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Collision-Induced Adhesion Behavior and Mechanism for Metal Particle and Graphene

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ABSTRACT

Micro- and nano-scale collisions are widely involved in molecular movement, drug delivery, the actuation of micro-nano devices, etc. They often exhibit extraordinary behaviour relative to the common macroscopic collisions. A deep understanding on the scale reduction-induced novel collision phenomenon and the related mechanism is rather crucial. In this work, the comprehensive impact behaviour of metal projectiles on graphene is investigated on the basis of molecular dynamics simulations. It is found that besides the common penetration and rebound behaviours, the impacting metal projectile can also be captured by the ultrasoft two-dimensional materials, i.e., the adhesion behaviour. This abnormal behaviour is mainly ascribed to the weak rebounded kinetic energy relative to the interactions between the impacting objects. Moreover, for graphene with finite size, the reflected cone wave from the boundary may provide the additional energy for the projectile to escape the binding, i.e., the adhesion-rebound behaviour. The phase diagrams, describing the impacting behaviours with the influences of projectile stiffness, impact velocity, graphene size, projectile size and projectile density, are presented. This work provides an insight into the multiscale collision phenomena and an instructive strategy for the design of transfer printing, collision protection, etc.

KEYWORDS

Collision; impact behaviour; adhesion; van der Waals forces; graphene; molecular dynamics simulation

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