

Europalet TA Scientific Report

PROJECT LEADER

Project number: 20-EPN-084
Name: Rahul Kumar Kushwaha
Home Institution: Physical Research Laboratory, Ahmedabad India
TA Facility visited: TA2 Facility 11 (Ice Chamber for Astrophysics / Astrochemistry), ATOMKI, Debrecen, Hungary

Project Title: *Converting one amino acid to the other containing sulfur via ion irradiation : Implication to chemical evolution on Europa surface ices*

Scientific Report Summary.

(plain text, no figures, maximum 250 words, to be included in database and published)

The non-equilibrium chemistry driven by the charged particle and photon irradiation processes are responsible for the rich chemistry on the surfaces of icy satellites. Among the icy satellites of the Jovian and Saturnian planetary systems few satellites such as Ganymede, Europa, Dione, Rhea, Callisto and Titan that are embedded in their respective planetary magnetospheres were observed to undergo rich chemical processes due to the bombardment of wide range of energetic atomic and molecular ions that are present in their planet's magnetospheres which processes the icy surfaces of satellites by irradiation and implantation. Magnetospheres also helps in bringing new species from one satellite to the other. Especially in the Jupiter system of icy satellites, sulfur transfer from Io to the other satellites is quite likely. The sulfur ions from Io are picked up by the magnetosphere and are accelerated towards the other icy satellites, Europa being the closest neighbor to Io will be implanted with sulfur ions. The Jovian satellites, due to the presence of the Jupiter's magnetosphere, are subjected to highly energetic S ion irradiation which leads to a range of chemical activity on their surfaces. In this project, we have studied the effect of S ion irradiation on Aspartic acid for a range of Energies at two different temperatures (100 K, 20 K), where the 100 K experiments are aimed to mimic the conditions of Europa. The irradiated residue was then analyzed using optical microscope, scanning electron microscope and liquid chromatography mass spectrometry.

Full Scientific Report on the outcome of your TNA visit

We encourage you to add figures to your report, which should be approx. 1 page of text plus figures.

To carry out the experiment to investigate the conversion of one amino acid to the other containing sulfur, we first coated the amino acid (aspartic acid) sample on to the infrared (IR) compatible ZnSe windows at room temperature by drop casting. The thickness of the sample depended on the number of layers of the sample. 2 windows thus prepared containing amino acid coating was loaded on to the sample holder along with 1 uncoated window for background and 1 collimator to calibrate the incoming beam. The system was pumped to UltraHigh Vacuum (UHV), 10^{-8} mbar to 10^{-9} mbar. A first spectra of the samples were taken before cooling down the system. The beamline was then calibrated to achieve the intended energy of the S⁺ ion. Before every irradiation, the charge accumulated in faraday cups 1 and 3 (FC1 and FC3) for a 100 second irradiation through a collimator is calculated. The system was then cooled down to the required temperature (100 K / 20 K). Then the sample was irradiated for the intended time while the sample was monitored real time using FTIR and QMS. The charge in the FC1 after the irradiated is also noted and using these values we calculate the ion fluence of the irradiation. After the irradiation an IR spectra was recorded and the system was gradually heated to 298 K, the vacuum was broken and the samples were taken out. The new samples were replaced and the same procedures were repeated for different energies. This table below lists the details of the irradiations for different samples that we did during the course of this project.

Sample	Layers of Asp acid	Substrate	Temperature	Irradiation
Sample - 1	2 Layers	ZnSe with Gold mesh	100 K	1 MeV S ⁺
Sample - 2	2 Layers	ZnSe with Gold mesh	100 K	1 MeV S ⁺
Sample - 3	2 Layers	ZnSe with Gold mesh	20 K	1 MeV S ⁺
Sample - 4	2 Layers	ZnSe with Gold mesh	20 K	1 MeV S ⁺
Sample - 5	3 Layers	ZnSe with Gold mesh	20 K	600 keV S ⁺
Sample - 6	3 Layers	ZnSe with Gold mesh	100 K	600 keV S ⁺
Sample - 7	3 Layers	ZnSe with Gold mesh	100 K	600 keV S ⁺
Sample - 8	3 Layers	ZnSe with Gold mesh	20 K	600 keV S ⁺
Sample - 9	3 Layers	ZnSe with Gold mesh	20 K	600 keV S ⁺
Sample - 10	3 Layers	ZnSe with Gold mesh	100 K	600 keV S ⁺
Sample - 11	3 Layers	ZnSe with Gold mesh	100 K	207 keV S ⁺
Sample - 12	3 Layers	ZnSe with Gold mesh	100 K	207 keV S ⁺
Sample - 13	3 Layers	ZnSe with Gold mesh	100 K	207 keV S ⁺
Sample - 14	3 Layers	ZnSe without Gold mesh	20 K	203 keV S ⁺
Sample - 15	3 Layers	ZnSe without Gold mesh	20 K	203 keV S ⁺
Sample - 16	3 Layers	ZnSe without Gold mesh	20 K	203 keV S ⁺

Initial analysis of the irradiated and unirradiated samples were done at the Heritage Lab, Atomki using SEM and OM. Further analysis using LCMS are being carried out at IIT-Gandhinagar, India.

In our initial LCMS analysis we see indications of other amino acid formation in the irradiated samples.

- Give details of any publications arising/planned (include conference abstracts etc)

Data acquired during this TA will be included in journal papers. Completion of data analysis is underway and a first paper draft is expected next year.

- Host confirmation

Please can hosts fill in/check this table confirming the breakdown of time for this TA project:


Dates for travel to accommodation for TA visit (if physical visit by applicant)	Start Date of TA project at facility	Number of lab/field days spent on TA Visit pre-analytical preparation	Number of days in lab/field site for TA Visit	Number of days spent in lab for TA Visit data analysis	End Date of TA project at facility	Dates for travel home (if physical visit by applicant)
Departed: 06.11. 2021 Arrived: 07.11. 2021	08.11.2021	-	13	-	19.11.2021	Departed: 22.11.2021 Arrived: 24.11.2021

TA measuring dates (for unit cost claim): 08, 09, 10, 11, 12, 15, 16, 17, 18, 19 of November (10 days)

Allowance paid: 70.00 EUR/day for 13 days, 910.00 EUR total.

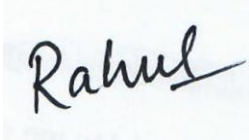
Justification: 10 working days plus one day before (07.11, because of the earlier arrival) plus the weekend in between the two working weeks (13.11, 14.11).

The host is required to approve the report agreeing it is an accurate account of the research performed.

<u>Host Name</u>	Dr Zoltán Juhász
<u>Host Signature</u>	 _____
<u>Date</u>	17.12,2021.

- Project Leader confirmation

Do you give permission for the full version of this TA Scientific Report (in addition to the 250 word summary) to be published by Europlanet 2024 RI on its website and/or public reports? YES

<u>Project Leader Name</u>	Rahul Kumar Kushwaha
<u>Project Leader Signature</u>	
<u>Date</u>	17.12.2021