(3 × 3) scanning tiles. The continuous scanning allows entire imaging in 7 minutes (~46 seconds for each tile).

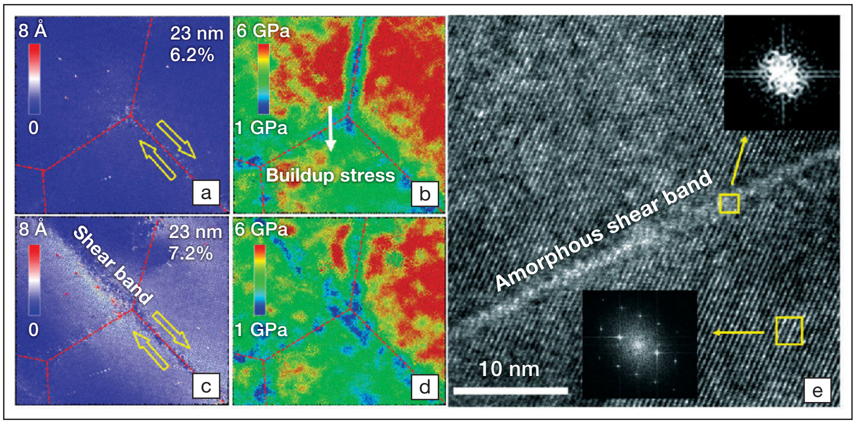
The fast sampling opens the possibility of *in situ* and *in operando* imaging. Alternatively, three-dimensional ptychography also provides an interesting avenue. Deng says that the Velociprobe is also a proof-of-concept for technologies and techniques to be incorporated into an upgrade of the instruments used at the Advanced Photon Source, a synchrotron facility at the Argonne National Laboratory, such as the PtychoProbe. Orders-of-magnitude improvement in the x-ray flux from the soon-to-be upgraded synchrotron is anticipated.

Jeff Gelb from Sigray, Inc., an industrial developer of laboratory x-ray systems, says that coherent diffraction imaging techniques, such as ptychography, are the future of synchrotron x-ray imaging. Gelb, who was not involved in this study, says the lensless approaches represent a major breakthrough in overcoming the limits imposed by x-ray optics, and that researchers have only begun to scratch the surface of what is possible with coherent radiation.

Aashutosh Mistry

Intermetallic samarium cobalt deforms without dislocation activity

The bending of metals is mediated by dislocations. Half-planes of atoms shift around, interacting primarily with grain boundaries, but also with other microstructural defects. As deformation continues, these interactions pile up and frustrate dislocation motion, which both increases the material's strength and reduces its ductility. The Hall–Petch relation, an empirical rule introduced in the 1950s, expresses this interplay between material strength, dislocation motion, and grain size. An international group of researchers has identified deformation that does not involve dislocations. This gives rise to an extended regime of inverse Hall–Petch behavior.



Amorphous shear bands. (a–d) Displacements of atoms relative to their positions in the unstrained samples and distribution of von Mises stress in the same area around a triple junction for grain size of 23 nm under the strain of 6.2% (a, b), and the strain of 7.2% (c, d). (e) High-resolution transmission electron micrograph of a selected shear band and its surrounding regions. Fast Fourier transform patterns are shown in the insets. Scale bar, 10 nm. Credit: Hubin Luo and Hongliang Zhang.

In a recent issue of *Nature Communications* (doi:10.1038/s41467-019-11505-1), Izabela Szlufarska and Hubin Luo of the University of Wisconsin–Madison and their colleagues discussed the unusual deformation mechanism of samarium cobalt. SmCo^5 is a hard magnetic intermetallic with hexagonal—but not close-packed—symmetry. "The initial goal of this project was to understand how we can control the grain size and texture of this material through plastic deformation," says Szlufarska. In particular, the researchers were interested in controlling the material's magnetic behavior through its microstructure, so Luo carried out molecular dynamics simulations to determine the active slip systems. However, no slip system had a low enough activation energy. Instead, the model predicted direct amorphization along shear planes. "Our first reaction was to question these predictions," Szlufarska says. "We spent a significant amount of time testing [them]."

Among those experiments were tensile tests. The researchers varied grain sizes across samples to examine the Hall–Petch behavior of SmCo^5. Inverse Hall–Petch behavior, where strength increases with grain size, had been predicted and observed in previous work, but such behavior was found only with grain sizes below about 15 nm. In SmCo^5, Szlufarska and her team observed strengthening over grain sizes from 5 nm to 65 nm. This led to deeper investigations, and the eventual discovery of direct amorphization in noncrystallographic planes.

While plastic deformation is typically accompanied by dislocation motion, in SmCo^5, deformation is initially mediated by grain-boundary sliding, before the stress buildup at a triple junction gives way to the nucleation of 2-nm thick amorphous shear bands. As a deformation mechanism, these amorphous shear bands can accommodate very large strains—up to 20% without fracture in micropillar samples of SmCo^5.

"We have discovered a new class of mechanisms underlying plasticity in materials and our next step is to find other materials that deform in this way," Szlufarska says. To help them accomplish that, the researchers need to identify exactly why and how direct amorphization occurs. If direct amorphization along shear bands can be controlled independently of dislocation-based deformation mechanisms, Szlufarska thinks it might be possible to design materials with heretofore anti-correlated properties such as high strength and large ductility.

Antonio Cruz