UNIVERSITÄT DUISBURG ESSEN | PHYSIK

Physikalisches Kolloquium

Mittwoch, 11.06.2025
13:00 Uhr
MC 122 und Zoom

https://uni-due.zoom-x.de/j/64228670246?pwd=RjVQeFNIUkRKRkpiNVpKYXhJaFNLdz09 (gilt für alle Vorträge)

Radiation-matter interaction in space analogous conditions: processing of astrophysical ices and polymers

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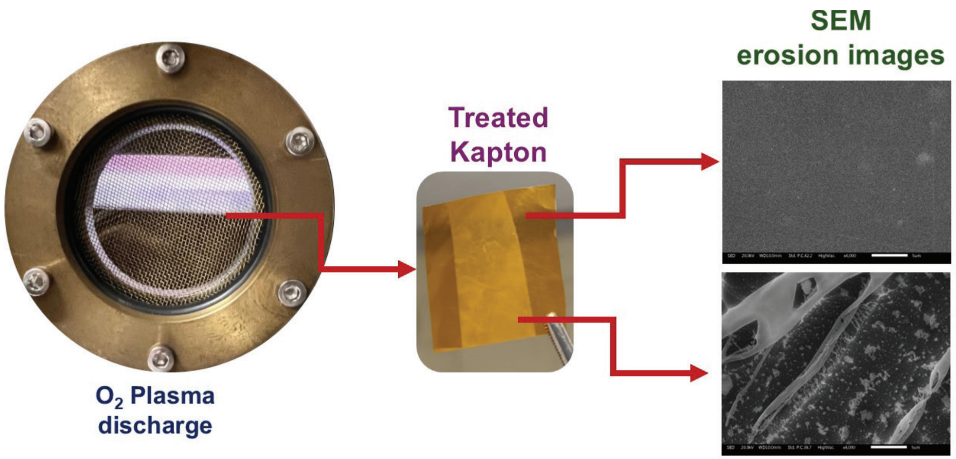

Radiation plays a fundamental role in shaping materials in space. Energetic particles, such as ions and atomic oxygen, interact with solid surfaces, leading to chemical transformations that influence both planetary environments and man-made materials.

Understanding these processes is crucial for astrochemistry, planetary science, and aerospace technology. This work explores two key aspects of radiation-driven processing: the chemical evolution of astrophysical ices under ion bombardment and the degradation of polymers by O_2 plasmas in space-like conditions. The icy surface of Europa, one of Jupiter's moons, is constantly exposed to cosmic radiation, with energetic ions – originating from Io's volcanic activity – becoming implanted in its trailing hemisphere. These interactions can generate new molecular species, including organosulfurs, which are of astrobiological relevance and may be detected by the upcoming JUICE and Europa Clipper missions. To simulate such conditions, 80 K ice films composed of a water-propane mixture (2:1) were irradiated with 105 keV sulfur and argon ions, and the resulting residues were analyzed using Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FT-ICR MS). The detected molecular diversity included polycyclic aromatic hydrocarbons (PAHs), aliphatic molecules, and CHS- and CHOS-type organosulfurs, confirming that sulfur implantation can lead to the formation of complex organic matter from simple hydrocarbons. Similarly, polymeric materials used in spacecraft construction are also subject to radiation-induced chemical alterations, particularly in Low Earth Orbit (LEO), where atomic and ionized oxygen cause surface erosion and degradation.

Despite numerous studies, the precise mechanisms governing these processes remain elusive. To address this, polyimide (Kapton) films were exposed to non-thermal oxygen plasmas under controlled conditions, varying exposure time, O_2 flux, and plasma power. X-ray Photoelectron Spectroscopy (XPS) was employed to assess surface modifications, while Quadrupole Mass Spectrometry (QMS) was implemented to analyze desorbed species. These complementary techniques should provide insights into the most fragile bonds within polyimide structures, revealing key aspects of polymer erosion in space environments. Polystyrene and graphite processing are planned to be included in the following experiments.