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## ABSTRACT:

### Atomic Scale Diffusion in Full View

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While diffusion has been studied for a long time, the phenomenon is still not fully understood yet, especially when it comes to diffusion at defects and interfaces. Grain boundaries for instance may enhance diffusion by orders of magnitude, however they can also act as sinks and pinning points for diffusive motion. Using advanced transmission electron microscopy (TEM) techniques it is now possible to gain novel insights into diffusion phenomena down to the atomic scale.

In this work we demonstrate interdiffusion using nanoscale Cu-Au diffusion couples in the form of core-shell nanowires. The interdiffusion at different temperatures is tracked using energy dispersive x-ray spectroscopy. This allows us to directly study the impact of disorder-order transitions and test the efficacy of ultrathin diffusion barriers.

Furthermore, we demonstrate atomic scale volume diffusion of single solute atoms in a metal matrix. A combination of high Z impurity with a low Z matrix element enables us to see individual solute atoms in high resolution. In situ heating allows us to stimulate these impurities to perform vacancy driven random walks in the host lattice. By following the movement of impurity atoms at different temperatures we are able to extract diffusion coefficients and activation energies. The direct imaging also allows us to differentiate between volume and grain boundary diffusion. Finally we study the impact of solute atoms on grain boundary dynamics.