Researchers unveil spatiotemporal sequence of shear band in amorphous solids

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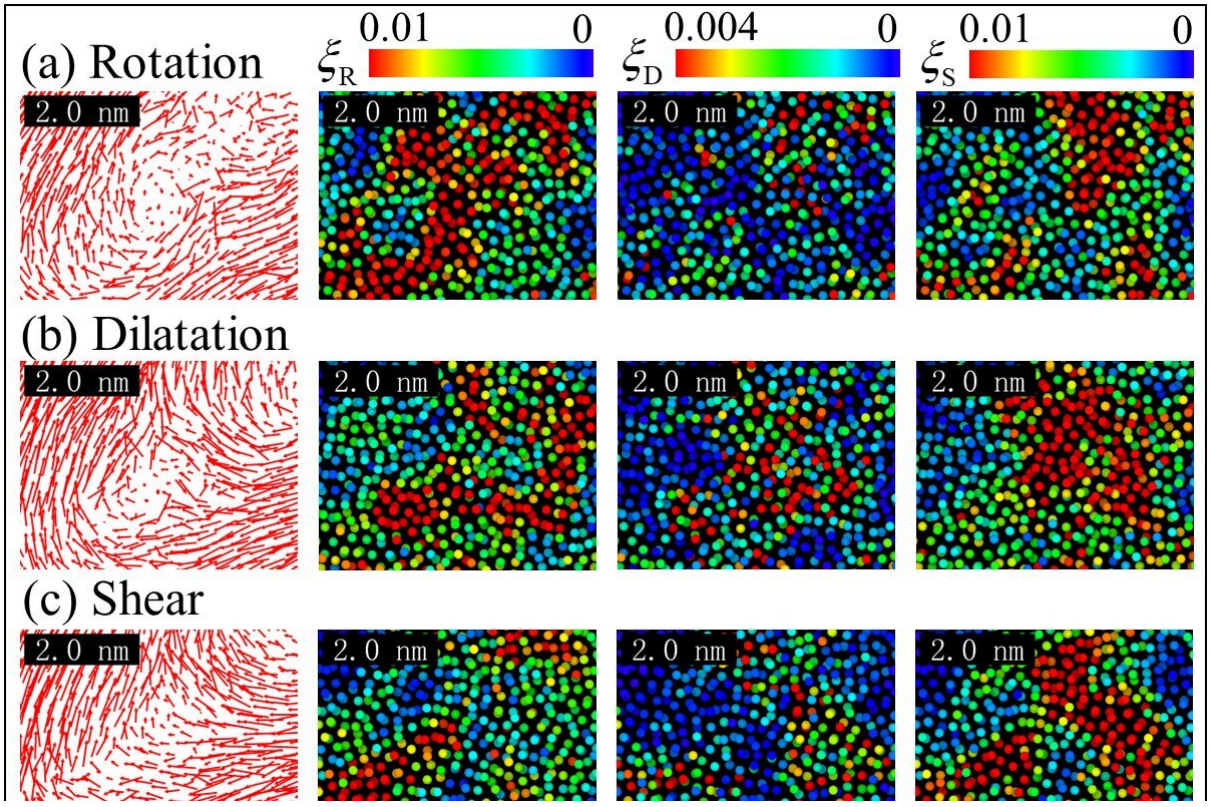

Quantitative characterizations of shear, dilatation and rotation motions in shear bands via the TTG model. Credit: IMCAS

The precise understanding of shear banding emergence in amorphous solids is still a mystery, due to the intrinsic entangling of three

elementary local atomic motions: shear, dilatation and rotation.

Recently, researchers from the Institute of Mechanics of the Chinese Academy of Sciences (IMCAS) have unveiled the spatiotemporal sequence of shear band in amorphous solids through decoupling and quantitatively characterizing the highly entangled shear, dilatation and rotation flow units.

The results were published in *Physical Review Research*.

The researchers proposed a new theoretical protocol, namely two-term gradient (TTG) model, which covers both affine and non-affine components of deformation to demonstrate the plastic behavior in disordered materials.

This combination gives rise to a much more comprehensive and more effective description of local deformation field beyond the conventional, pure affine or non-affine model.

Based on this theoretical framework, the researchers decoded the highly entangled shear, dilatation, and rotation events. Thus, with the unprecedented spatial and temporal resolution, the plastic behavior could be demonstrated comprehensively as the operative manipulation of newly defined shear-dominated zones (SDZ), dilatation-dominated zones (DDZ) and rotation-dominated zones (RDZ).

Following this three-unit atomistic demonstration, the intuitive physical picture from initially synchronous motion to the onset of localized shear band is unveiled, manifesting as the percolating process of localized plastic regions with critical power-law scaling nature akin to classical percolating theory.

These findings provide insights into the understanding of plastic

behavior in disordered materials.

More information: Zeng-Yu Yang et al, Hidden spatiotemporal sequence in transition to shear band in amorphous solids, *Physical Review Research* (2022). DOI: 10.1103/PhysRevResearch.4.023220

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