Computer simulation of ion stopping in a dense plasma by the Monte Carlo method

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In this work, the Monte Carlo method was used to simulate ion trajectories in a dense plasma of inertial confinement fusion. The results of computer simulation are numerical data on the dynamic characteristics, such as energy loss, penetration depth, the effective range of particles, stopping and straggling. By the results of the work the program of 3D visualization of ion trajectories in a dense plasma of inertial confinement fusion was developed.

Recently, a large number of theoretical and experimental studies of the physical processes that determine the construction of a thermonuclear target and the required parameters of a future driver carried out [1-2]. The calculation of thermonuclear target parameters for heavy ion inertial fusion requires adequate quantitative description of heavy ion interaction with the dense plasma in a wide range of parameters. Therefore, in order to know the properties of the dense plasma under different conditions, the most attractive way is a computer experiment. Computer simulation can answer many important questions, which are to be known to use the dense plasma.

Nowadays, there are various programs which allow us to carry out simulation of ion implantation process in solids without experiments. Simulation has some error and is not able to fully replace real experiments, but its results provide invaluable assistance in future research. The best-known programs are the SRIM (The Stopping and Range of Ions in Matter) [3] and Geant4 [4].

The main energy contribution of heavy ion beams in different types of fusion targets occurs in dense high-temperature plasma. Therefore, knowledge of free paths and energy input profiles of fast and heavy charged particles in the plasma will help to determine the characteristics of the thermonuclear target most precisely.

In this work, the Monte Carlo method is used for simulation of ion trajectories in a dense plasma of inertial confinement fusion. The main advantage of calculations by the Monte Carlo method is that they allows us to take into account any physical process directly, for example, local and non-local inelastic energy losses, binding energy between atoms, replacing collision, etc. Moreover, it is possible to obtain accurate solutions for multi-target and multi-layered complex geometry, which allows us to simulate actual interactions with the plasma ion beam. The paper considers the interaction of xenon ions in copper and beryllium, and iron ions in the mixture of deuterium, tritium and hydrogen at different energies.

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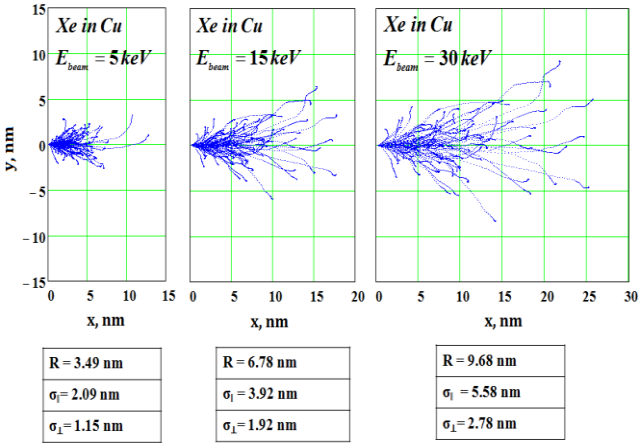

Fig. 1. The trajectories of the xenon ions in the copper: a) with an initial energy of $5 keV$, b) $15 keV$, c) $30 keV$. Figure shows the stopping range of the xenon ions depending on the energy in copper.

References

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