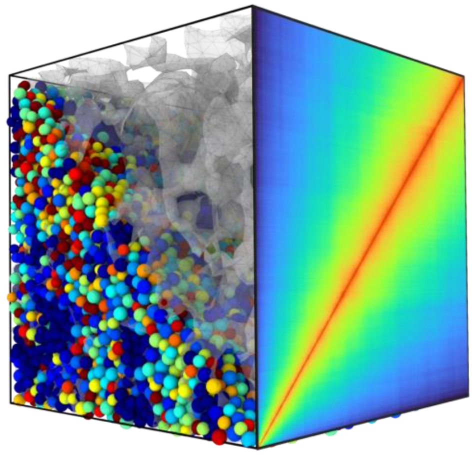
SCIENCE AT THE ADVANCED PHOTON SOURCE

METALLIC GLASS KEEPS ITS COOL UNDER PRESSURE THROUGH STRESS-INDUCED MICROSCOPIC FLOW

Dropped your phone recently? One possible reason it didn't break is that it's made from metallic glass. Metallic glasses are highly disordered at the atomic level but are macroscopically strong and resistant to wear and corrosion. Because of their unique chemical structure, however, they deform easily under external stress.

Researchers using the APS have investigated how metallic glass responds to external stress to better understand its pertinent physical changes as well as determine whether stress-induced deformation - like a ding on a dropped cell phone - could be reversible. To observe the behavior of the zirconium-based metallic glass under stress and test the two-component hypothesis, the team took X-ray photon correlation spectroscopy using at the 8-ID-E beam line at the APS. (This technique is greatly enhanced at the upgraded APS, particularly at the 8-ID beamlines.)

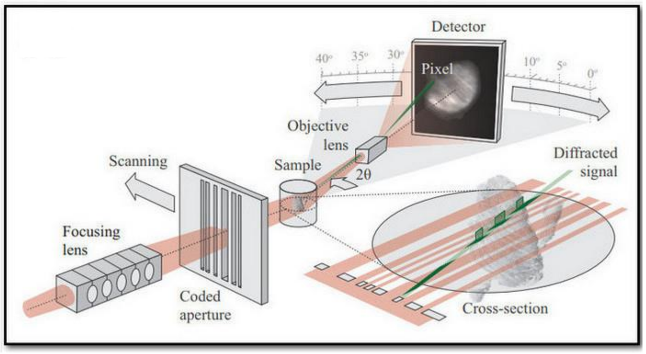
From the changes to the relaxation times under external stress, the team concluded that the two-component hypothesis for zirconium-based metallic glass is accurate. They further concluded that the elastic, stiff, and stable component is responsible for the high macroscopic yield strength of the metallic glass, while the plastic component is responsible for the highly-accelerated transport of atoms and the decrease in relaxation times. Based on the extremely low stress required to induce transport, the team concluded that microscopic structural deformation within a zirconium-based metallic glass should be recoverable, which is good news for all of us with dropped phones.



B. Reichers, et. Al., "Metallic glasses: Elastically stiff yet flowing at any stress," *Mat Today* **82** 92-98 (2025)

Three-dimensional model representation of the metallic glass, where half the structure is visualized atom per atom, and the other half shows in gray the elastic network. Atoms colored differently than blue are indicating highly mobile environments. The right-hand cube face visualizes experimental X-ray photon correlation spectroscopy data that describes the materials transport of atoms. *Image courtesy Federal Institute of Materials Research and Testing.*

PRECISE 3D IMAGING USING DARK-FIELD X-RAY MICROSCOPY UNDER A STRUCTURED ILLUMINATION



D. Gursoy, et. Al. "Dark-field X-ray microscopy with structured illumination for three-dimensional imaging," *Commun Phys* **8** 34 (2025)

Experimental setup for 3D imaging using DFXM with coded aperture. The X-ray beam is first focused onto the coded aperture. Large arrow indicates aperture's movement. The structured X-ray beam diffracts from the sample (inset with green highlights) and is magnified onto the 2D detector. 3D images are subsequently assembled from the 2D detector data.

Synchrotron X-ray tomography provides scientists a powerful tool for obtaining three-dimensional, high-resolution images of ordered materials. But successfully performing synchrotron tomography typically involves a complex and tedious process.

In pursuit of a more efficient and reliable approach, a research team recently combined dark-field X-ray microscopy (DFXM) with a technique called structured illumination. This combination allows the sample and sample environment to remain stationary throughout the imaging process, resulting in quicker setup times, faster data collection, and a more robust path to achieving high-quality 3D images. The new imaging technique was performed on a pnictide superconductor at beamline 6-ID-C of the APS.

The experimental results demonstrate the practicality of the less complex, yet still powerful, modified DFXM technique, opening up a new approach for scientists to obtain accurate 3D imaging at sub-micrometer resolutions. More information is on the APS website.

Read more about the upgraded APS at aps.anl.gov

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Advanced Photon Source
Bldg. 401
Argonne National Laboratory
9700 S. Cass Ave.
Lemont, IL, 60439

www.aps.anl.gov
www.aps.anl.gov/APS-Upgrade
apsinfo@aps.anl.gov

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