

Vacancy-Driven Tensile Ductility in Covalent Boron Carbide at Room Temperature

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Achieving tensile ductility in strong covalent materials is critical yet challenging, primarily due to their inherent brittle nature and strong directional bonds. In this talk, we discuss our recent discovery of remarkable tensile ductility (~26.8%) in boron carbide (B_4C), a covalent material traditionally known for its brittleness. Using advanced electron ptychography and in situ high-resolution transmission electron microscopy, we identified unique structural features—specifically, carbon-vacancy-carbon chains associated with boron vacancies. Our atomic-scale simulations confirm that localized amorphization induced by the formation of carbon-carbon bonds at these vacancy sites enables significant plastic deformation. These findings not only provide deep insights into the underlying mechanisms governing ductility in covalent solids but also present a promising strategy to enhance mechanical performance in other strong covalent materials.

Reference:

- 1) P. Li, et al. Unveiling high ductility in boron carbide crystal at room temperature. *Science Advances* 11 (15), eadr4648 (2025)