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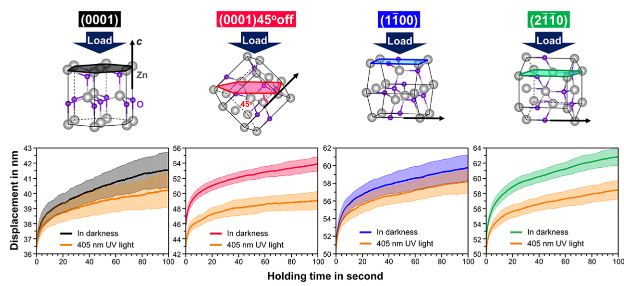
Zinc oxide, a semiconductor used in power electronics, indents less in light, but the depth depends on its surface orientation.



Light can affect the mechanical deformation -- and thus performance -- of some semiconductors, including compound, wide-bandgap semiconductors that have promising applications in power electronics. This has not yet been systematically studied, especially at small scales relevant to electronics, however, and few studies have examined how light affects deformation in materials demonstrating anisotropy, or directionally dependent characteristics.

Oguri et al. examined how much single-crystal zinc oxide, an anisotropic, wide-bandgap semiconductor, indented at the nanoscale. They conducted these nanoindentation tests on zinc oxide crystals in four surface orientations and in both light and darkness. In all orientations, the crystals exhibited a smaller indentation depth in light, confirming that light suppresses deformation.

However, the degree of suppression varied depending on the surface orientation of the zinc oxide. This anisotropy suggests that indentation deformation under light illumination is modulated by features of the crystal that differ depending on its orientation. These features include activated slip systems, a route of deformation, and line defects, one of the main carriers for plasticity.

“Understanding the impact of anisotropy on light illumination effects is crucial to further advancing the promising approach of controlling material behavior by light illumination, as well as to paving the road for designing prospective functional devices,” said author Xufei Fang.

This methodology, which involves nanoindentation tests under controlled light illumination, could also be extended to experiments with other semiconductors.

“The established experimental protocol can serve as a fast-probing tool for many other semiconducting materials,” said author Atsutomo Nakamura.

Next, the authors plan to characterize the dislocation structures in zinc oxide at the atomic scale through transmission electron microscopy.

Source: “Photoplastic anisotropy in nanoindentation of wurtzite ZnO single crystals,” by Hiroto Oguri, Yan Li, Xufei Fang, and Atsutomo Nakamura, *Applied Physics Letters* (2025). The article can be accessed at https://doi.org/10.1063/5.0248543.