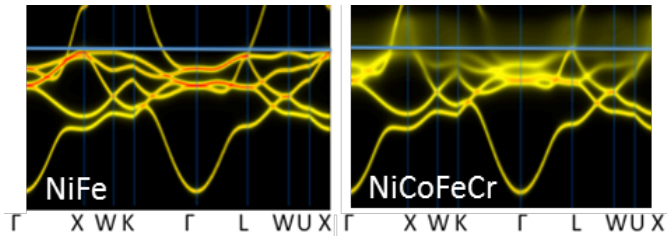
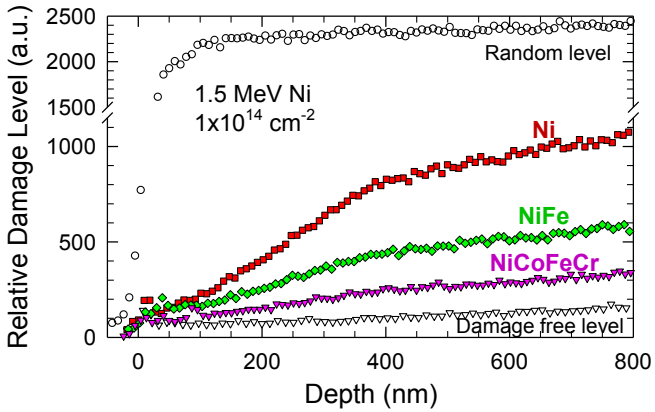
Chemical Complexity Controls Energy Dissipation and Defect Evolution





(Top) Increased majority spin electronic structure broadening of NiCoFeCr relative to NiFe in equiatomic solid-solution alloys with increasing complexity. Note the lack of disorder broadening in NiFe. (Bottom) Reduced defect production as alloy disorder increases.

Scientific Achievement

Experiments and theory demonstrate that increasing alloy chemical complexity profoundly reduces thermal and electronic conductivity, as well as suppresses defect production and damage accumulation in complex alloys.

Significance and Impact

Exploiting extreme chemical disorder of equiatomic multi-component solid-solution alloys provides a new design paradigm for radiation-tolerant materials for energy.

Research Details

- Ion channeling experiments on ion-irradiated Ni, NiCo, NiFe and NiCoFeCr show a significant reduction of damage as alloy complexity is increased.
- A*b initio* electronic structure calculations and transport measurements reveal orders of magnitude reductions in electronic and thermal conductivities.
- The confined energy dissipation modifies irradiation-induced atomic processes and increases annealing of the defects.

Y. Zhang, G. M. Stocks, K. Jin, C. Lu, H. Bei, B. C. Sales, L. Wang, L. K. Beland, R. E. Stoller, G. D. Samolyuk, M. Caro, A. Caro, and W. J. Weber, "Influence of chemical disorder on energy dissipation and defect evolution in nickel and Ni-based concentrated solid-solution alloys," *Nature Commun.* ***6***, 8736 (2015). DOI: 10.1038/ncomms9736.

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