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A laboratory study of oxygen and water ice sputtering by low energy ions

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Naturally occurring ices such as oxygen ice and water ice cover the surface of dust grains and various celestial objects, such as those in the outer solar system. These ices are continuously irradiated by ions from the solar wind and cosmic rays which modify their surface. As a result of this bombardment, new species may form and remain embedded into the ice, whilst others are sputtered off into space and are absorbed into planetary atmospheres.The current work is a laboratory measurement of sputtering yields for H_2O ice and O_2 ice. The astrophysical ices were subjected to irradiation by 4 keV singly and doubly charged ions. The experimental setup consists of an Electron Cyclotron Resonance ion source attached to a floating beamline accelerator and an ultrahigh vacuum chamber with a base pressure $\sim 10^{-9}$ mbar. The ices were formed by vapour or gas deposition onto a KBr substrate at 10 K and the thickness was monitored during the deposition and irradiation phases using a laser interferometer.

For O_2 ice the sputtering yield increases linearly as the ion mass increases for both singly and doubly charged ions, varying from 25 molecules/ion for He^+ to 252 molecules/ion for Ar^+. Both singly and doubly charged ions have the same experimental sputtering yield, as expected from a momentum dominated process. For H_2O ice the yield does not increase linearly with increasing incident ion mass. For singly and doubly charges ions the yield are similar. Additionally, thermal programmed desorption after irradiation of O_2 ice showed O_3 formation, and ^{13}CO and $^{13}CO_2$ formation in the case of H_2O ice irradiated with $^{13}C^+$. The experimental values of the sputtering yield have been compared with the values from a theoretical model predicted by Famá et al 2010 and are found to be in good agreement.

REFERENCES

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