# Amorphous and crystalline pyridine ices irradiated by MeV ions

C.-A.P. da Costa[1], A. Bychkova[1], P. Boduch[1], A.-L.F. de Barros[2], I. Bouchard de La Poterie[1], Z. Kaňuchová[3], H. Rothard[1] and A. Domaracka[1]

*[1]Centre de Recherche sur les Ions, les Matériaux et la Photonique (CEA/CNRS/ENSICAEN/Université de Caen- Normandie/Normandie Université),UMR 6252, CIMAP – CIRIL – Ganil, Boulevard Henri Becquerel, CS 65133 14076 Caen cedex 5, France; E-mail: cintia-apc@hotmail.com*

*[2]Departamento de Física, Centro Federal de Educação Tecnológica Celso Suckow da Fonseca, Av. Maracanã 229, 20271-110 Rio de Janeiro, RJ, Brazil.*

*[3]Astronomical Institute of the Slovak Academy of Science, 059 60 Tatranska Lomnica, Slovak Republic.*

Pyridine ($C_5H_5N$) is an important complex organic molecule (COM). It is heterocyclic and appears in compounds such as vitamins and pharmaceuticals [1]. Although pyridine has not yet been directly observed in space, Parker et al. (2015)[2] have revealed a potential pathway to a facile pyridine synthesis in the gas phase via the reaction of the cyano vinyl ($C_2H_2CN$) radical with vinyl cyanide ($C_2H_3CN$) in high temperature environments simulating conditions in carbon-rich circumstellar envelopes.

Pyridine ices, in amorphous and crystalline phases, have been irradiated with 396 MeV $Ar^{17+}$ and 61 MeV $Kr^{15+}$ at 10, 15 and 130 K in the SME and IRRSUD beam lines of the GANIL heavy ion accelerator facility. Infrared spectroscopy was employed to follow the structural and chemical evolution of the samples as a function of projectile fluence. The apparent destruction cross sections, $\sigma_d^{ap}$, which includes the dissociation effects of radiolysis and also ejection of particles by sputtering, were measured for all samples. The local doses needed to complete amorphization of the crystalline samples were calculated as well, see Fig. 1.

Pyridine ices that were initially crystalline present apparent destruction cross sections approximately three times higher than amorphous ones. However, after amorphization is completed, originally crystalline samples have the same $\sigma_d^{ap}$ as ices that were initially amorphous. Targets irradiated at 130 K are more radioresistant than the ones at 10 K, they have smaller destruction cross sections $\sigma_d^{ap}$.

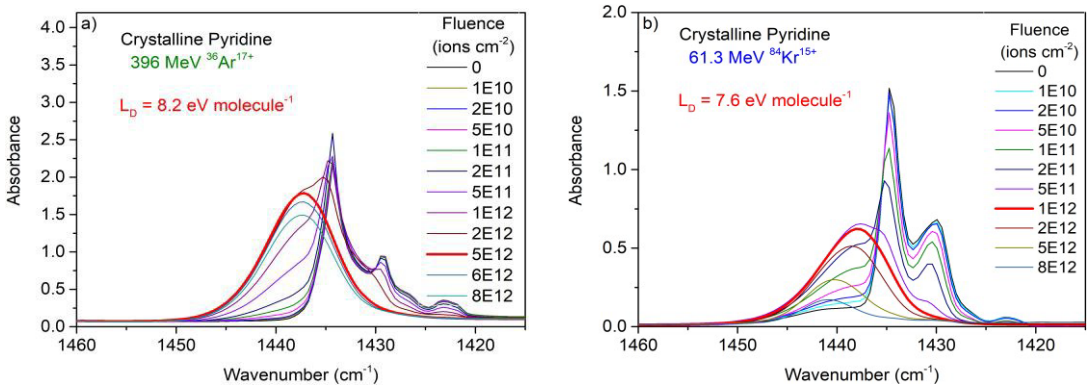


Figure 1: Evolution of infrared spectra of crystalline pyridine with projectile fluence of (a) 396 MeV Ar17+ and (b) 61.3 MeV Kr15+ ion beams irradiated at 15 K. Thicker red curves indicate the transition fluence value to complete amorphization. Obtained local doses are 8.2 and 7.6 eV/molecule, respectively.

## References

[1] E. F. Scriven, & R. Murugan, 2000, Kirk-Othmer Encyclopedia of Chemical Technology.

[2] D. S. Parker, R. I. Kaiser, O. Kostko, et al. 2015, Physical Chemistry Chemical Physics, 17, 32000.