The effects of sputtering yields on the Rosetta/COSIMA instrument efficiency

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The COSIMA experiment on the Rosetta spacecraft will use the SIMS (secondary ion mass spectrometry) technique to investigate the composition of dust from comet 67P/Churyumov–Gerasimenko. In COSIMA, a beam of $^{115}In^{+}$ ions is directed at cometary dust grains which have been collected on targets. The beam ejects secondary ions which are electrostatically collected and directed through an ion reflector in which the time of flight is proportional to the square root of the ion mass. COSIMA has excellent mass resolution ($m/\Delta m \sim 2000$) over a wide mass range (1–3500 amu), but the instrument efficiency is a very complex function, depending on a number of physical effects, including the sputtering yields of various substances, the charge state of particles ejected from the target, the possibility of molecular breakup en route to the ion reflector, and many others. In this work, one of those physical effects will be considered: sputtering. The ejection of secondary ions as a function of target composition are modelled, using existing techniques for cascade sputtering and high-stopping-power sputtering in the nuclear energy loss regime. Using the modelled efficiency, comparisons are made with spectra obtained in the laboratory from targets whose composition is known, attempting to explain in part the different spectra observed.