Ejection of glycine molecules adsorbed on a water ice surface by swift-heavy ion irradiation

Christian Anders*†[1], Eduardo Bringa[2], and Herbert Urbassek[1]

[1]Technische Universität Kaiserslautern – Fachbereich Physik Erwin-Schrödinger-Straße 46 67663 Kaiserslautern, Germany

[2]Universidad de Mendoza – CONICET and Facultad de Ingenería, Mendoza 5500, Argentina, Argentina

Abstract

Since the Pioneer and Voyager missions the existence of a subsurface ocean on Jupiter' s ice moon
Europa has been suspected. Liquid water might contain prebiotic molecules such as amino acids
which could possibly be brought to the surface by fissures, convective processes or cryovolcanism.
We study the desorption process induced by swift-heavy ion irradiation using molecular dynamics
simulation. Focusing on the amino acid glycine adsorbed on water ice, we model a 2 MeV S ion
impact as it might be typical of magnetospheric ion impact on the surface of Europa. We find that
molecules are ejected intact within a radius of 25 ± 5 Å around the ion track. Within a core region
of 2 ±1 Å, the glycine is certainly fragmented and only fragments are emitted while a maximum of
the emitted glycins comes from a distance of about 14 ± 5 Å from the track. Prominent fragments
produced are cyanide CN-, carbon monoxide CO, cyanate OCN-, and carbon dioxide CO2, in
agreement with experimental studies. In addition, radiolysis of water ice generates the radicals H+,
H3O+ and HO- as well as the gases H2, O2 and some H2O2. While the smaller fragments easily
obtain velocities above 2 km/s - the escape velocity from Europa - most ejected glycine molecules
receive smaller velocities and will thus not leave the moon permanently. Future space mission such
as JUICE might detect the organic material on the surface or in the vicinity of Europa's orbit.
Keywords: sputtering, molecular dynamics, ice, glycine, reactive chemistry, Europa

*Speaker

†Corresponding author: anders@physik.uni-kl.de