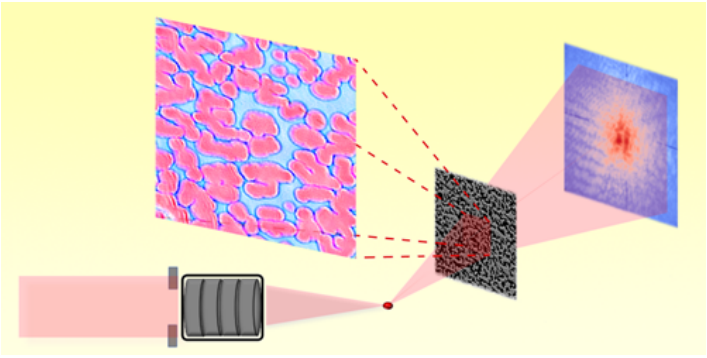
Measuring Large Strains in a Nanocrystal

Researchers have demonstrated a technique for measuring lattice distortions that are too big for conventional methods to handle.

By **Marric Stephens**

A crystalline nanomaterial's functional properties are closely linked to its lattice strain. Measurements of this strain can be made via its effect on the diffraction pattern obtained when a coherent x-ray beam is sent through the sample—a technique called Bragg coherent diffraction imaging (BCDI). Unfortunately, BCDI becomes unreliable for large strains. Now Jiangtao Zhao of the European Synchrotron Radiation Facility in France and colleagues have demonstrated a modified technique—Bragg coherent modulation imaging (BCMI)—that succeeds even when the strain is too large for conventional BCDI [**1**].

In BCDI, hundreds of diffraction patterns are obtained sequentially as the nanocrystal is rotated in tiny angular increments. Lattice strain shifts the phase of the transmitted x rays, altering the diffraction pattern. An iterative algorithm combines these patterns—each of which constitutes a 2D slice through the sample—to yield a representation of the lattice strain in 3D. But if the phase shifts are greater than 2π, equivalent to a single lattice-spacing shift relative to a perfect lattice, the strain-reconstruction problem has many mathematically valid solutions, and the algorithm can fail to find the correct one.



Credit: J. Zhao *et al* [**1**]; adapted by APS

BCMI breaks this ambiguity by inserting a patterned wave-front modulator a few millimeters down beam of the nanocrystal. The modulator imprints a known, spatially varying phase shift on the diffracted beam, introducing additional interference that excludes the spurious solutions. Zhao and colleagues applied their method to platinum nanocrystals, showing that BCMI reliably produces unique valid reconstructions for both weakly and strongly strained samples. They now intend to improve the technique's user friendliness so that it can be used more widely for the strain engineering of nanomaterials.

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REFERENCES

1. J. Zhao *et al.*, "Bragg coherent modulation imaging of highly strained nanocrystals," **Phys. Rev. Lett. 135, 256101 (2025).**