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A new setup for experimental investigations of solar wind sputtering

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The surfaces of Mercury and Moon are not shielded by a thick atmosphere and therefore they are exposed to bombardment by charged particles, ultraviolet photons and micrometeorites. These influences lead to an alteration and erosion of the surface, and the emitted atoms and molecules form a thin atmosphere, an exosphere, around these celestial bodies [1]. The composition of these exospheres is connected to the surface composition and has been subject to flyby measurements by satellites. Model calculations which include the erosion mechanisms can be used as a method of comparison for such exosphere measurements and allow conclusions about the surface composition. Surface sputtering induced by solar wind ions hereby represents a major contribution to the erosion of the surfaces of Mercury and Moon [1]. However, the experimental database for sputtering of respective analogue materials by solar wind ions, which would be necessary for exact modelling of the space weathering process, is still in its early stages.

Sputtering experiments have been performed at TU Wien during the past years using a quartz crystal microbalance (QCM) technique [2]. Target material is deposited on the quartz surface as a thin layer and the quartz's resonance frequency is measured under ion bombardment. The sputter yield can then be calculated from the frequency change and the ion current [2]. In order to remove the restrictions of a thin layer QCM target and simplify experiments with composite targets, a new QCM catcher setup was developed. In the new design, the QCM is placed beside the target holder and acts as a catcher for material that is sputtered from the target surface. By comparing the catcher signal to reference measurements and SDTrimSP simulations [3], the target sputter yield can be determined.

In order to test the setup, we have performed experiments with a Au-coated QCM target under 2 keV Ar+ bombardment so that both the mass changes at the target and at the catcher could be obtained simultaneously. The results coincide very well with SDTrimSP predictions showing the feasibility of the new design [4]. Furthermore, Fe-coated QCM targets with different surface roughness were investigated in the new setup. The surface roughness represents a key factor for the solar wind induced erosion of planetary or lunar rocks. It has a strong influence on the absolute sputtering yield as well as on the spatial distribution of sputtered particles and was therefore investigated.

As a next step, sputtering experiments with Mercury or Moon analogues will be conducted. Knowledge gained in the course of this research will enhance the understanding of surface sputtering by solar wind ions and used to improve theoretical models of the Mercury's and Moon's exosphere formation.

References:

[1] E. Kallio, et al., Planetary and Space Science, 56, 1506 (2008).
[2] G. Hayderer, et al., Review of Scientific Instruments, 70, 3696 (1999).
[3] A. Mutzke, R. Schneider, W. Eckstein, R. Dohmen, SDTrimSP: Version 5.00, IPP Report, 12/8, (2011).
[4] B. M. Berger, P. S. Szabo, R. Stadlmayr, F. Aumayr, Nucl. Instrum. Meth. Phys. Res. B, doi: 10.1016/j.nimb.2016.11.039