The Stored Energy Fingerprints of Radiation Damage

Abstract: The current unit of radiation damage, the displacements per atom (DPA), is a calculated exposure parameter that does not directly yield the defect populations responsible for irradiation-induced material properties. Were an 'a posteriori' measure of radiation damage to exist, it would help to answer numerous, lingering questions about the nature and effects of irradiation. We propose the use of stored energy fingerprints as this new, more descriptive unit of radiation damage. They can be measured after irradiation, and they are hypothesized to yield information about the resulting defect populations. We present a combination of time-accelerated molecular dynamics (MD) simulations and nanoscale differential scanning calorimetry (nanoDSC) measurements, which together paint a more measurable picture of the multiscale nature of radiation damage. Potential applications range from settling the question of neutron/ion irradiation equivalency, to quantitatively understanding dose rate effects, to verification of historical uranium enrichment.