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Defect Physics of Structural Materials under Extreme Conditions

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"Crystals are like people: it is the defects in them that make them interesting." This oft quoted quip of Sir Charles Frank speaks to the heart of structural alloys. Indeed, the extent to which the collective effects of defects can be manipulated and controlled determines the combination of structural materials properties that underpins modern energy and transportation technologies. Furthermore, the bounds on performance of current structural materials generally result from limitations in our understanding of defects, rather than insurmountable physical principles. I will describe research in the *Center for Defect Physics*[1] in three thrust areas:

- *Fundamental Physics of Defect Formation and Evolution during Irradiation*
- *Fundamental Physics of Defect Interactions during Deformation*
- *Quantum Theory of Defects and Interactions*

Specifically, I will described ongoing and planned research that is based on the realization that we are on the verge of a new era of "quantitative measurement" and "direct quantum simulation" of defects and their interactions enabled by major national facilities (APS, SNS, and LCLS) and the PFlop/s computing (NCCS and NERSC).

[1]The CDP is an Energy Frontier Research Center (EFRC), DOE Office of Basic Energy Sciences.