

# Irradiation of icy astrophysical compounds: high mass resolution spectrometry and the formation of sulfurous organic species at the moon Europa

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The jovian moon Europa presents an icy surface that is exposed to cosmic radiation. In particular, the volcanic activity of the moon Io places ions as S, O, Na, K and Cl in the magnetosphere of Jupiter and they may end up implanted on Europa's surface, predominantly its trailing hemisphere [1]. Any organic matter on the surface (including matter potentially originating in the internal ocean) will be heavily processed by ionizing radiation and its composition will be extensively altered. Understanding this process and its effects will be key to interpret the observations of the JUICE [2] and Europa Clipper [3] space missions.

We performed experiments about the evolution of organic matter under radiation, in conditions relevant to Europa. 80 K ice films of a 2:1 water:propane mixture, were irradiated by 105 keV sulfur and argon ions and their residues were analyzed by FT-ICR MS (Fourier Transform Ion Cyclotron Resonance Mass Spectrometry). The main objectives of the present work are the characterization of this kind of material in similar conditions as of Europa's surface, and to investigate the likelihood of organosulfurs' formation from the processing of the simplest alkane that could be found in solid form on Europa's surface.

Results present a great diversity of organic compounds, including PAHs (Polycyclic Aromatic Hydrocarbons) and aliphatic molecules with inclusion of oxygen atoms from water. Sulfur bombardment induced the formation of organosulfurs, found in CHS and CHOS forms, indicating that organosulfurs can be formed from organic compounds after sulfur implantation.

## References

1. R. W. Carlson et al., Europa **283** (2009)
2. O. Grasset et al., Planetary and Space Science **78**, 1 (2013)
3. S. M. Howell, R. T. Pappalardo, Nature Communications **11**, 1311 (2020)