Electron emission from HOPG due to highly charged ion impact

Katharina Dobes[1], Erwin Bodewits[2], Ronnie Hoekstra[2], and Friedrich Aumayr[1]

[1]*Institute of Applied Physics, TU Wien, Vienna Austria*
[2]*KVI-Atomic and Molecular Physics, University of Groningen, Groningen, The Netherlands*
dobes@iap.tuwien.ac.at

Electron emission as a result of the interaction of highly charged ions (HCI) with solid surfaces is of substantial interest both with regard to fundamental research as well as technical applications such as single particle detection, controlled nano-structuring of surfaces or plasma surface interaction in e.g. thermonuclear fusion devices. The emission of electrons during the impact of a HCI on a solid surface is generally divided into two different categories: kinetic electron emission (KE), which is driven by the kinetic energy of the impinging projectile and potential emission (PE), which is induced by the potential energy stored in a HCI Z^{q+} as a result of the removal of q electrons. Following the widely accepted hollow atom scenario [1,2], the relaxation and neutralization of such a HCI upon surface impact is governed not only by the potential energy of the projectile, but also by the electronic structure of the surface, the work function and electron transport properties of the target material [2]. Generally the contributions of KE and PE to the total electron emission yield cannot be separated easily, because a projectile usually carries both, kinetic as well as potential energy at the same time.

We have investigated electron emission yields of a HOPG surface under HCI impact. Aiming at a better understanding of the contributions from the two above-mention electron emission phenomena (PE and KE) in our experiments, we covered a wide range of projectile charge states (corresponding E_{pot} ~ 140 eV – 12 keV) and kinetic energies (E_{kin} ~ 3.9 - 328 keV). Complementary measurements with Au and C_{60} covered Au surfaces were also conducted, to furthermore asses the influence of the electronic properties of the target material on the electron emission yield [3]. Experiments were performed at the IISIS setup at KVI Groningen [4]. In preparation of the experiments, the HOPG target was cleaved with a scotch tape. Experiments were performed in a UHV chamber at a base pressure of the order of 10^{-10} mbar. Ar^{q+} and Xe^{q+} ions were extracted from a 14 GHz ECR ion source. Electron statistics spectra were recorded by means of an energy sensitive, passivated implanted planar silicon (PIPS) detector, which is mounted under 90° with respect to the incoming ion beam in the experimental chamber. Electrons, which are emitted in an ion-surface collision, are collected by a set of electrodes and accelerated towards the detector through a bias voltage of 30 kV. The number of electrons produced in an ion impact event is then determined by pulse height analysis. We will present our experimental data in detail and thoroughly discuss contributions from PE and KE to the total electron emission yield of HOPG.

References:

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