Hypervelocity dust impacts on plasma facing materials through molecular dynamics simulations

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It has been recognized that the production and dynamics of dust in the vacuum chamber of tokamaks are important problems in the framework of the safety and tokamak performance [1]. It is expected that during plasma discharges most of the dust particles concentrate in the scrape-off layer close to the chamber walls [2]. For almost all materials the hypervelocity regime (when the speed of an impact exceeds the speed of the compression waves both in the target and in the projectile) is reached when the impact speed exceeds a few km/s; it is therefore common to consider velocities above 2–3 km/s as hypervelocity impacts [3]. In studies related with plasma facing materials (PFMs) for future nuclear fusion technology, high velocity impacts have been reported, with velocities being around 500 m/s and up to a few km/s [4,5].

In this study we focus on understanding the fundamental characteristics of the mechanisms underlying the crater formation caused by nanoparticles impacts on PFMs. From molecular dynamics involving very large samples (up to 40 million atoms). We have determined the detailed atomistic and thermodynamic aspects of crater formation mechanism. Different stages of the penetration process is identified, and a model is being developed to understand the damage produced by hypervelocity impact in terms of geometrically necessary dislocations, much like in classic indentation theory, will be discussed.

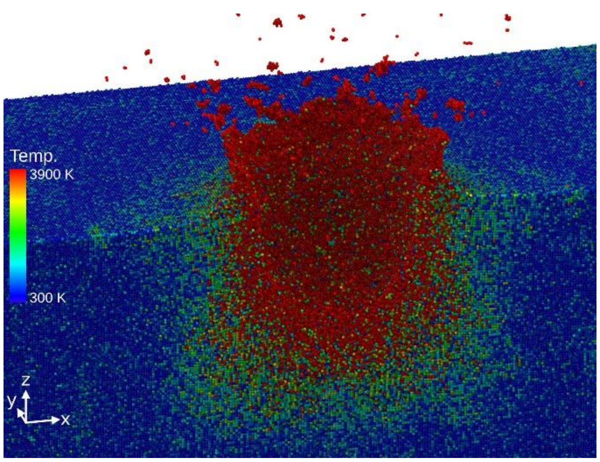

Fig. 1 High velocity impact (3 km/s) of a W cluster on a W single crystal target at time 10ps. Color code: local temperature Blue atoms are at room temperature and red ones at melting point of above.

References:

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