

Junior researchers showing world the way to advanced nuclear fuel design

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Dr. Melissa Teague, an INL materials engineer, pioneered advanced microscopy on irradiated nuclear fuel.

Two early-career researchers at DOE's Idaho National Laboratory are earning international attention for their groundbreaking work. They're getting a long-sought look into the 3-D microstructure of irradiated nuclear fuel, and then feeding that data into cutting-edge fuel behavior models. Their work will make the design and testing of even safer nuclear fuels more informed and efficient.

The distinctive collaboration stemmed from a fertile environment at the Department of Energy's lead laboratory for nuclear energy research and development. That environment enabled an engineer and a computational scientist to easily work hand-in-hand toward a common goal. Their collaboration is noteworthy "because computer people and

experimental scientists don't tend to interact much," said Michael Tonks.

Tonks is an INL computational materials scientist who built a model of nuclear fuel microstructure. Melissa Teague is an INL materials engineer doing first-of-a-kind microscopic studies on nuclear fuel. Her work is helping refine his models and capturing attention from international scientists.

"We've had people from all over the world coming and asking, 'How do you do this?'" she said.

The intrigue centers around microscale glimpses of irradiated fuel, which researchers have long pondered but never seen in 3-D. Such information will lead to a more fundamental understanding of how irradiation affects nuclear fuel safety and performance.

INL has singular capabilities that enabled Teague to perform a common microanalysis technique on an uncommon material: irradiated nuclear fuel.

Electron Backscatter Diffraction (EBSD) shoots electrons at the surface of a material sample. Electrons that encounter atoms in the material scatter to form patterns on a detector screen. Skilled crystallographers interpret the patterns to reconstruct the atomic structure and glean insights.

"These were the first 3-D characterizations of irradiated fuel reported anywhere in the world," Teague said. "Before, no one really knew what it looked like in 3-D."

Around the time Teague was pioneering advanced microscopy on irradiated fuel, Tonks was developing a new model to simulate how irradiation changes [nuclear fuel](#) on the microscopic level. Early versions

of his MARMOT code incorporated limited published data about the texture of irradiated fuel, but made many assumptions.

Tonks started looking for research data that could fill in some of those gaps. He quickly learned of the work being done by Teague, whose desk he could walk to in less than a minute. The two applied for Laboratory Directed Research and Development funding and recruited an EBSD reconstruction expert.

The data they collected provided several important insights, such as revealing how solid particles form, grow and migrate along crystal boundaries inside the fuel during irradiation. It enabled modelers to replace assumptions in the code with real-world information, and also allows simulation outcomes to be compared with real-world data to ensure the model yields accurate predictions.

Provided by US Department of Energy

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