Interaction of highly charged ions with different Allotropic varieties of carbon surfaces

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Synopsis. We present experiments on the interaction of Slow Highly Charged Ions (SHCI) with carbon surfaces owning different structured or structureless (amorphous) natures and conductivities.

The commonly accepted scenario describing the interaction of Slow Highly Charged Ions (SHCI) approaching surfaces at nanometric distances is that these ions capture, by field effect many electrons of the solid into their very highly excited Rydberg states, leaving their innermost shells vacant, to form very excited (autoioizing) exotic atomic species. These above the surface hollow atoms mainly decaying via Auger transitions, losing one electron at each step of their decay, i.e. through a very long cascade of electron capture and lost. While touching the surface, these ions in very weakly bound Rydberg states of very large radius cannot penetrate the target and are peeled off at surface. Below the surface these re ionized ions recapture electrons but in lower excited states, leaving empty their innermost shells, forming hollow atoms [1]. There are then two different kinds of hollow atoms stepwise formed, filling the ion above and below the surface [2].

Wilhelm et al. [3] proposed two years ago a completely new scenario based on the Interatomic Coulombic Decay (ICD) which we contested, as quoted in our contribution to the ICPEAC meeting, and which we will briefly review in this presentation.

One of the main striking features of most of the experiments in this field in the last two decennia is that these interactions are dramatically dependent of the nature (metal, dielectric) of the surfaces of the considered targets i.e. of their electric properties, and the ion velocities [2].

In the case of carbon made targets conductive and isolative materials own also different structures and sometime exceptional properties (graphene), showing up new mechanisms of interactions of SHCI with their surfaces.

We have studied in x-ray spectroscopy the processes of electron capture and decay of Ar^{9+} and Ar^{17+}ions which respectively own a single L vacancy and a fully vacant L shell (hollow atoms) while interacting at normal incidence with Diamond Like Carbon (DLC # 90 % pure sp3 diamond structured carbon), Highly Orientated Pyrolytic Graphene (HOPG purely sp2 graphitic carbon parallel graphene planes), and fully amorphous layers of carbon prepared by subimplantation on superficial Diamond Like Carbon, and also mosaic gem diamond H and O passivated.

We present in this communication some of the most illustrative results of this wide study which mainly shows that the capture processes behave very differently in amorphous disordered C targets than in ordered diamond or graphene planes, and that the differently orientated electric conductivities of these materials may play an essential role in the extremely fast screening of the ions before being captured.

References

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