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Jodi Ackerman Frank

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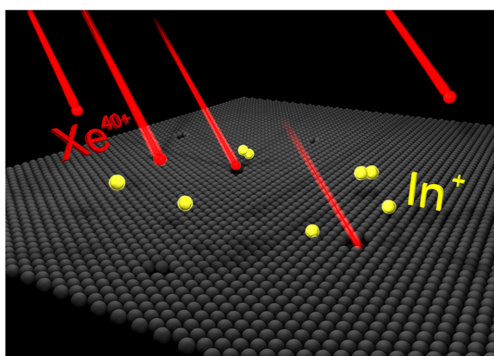
Increasing the charge state of ionized xenon projectiles without changing their impact velocity boosts secondary-ion formation probability of sputtered surface atoms.



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In secondary ion mass spectrometry, sputtering is used to generate secondary ions for chemical analysis. A beam of ionized gas projectiles bombards a solid surface, thereby ejecting mostly neutral surface material. In the process, a fraction of the ejected particles forms into secondary ions.

Researchers have long desired to find ways to increase secondary-ion yields in sputtering. Herder et al. found that increasing the electronic excitation induced by the potential energy stored in a highly charged projectile ion can significantly enhance the probability of secondary ion formation, without changing the projectile's impact velocity.

Pulsed beams of ionized xenon atoms at different charge states were used to bombard the surface of an indium substrate with the same kinetic impact energy of 20 keV. At this impact velocity, the projectile's kinetic energy is deposited via nuclear stopping. In other words, the ion projectiles are slowed down by elastic collisions with the target material, leading to a collision-dominated sputtering process.

At the higher charge state, where the ionization energy stored in the ion projectile was twice as large as the kinetic impact energy, the additional local electronic excitation generated by this potential energy was found to boost the secondary ion formation probability by a factor of five, corresponding with theoretical simulations.

The researchers also determined that the potential energy introduced by a highly charged ion impact leads to an additional contribution in the flux of sputtered particles in terms of atoms leaving the surface at extremely small emission velocities. This finding, which was found to strongly depend on surface chemistry, indicates that both the sputter ejection mechanism and the secondary ion formation process is clearly influenced by the projectile's ionization state.

Source: "Ionization probability of sputtered indium atoms under impact of slow highly charged ions," by Matthias Herder, Philipp Ernst, Lucia Skopinski, Boris Weidtmann, Marika Schleberger, and Andreas Wucher, *Journal of Vacuum Science and Technology B* (2020). The article can be accessed at https://doi.org/10.1116/6.0000171.

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