Simulation study of interaction between hydrogen isotopes and nuclear fusion related materials based on binary collision approximation

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In nuclear fusion devices plasmas of hydrogen isotopes exist and contact material surfaces. The “divertor configuration” is employed to control impurities produced by impacts of plasmas to the surface and to reduce the heat load to plasma facing materials. Divertor plates, whose potential constituent includes carbon and tungsten, are installed in the configuration.

It is essential for the establishment of nuclear fusion reactor to understand the physics of divertor, which requires knowledge on plasma-surface interactions (PSI), and to design an appropriate configuration. Thus we have investigated the interactions between hydrogen atoms and carbon material with molecular dynamics (MD) simulations [1,2].

There exist intensive PSI related works with binary collision based monte carlo simulations [3,4]. Binary collision approximation model simplifies interactions between material elements and reduces them to the sequence of the binary collisions. A benefit of the model is that it is rather simple and requires less computing resources than MD model. It, however, holds limit of application on the lower energy region.

The base code which we have employed is the binary-collision-approximation-based monte carlo simulation code ACAT [3]. The original code simulates the atomic collisions in amorphous target based on the binary collision model. In the code, projectile particles are traced through binary collisions and target particles of material constituent are randomly located with satisfying the given number density. In terms of randomly located target particles, the ACAT code employs the monte carlo method and aims for the atomic collisions only in amorphous target.

The integration of molecular dynamics and binary collision based monte carlo simulation is expected to be promising. In order to combine the two simulation models, we extended the ACAT code. This extention enables us to simulate atomic collisions in structured target as well as in amorphous target.

Simulations of interaction between hydrogen isotopes and nuclear fusion related materials with the modified ACAT code, named AC∀T, are reported in this presentation. Properties of hydrogen isotopes retention in the material target are especially addressed.

References

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