EGU22-5236
https://doi.org/10.5194/egusphere-egu22-5236
EGU General Assembly 2022
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An optimised Quartz Crystal Microbalance setup to investigate the sputtering behaviour of bulk targets

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In modelling the exosphere formation of atmosphere-less planetary objects [1], the sputtering contributions is often calculated using Monte-Carlo style simulations like SRIM [2]. However, input parameters of these codes often need to be adapted to successfully describe experimental data [3].

To provide such experimental data, we perform sputter measurements in which we irradiate mineral samples relevant for modelling the surfaces of Mercury or the Moon. Usually, such experiments are performed using thin sample films deposited onto a Quartz Crystal Microbalance (QCM), allowing to determine mass changes in real time and in situ [4, 5]. Advancing on this technique, we conduct measurements using a previously presented setup with a second QCM facing the irradiated samples [6]. It collects particles liberated by sputtering and probes their angular distribution. This setup allows for experiments with bulk samples, including pellets made of mineral powders [7]. These are currently being used in addition to the aforementioned thin films on primary QCMs. The goal with these samples is to detect possible differences in sputtering behaviour between the amorphous films and the bulk specimens that might be explained by crystallinity [8].

Experiments with such an advanced setup require an optimisation of the measurement procedure. Due to the high sensitivity of the QCM technique, small fluctuations in the experimental conditions can lead to noticeably different catcher signals. We therefore adapted the setup geometry to ensure constant relative distances between all specimens. Additionally, sample preparation cycles were changed to minimise transient effects on the QCMs which can be caused by non-equilibrium sticking on the catcher QCM. Furthermore, data evaluation was adapted to focus on relative changes from thin film to pellet measurements, rather than absolute signals. We immediately irradiate both types of samples after each other at a fixed catcher angle. This allows us to neglect long-term changes in experimentation parameters at this chosen position. Using these procedures, we can reliably reproduce irradiation results. We are therefore capable of precisely measuring sputtering yields and angular distributions of atoms sputtered by solar wind ions for bulk samples.

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