Strengthening metal nanolaminates under shock compression through graphene interface with strong/weak duality

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Abstract

We use molecular dynamics method to study the strengthening effect of graphene-metal nanolayered composites under shock loading. A paradox to strengthen the composites under shock loading is that the interfaces should be weak and strong simultaneously. On one hand, weak interfaces can weaken the shock wave due to the high shock wave resistance, while the interfaces will be destroyed when the shock wave propagates past them (e.g., Kurdjumov–Sachs interface). On the other hand, strong interfaces can constrain the propagation of dislocations and heal the materials, while the shock wave with high frequencies can coherently propagate past them. Our results reveal that the graphene interfaces have the advantages of both strong and weak interfacial features simultaneously, which solves this paradox. The graphene interfaces can weaken the shock wave, impede dislocations and melting of materials, and heal the dislocations of material after shock. The elastic recovery due to graphene interfacial constraints plays an important role in the strengthening effect, and the shock strength can be enhanced by decreasing the interlayer distance. This dual-effect interface should lead to an improved fundamental understanding on the dynamic mechanism of composites with interfacial structures.

Keywords: Graphene composite, Interface, Molecular dynamics, Metal nanolaminates