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A comprehensive study on the sputtering of the lunar surface

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The Moon is subjected to a variety of influences in the space environment. One of these is the solar wind, a plasma stream consisting of mostly H^+ and He^{2+} ions, that impinges on the lunar surface. As a consequence, material is released through the process of ion sputtering, mostly on an atomic level. These ejecta subsequently take part in the formation of the lunar exosphere [1]. Constraining their physical properties, most notably the parameters sputtering yield, ejecta angular distribution and their energy distribution, is thus crucial to properly model the exosphere creation [2]. Such investigations have been of interest for decades and have recently been carried out with samples representative for the lunar mineralogy [3–6].

In this contribution, we present our current investigations on the aforementioned parameters using samples prepared from material collected during the Apollo 16 mission. Using a quartz crystal microbalance (QCM), we are able to measure mass changes due to sputtering caused by H and He ions and therefore also the sputtering yield. Additionally, we place another QCM in the experimentation chamber in a rotatable manner that collects the ejecta. Doing so enables us to probe the angular distribution of the ejecta. For these experiments, we use two types of samples: flat vitreous films as well as pellets pressed from lunar regolith and prepared according to [7]. Along with numerical simulations considering the sample morphology, this allows us to untangle intrinsic material properties from modifications thereof due to surface roughness. Lastly, we will present plans for future measurements to experimentally resolve the ejecta energy distribution. These energy distributions of particles sputtered from compound materials (rather than monatomic ones) are an actively researched area, especially from a numerical standpoint [8–11] – experimental data are scarce, however. This study combining the three physical quantities describing the sputtering process will therefore close a knowledge gap and be applicable not only to the Moon, but also to the sputtering of other planetary bodies.

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