contributions to the fundamental understanding associated with the structure and dynamics of soft materials, including polymers, colloidal systems and emulsions,” said Frank Bates, a UCSB Distinguished Visiting Professor and a regent at the University of Minnesota. “He has pioneered the use of

innovative rheological devices that can be operated in-situ while simultaneously acquiring neutron scattering data, complemented by the development of sophisticated analytical tools."

Helgeson previously received numerous awards that he describes as ‘young person’ awards, given to graduate students or young faculty members to recognize their potential and encourage them to develop their ideas.

“This one hits differently, since it recognizes the ability to execute on those ideas and make a sustained impact,” he said.

“It’s very rewarding to receive feedback from your peers in the community saying, ‘We value not only your ideas, but the contributions that have resulted from them.’ It’s definitely an honor.”

There are ample reasons to scatter neutrons, especially, in the case of Helgeson’s lab, when working on soft or biological materials made of organic molecules. “In many cases,” he said, “these materials are mechanically processed in ways that change their microstructure. Polymers stretch and orient, particles change their arrangement relative to each other, droplets deform, and biomolecular assemblies can break or combine in ways that can dramatically alter the properties and function of materials, ranging from pharmaceuticals and foods to high-tech polymers for energy efficiency and photovoltaics.”

Scattering, which measures the patterns formed when beams of particles or radiation bounce off atoms and molecules, provides information that can be used to measure those processes – but only if the material remains intact while in the beam. Helgeson explained that X-ray beams produced at synchrotrons [which Helgeson’s group also uses] have high energies and can interact with electrons to cause molecules to undergo chemical reactions that cause decomposition of the material. Neutrons, however, are lower-energy and interact only with the nucleus and nothing else, allowing them to interact with the material passively, without altering its chemistry.

Because they interact only with the nucleus, neutrons also penetrate equipment more easily. Helgeson’s group often works with in situ and in operando measurements, placing complex processing devices, such as a microfluidic cell or a

high-pressure capillary, into the neutron beam. Thanks to their “non-destructive nature” he said, “the neutrons transmit right through metal, plastic or other materials without reacting with them. That allows us to use the neutron beam to actually see the scattering from materials deep inside a piece of equipment.”

In particular, Helgeson and his group develop flow devices that are meant to emulate real manufacturing processing flows, using scattering to track how materials transform in a flow to produce desirable structures and properties.

Thanks to the tools and techniques developed in his lab, said Helgeson, "We can measure structural transformations that are occurring during flow and that can't be resolved using any other method.

"Being able to resolve structures as they form and change in these flows is allowing us to provide more useful information and guidelines for designing new materials and advanced manufacturing processes."

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