Room-temperature Dislocations in Oxides: Understanding, Engineering, and Application

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Abstract

In light of the increasing interest in dislocation-tuned functional properties of oxides [1, 2], the dislocation-based mechanical behaviour, for instance, dislocation plasticity and potentially the crack formation induced by dislocation pileup is also drawing increasing attention. Due to the brittle nature of oxides, it remains a great challenge to introduce dislocations with controlled structures into oxides without forming cracks. Understanding the dislocation-based mechanics in oxides plays a critical role in tackling such a challenge as well as assessing the mechanical and functional reliability of future dislocation-based devices. In this talk, I will focus on room-temperature dislocation mechanics in oxides and present a feasible roadmap to first understand the dislocation behaviour (dislocation nucleation, multiplication, and motion), then to actively tailor the dislocation-mediated plasticity in a model oxide ($SrTiO_3$) by combining nanoindentation [3], micro-pillar compression, bulk indentation, and scratching tests across the length scales. Several protocols and concepts for experimental design such as *defect chemistry engineering* [4, 5], *cyclic indentation tests [6], surface dislocation engineering* will be demonstrated to tailor the dislocation plasticity and, more strikingly, the damage tolerance as well as the fracture toughness of oxide crystals. The proof-of-concepts on $SrTiO_3$ will be further validated on other oxides to showcase the general applicability of our findings. In addition to mechanics, I will also showcase some examples of dislocation-enhanced functional properties based on the dislocation engineering approaches.

References

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