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Interaction of slow highly charged xenon ions with metallic surfaces

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Slow single charged ions interacting with solid surfaces dissipate their kinetic energy mainly by nuclear collisions which results in, e.g. defect creation and erosion of material from the surface. Highly charged ions (HCI) are missing a few or even all of their electrons, and therefore carry additional potential energy, which is defined as the sum of the binding energies of all the electrons removed. Such configuration of ions interacting with solids provide unique opportunity for formation of Rydberg hollow atoms (RHA) in fast process of HCI neutralization close to the solid surface. In the RHA a large part of the electrons are in high Rydberg levels (n~30) while some of the inner shells remain empty. Such highly excited atoms quickly decay by Auger electron and x-ray emission. Consequently, their neutralization energy (and part of kinetic energy) is deposited in a small volume close to the surface, eventually leading to the material sputtering and nanostructure formation. The measurement of X-rays and electrons emitted during the neutralization process and the analysis of surface modification give a unique opportunity to study many exotic processes taking place during the interaction of HCI with solid surfaces.

In this talk, I will present the results of experiments carried out at the EBIS facility in Kielce (Jan Kochanowski University, Kielce, Poland), in which we studied the M-X radiation emitted during the neutralization of slow highly charged X^{q+} ions and nanostructures resulting from the deposition of ion energy on metallic surfaces. I will discuss role of such processes as Internal Dielectronic Excitation (IDE), Interatomic Coulombic Decay (ICD) and Two-Electron One-Photon (TEOP) transitions occurring during deexcitation of the RHA. The nanostructure creation process I will interpret using recently developed micro-staircase model based on the quantum two-state vector model of the ionic Rydberg states population. The model takes into account the neutralization energy, and the kinetic energy deposition inside the solid.

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