Exploring the Effect of Low Energy Oxygen Ions on the High Atmosphere of Titan

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Résumé

During the Cassini-Huygens' exploration of the Saturn system, the atmosphere of Saturn's moon Titan was analyzed using mass spectrometry. A plethora of complex molecules with mass over charge ratios in the thousands were detected, making it the most chemically complex atmosphere in the solar system. The Cassini spacecraft also measured plumes of water ejected from the moon Enceledus, where the ejected molecules are then ionized by the magnetosphere. These oxygen ions precipitate into Titan's high atmosphere with an energy of 1-100 keV and can interact with the diverse complex molecules. If the oxygen implants into large molecules, it can form heavier prebiotic material that can fall to the surface to create a complex chemistry. This coupled with Titan's subsurface liquid water and surface methane/ ethane lakes makes it a prime candidate of exobiological interest. The goal of this project is therefore to study the effects of low-energy oxygen ion irradiation on aerosol analogs of Titan's atmosphere and organic molecules using infrared spectroscopy and high resolution mass spectrometry (HRMS).
A preliminary experiment using adenine samples prepared at LISA was carried out at GANIL in June 2021. The samples were irradiated with 18O ions at 35 keV and 70 keV depending on their thickness to maximize implantation. Using infrared spectroscopy, we were able to characterize the destruction of adenine from low energy oxygen ions as a combination of radiolysis and sputtering. HRMS revealed that some oxygen was indeed implanted into the sample. Using these first results, we can optimize the experimental parameters such as maximum fluence to ensure that the oxygen is effectively implanted with minimal sputtering.

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