Classical molecular dynamics simulations of hypervelocity nanoparticle impacts on tungsten

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The presence of dust in the scrape-off layer (SOL) close to the chamber walls is an important issue for the development of fusion reactors [1,2]. Hypervelocity dust particles can be particularly harmful if they collide with tokamak material surfaces. Therefore, controlling plasma-wall interactions is critical to achieve high performance in present day tokamaks. Tungsten (W) is the main candidate as plasma facing components for fusion reactor and will be exclusively used in the ITER divertor [1]. The presence of high velocity impacts has been reported in several studies, with velocities being around 500 m/s to a few km/s [3,4].

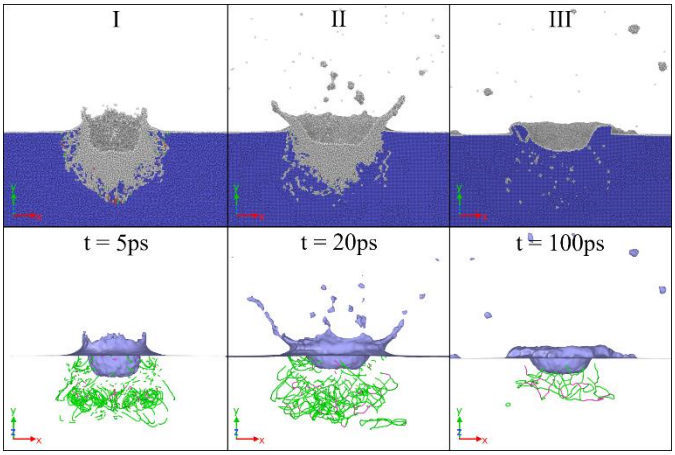

Fig. 1 High velocity impact (5 km/s) of a 40 nm-size W cluster on a W single crystal target, at times 5, 20 and 100 ps. Top row: Color code: Structural analysis. Bottom row: Same system, Blue surface indicate the sputtered atoms and Green curves corresponds to dislocations forest in the target.

In this work, the atomistic mechanisms of damage initiation during high velocity (v up to 9 km/s) impact of W projectiles on W has been investigated using molecular-dynamics simulations involving very large samples (up to 40 million atoms). Various aspects of the impact at high velocities where the projectile and part of the target materials undergo massive plastic deformation, breakup, melting, or vaporization are analyzed. Different stages of the penetration process are identified. Whether the damage occurring in the subsurface of the target is described by collision cascades or as the effect of shock waves will be discussed.

References:

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