

Production of N_3 from irradiation of the N_2 -rich ices using soft X-rays and cosmic rays analog

Fredson de Araujo Vasconcelos *¹, Sergio Pilling *²

* Research and development institute (IP&D), Universidade do Vale do Paraiba - UNIVAP, Sao Jose dos Campos-SP/Brazil

Synopsis N_2 -rich ices may exist in various environments in the solar system and interstellar medium. These ices are exposed to ultraviolet photons and cosmic rays, which may cause changes in the molecular structure, thus leading to formation of new species. In this study we investigated experimentally the production of N_3 from the irradiation of N_2 -rich ices, using soft X-rays and cosmic rays analog. The results of the experiments using these sources of radiation showed that the azide radical, N_3 , was observed in ices that have been bombarded by ions and in those that have been photolyzed (range of vacuum ultraviolet and soft X-rays).

Astrophysical ices are constantly processed by ionizing agents that may be in the form of radiation or particles (ions, x-rays and gamma, photons, electrons, neutrons). Significant amounts of molecular nitrogen (N_2) are found in the constitution of some of these ices. The ionizing agents deposit high doses of energy on the ice, inducing changes in their structures and a series of chemical reactions that can be verified in the laboratory. The result is the appearance of various molecular species.

In this study we investigated experimentally the production of N_3 from the irradiation of N_2 -rich ices, using soft X-rays and cosmic rays analog.

The experiments with ions were performed in the Grand Accélérateur National d'Ions Lourds (GANIL) located at Caen, France. For photons (range of vacuum ultraviolet and soft X-rays), the experiments have been performed using a high vacuum portable chamber from the Laboratório de Astroquímica e Astrobiologia (LASA/UNIVAP) coupled to the the Brazilian Synchrotron Light Source (LNLS) located at Campinas, Brazil.

The results indicate that during the sample processing by radiation, the infrared spectra have presented several daughter species, including the N_3 (1657 cm^{-1}). This band of N_3 also was identified elsewhere [1], which showed that the irradiation of solid N_2 and N_2 -rich ices with 0.8 MeV protons produces the N_3 (azide) radical. In the experiment employing ions the species N_2O was also observed (2235 cm^{-1}) due to the implantation of Oxygen atoms in the frozen sample. The destruction cross section of the parental species was determined, as well as, the formation cross section of N_3 and N_2O . Details of this works is given elsewhere [2].

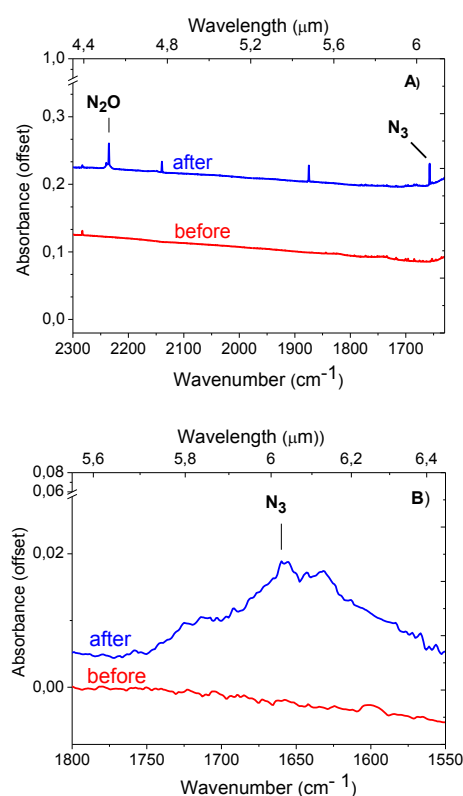


Figure 1. A) Infrared spectra of the N_2 -rich ices at 16 K before (lower) and after (upper) irradiation using ions. The vibration 2235 cm^{-1} corresponds to the N_2O . B) Infrared spectra of the $N_2 + CH_4$ ice at 12 K before (lower) and after (upper) irradiation using photons (vacuum ultraviolet and soft X-rays). Other peaks in the infrared spectra are associated with other molecules.

References

- [1] R.L. Hudson & M.H. Moore 2002 *Astrophys. J.* 568, 1095–1099.
- [2] F. A. Vasconcelos et al 2015 *A&A* (in preparation).

¹ E-mail: fred.vasco@hotmail.com ² E-mail: sergiopilling@yahoo.com.br

