Understanding Radiation Induced Embrittlement of Steel

Scientific Achievement
Identifies, for the first time, the crystal structure of the nanoprecipitates that cause embrittlement and degradation of steel in nuclear reactor pressure vessels

Significance and Impact
Improved predictions of material performance for the life extension of nuclear reactors. Maintaining the existing fleet of commercial reactors is essential to meeting carbon reduction goals.

Research Details
- Nanoprecipitates form due to radiation damage in reactor vessel steels. The process is a complex function of metallurgical variables (microstructure, alloying elements) and irradiation conditions (flux, fluence, temperature)
- Robot at a NSLS-II synchrotron beamline was used to collect X-ray data on hundreds of irradiated (radioactive) steels
- Data are used to inform thermodynamic modeling of nanoprecipitate formation and stability

(a) Robot installed at NSLS-II (b) small-angle and (c) wide-angle X-ray scattering profiles from an irradiated RPV sample. The inset of (b) shows the shape of a precipitate from atom probe tomography. The phase components are overlaid in (c) for reference

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