THE NOBLE GAS CLUSTER SPECIES EFFECT ON THE CLUSTER-SURFACE INTERACTION

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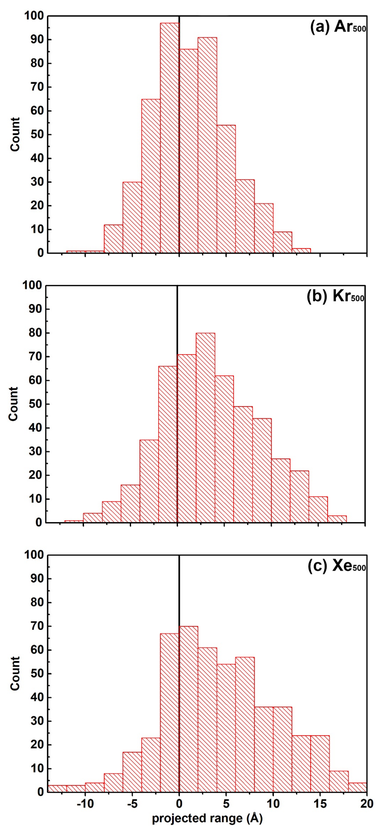
Abstract

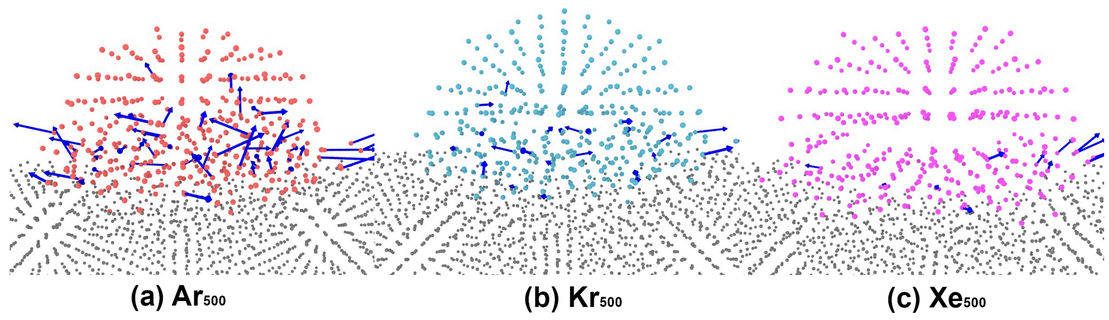
The cluster species effect on the gas cluster ion interaction with the solid surface is studied in the present work. The MD simulations of Ar, Kr and Xe atoms with the sizes in the range of 50 -5000 atoms and 20 keV energy impacting Mo and Cu surface were performed. The projected ranges of cluster atoms, cluster thermalization and cluster energy transfer to target atoms are studied. The E/n dependencies for mentioned aspects are considered.

Cluster atom ranges



Projected ranges of 20 keV Ar500, Kr500 и Xe500 cluster atoms into Mo target are presented in the figure. Atoms of a lighter cluster penetrate the target less, many of them do not even reach target surface. The reason is the backscattering of front atoms of the cluster and resulting multiple collisions of cluster atoms with each other. In case of heavier cluster atoms, these atoms penetrate deeper into the target as a result of so-called “clearing the way” effect.

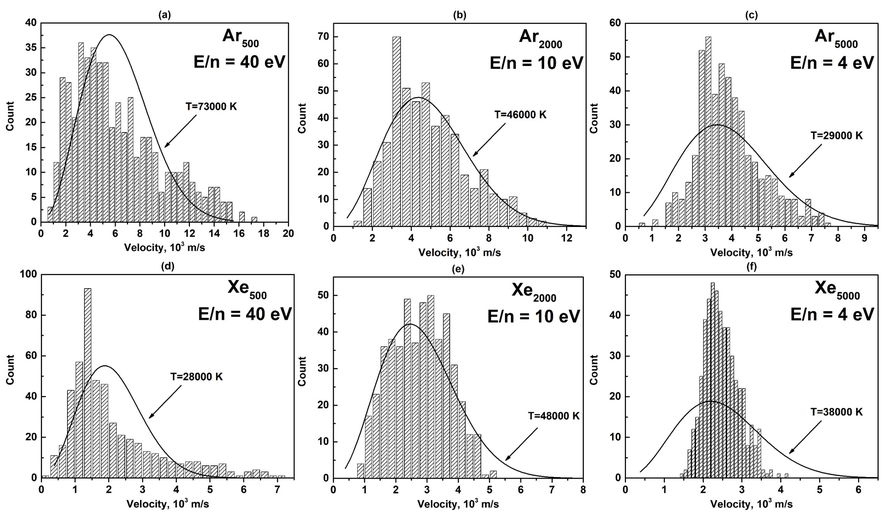
Cluster atoms scattering



Lighter cluster atoms scatter at large angles with higher probability. This leads to more intense multiple collisions between cluster atoms.

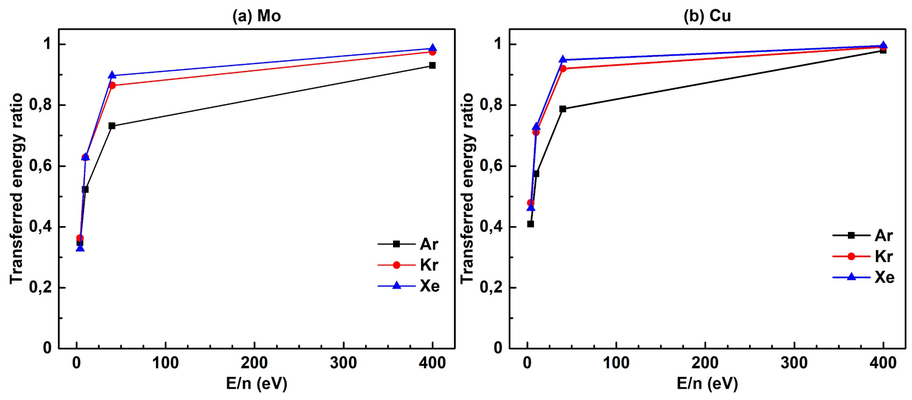
The arrows in the figure represent the cluster atoms velocities $V_z > 0$ (directed away from the surface).

Cluster thermalization



The histogram represents the calculated from the simulation cluster atoms velocity distribution after the impact. The solid line represents Maxwell distribution for the temperature that corresponds to the mean energy of the cluster atoms after the impact.

Cluster energy transfer to target atoms



The cluster species effect on the amount of energy, transferred to the target, is observed in a certain range of E/n.

At high E/n cluster fully penetrates into the target, loosing most of its energy regardless its atoms species. At low E/n the cluster does not penetrate the target, undergoing compression on the surface. During this compression cluster atoms get momentum along the surface mostly without loosing energy.

Publications

1. A. V. Nazarov, V. S. Chernysh, A. D. Zavilgelsky, A. A. Shemukhin, A. Lopez-Cazalilla, F. Djurabekova, and K. Nordlund // *SURFACES AND INTERFACES*, (26):101397, 2021.
2. V.S. Chernysh, A.E. Ieshkin, D.S. Kireev, A.V. Nazarov, A.D. Zavilgelsky // Surf. Coat. Tech. 2020, 388, 125608.
3. A.E. Ieshkin, A.V. Nazarov, A.A. Tatarintsev, D.S. Kireev, A.D. Zavilgelsky, A.A. Shemukhin, and V.S. Chernysh.// Surf. Coat. Tech. 2020, 404, 12650
4. A. V. Nazarov, V. S. Chernysh, K. Nordlund, F. Djurabekova, and J. Zhao //Nucl. Instrum. Meth. B. 2017, 406, 518-522

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