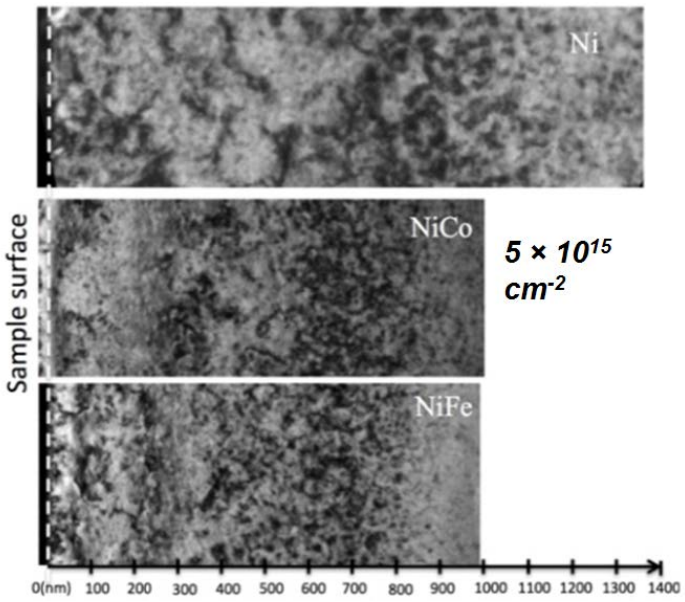
Compositional Complexity Effectively Modifies Defect Migration Barriers

Compared to pure nickel, tuning chemical composition in binary alloys has altered migration barriers of defects, and significantly affected defect dynamics under ion irradiation. This finding indicates that controlling the production and migration of defects to a more confined region can enhance the defect recombination rate, and lead to a higher radiation tolerance in the alloys.



Cross-sectional transmission electron microscopy images of Ni, NiCo and NiFe showing irradiation-induced damage is much deeper in Ni, as compared with the two binaries.

In ion-irradiated single crystalline nickel and Ni binary alloys, cross-sectional transmission electron microscopy images show that the damage range beneath the irradiated surface increases with increasing ion fluence, and defect clusters migrate faster in pure Ni than in the alloys, as shown in the figure. The results from high-resolution transmission electron microscopy images and molecular dynamic simulations show that the vacancies condensed into stacking fault tetrahedra and the interstitials condensed into dislocation loops in nickel and Ni alloys.

[1] Chenyang Lu, Ke Jin, Laurent K. Béland, Feifei Zhang, Taini Yang, Liang Qiao, Yanwen Zhang, Hongbin Bei, Hans M. Christen, Roger E. Stoller and Lumin Wang, "Direct Observation of Defect Range and Evolution in Ion-Irradiated Single Crystalline Ni and Ni Binary Alloys," *Sci. Rep.* **6**, 19994; doi: 10.1038/srep19994 (2016).