EML WEBINAR

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ROBERT RITCHIE

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DAMAGE-TOLERANCE IN ENGINEERING ANDBIOLOGICAL MATERIALS

The ability of a material to undergo limited deformation is a critical aspect of conferring toughness as this feature enables the local dissipation of high stresses which would otherwise cause fracture. The mechanisms of such deformation can be widely diverse. Although plasticity from dislocation motion in crystalline materials is most documented, inelastic deformation can also occur via in situ phase transformations in certain metals and ceramics, sliding of mineralized collagen fibrils in tooth dentin and bone, rotation of such fibrils in skin, frictional motion between mineral “platelets” in seashells, and even by mechanisms that also lead to fracture such as shear banding in glasses and microcracking in geological materials and bone. Resistance to fracture (toughness) is thus a compromise - a combination of two, often mutually exclusive, properties of strength and deformability. It can also be considered as a mutual competition between intrinsic damage processes that operate ahead of the tip of a crack to promote its advance and extrinsic crack-tip shielding mechanisms that act mostly behind the crack tip to locally diminish crack-tip stresses and strains. Here we examine the interplay between strength and ductility and between intrinsic and extrinsic mechanisms in developing toughness in a range of biological and natural materials, including bone, skin and fish scales, and in new advanced metallic alloys, notably high-entropy alloys.

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Discussion leader: Professor Nanshu Lu, University of Texas at Austin.

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