Mechanics-based Tailoring of Room-temperature Dislocations in Ceramics

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Abstract

Dislocations are one-dimensional or line defects that carry plasticity in crystalline solids. In the conventional picture, ceramics are considered brittle and exhibit little or no plasticity at room temperature. However, recent research on dislocations in ceramics suggests that dislocations may have been much under-appreciated. Demonstrated promising proofs-of-concept for dislocation-tuned functional properties suggest that dislocations may hold great technological potential in advanced ceramics (1). As the prerequisite to harvest dislocation-tuned properties, engineering dislocations into ceramics without brittle fracture has thus become a pressing bottleneck. To tackle this challenge, we adopt the mechanics-based approach to separately examine the dislocation behavior including dislocation nucleation, multiplication, and motion, enabling us to tailor dislocations in ceramic oxides such as SrTiO3 at room temperature (2). We can now achieve a dislocation density ranging from _˜10ˆ11/mˆ2 to _˜10ˆ15/mˆ2 with a plastic zone size of up to milli-/centimetres using a mechanical deformation toolbox, which further equips us to extend the material toolbox by discovering and reporting more room-temperature plastically deformable ceramics (3). These combined deformation and material toolboxes offer a new platform for studying the dislocation-tuned functional properties and the mechanical properties (such as plasticity, toughness, and damage tolerance) over a wide range of length scales.

References:

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