Ripplocations: A universal deformation mechanism in layered solids

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Ripplocations, a unique crystallographic defect in layered materials, have garnered significant interest due to their role as topological solitons, enabling the efficient transport of mass and energy, as well as mediating plastic deformation. This study, based on atomistic simulations of graphite and instrumented cylindrical thin steel, and Al sheets, reveals that confined buckling leads to the nucleation of multiple ripplocation boundaries, which propagate rapidly upon unloading, dissipating significant frictional energy. The understanding of ripplocation nucleation, self-assembly, and propagation is crucial for comprehending the deformation of various layered solids. Furthermore, in graphene, molecular dynamics simulations have demonstrated that ripplocations are attracted to each other and can spontaneously aggregate on multiple layers. Additionally, ripplocations in multilayer graphene have been characterized as topological defects that allow atomic layers to slide relative to each other without breaking in-plane bonds. Moreover, the dynamics of surface graphene ripplocations have been shown to be robust solitary waves that propagate with minimal energy radiation. The findings emphasize the applicability of the same physics at the atomic-layer scale of crystalline solids, shedding light on a fundamental aspect of layered materials behavior.

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