Mesoscale Priority Research Direction

Mesoscale Structural Changes from Atomic Scale Radiation Damage

Opportunity

-Radiation damage at the mesoscale and atomic scales has been extensively studied; however, it is difficult to experimentally determine how atomic scale events lead to mesoscale defect structures and ultimately macroscopic changes in material properties.

-New advanced experimental techniques can now begin to address these issues.

Meso Challenge

-Radiation damage is difficult to study and understand experimentally at its two characteristic length scales – atomic and mesoscale.

-Predicting macroscopic effects requires better understanding the link between atomic and mesoscale effects, from both experiment and theory.

Approach

-Experimental atomic scale and mesoscale knowledge coupled with theory to gain a complete understanding radiation damage effects in materials.

-Differentiate length scale phenomena in materials classes (e.g., compare metals to oxides)

-Utilize and develop emerging techniques (TEM, STXM, SAXS, PDF, and tomography)

Impact

-Develop rules and principles for identification, design, development, and synthesis of new radiation-resistant materials (e.g., self-healing, nanocomposites, amorphous materials) for application in extreme environments.

-Predictive understanding of materials lifetimes under extreme conditions

References: Basic Research Needs for Nuclear Energy, U.S. DOE (2006).

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