Combining Experiments and Modelling to Understand the Role of Potential Sputtering by Solar Wind Ions

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In the absence of a protecting atmosphere, the surfaces of rocky bodies in the solar system are affected by significant space weathering due to the exposure to the solar wind [1]. Fundamental knowledge of space weathering effects, such as optical changes of surfaces as well as the formation of an exosphere is essential for gaining insights into the history of planetary bodies in the solar system [2]. Primarily the exospheres of Mercury and Moon are presently of great interest and the interpretation of their formation processes relies on the understanding of all space weathering effects on mineral surfaces.

Sputtering of refractory elements by solar wind ions is one of the most important release processes. We investigate solar wind sputtering by measuring and modelling the sputtering of pyroxene samples as analogues for the surfaces of Mercury and Moon [3, 4]. These measurements with thin film samples on Quartz Crystal Microbalance (QCM) substrates allow recording of sputtering yields in-situ and in real time [5]. For the simulation of kinetic sputtering from the ion-induced collision cascade we use the software SDTrimSP with adapted input parameters that consistently reproduce measured kinetic sputtering yields [4, 6].

This study focuses on investigating the potential sputtering of insulating samples by multiply charged ions [7]. Changes of these sputtering yields with fluence are compared to calculations with a model based on inputs from SDTrimSP simulations. This leads to a very good agreement with steady-state sputtering yields under the assumption that only O atoms are sputtered by the potential energy of the ions. The observed decreasing sputtering yields can be explained by a partial O depletion on the surface [4]. Based on these findings expected surface composition changes and sputtering yields under realistic solar wind conditions can be calculated. Our results
are in line with previous investigations (see e.g. [8, 9]), creating a consistent view on solar wind sputtering effects from experiments to established modelling efforts.

References: