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K Alcantara, A. de Barros, E. da Silveira, H. Rothard, P. Boduch. Effects on nitrogen-acetone ice induced by energetic heavy ion collisions. *Journal of Physics: Conference Series*, 2015, 635 (2), pp.022067. 10.1088/1742-6596/635/2/022067 . hal-02341330

HAL Id: hal-02341330

<https://normandie-univ.hal.science/hal-02341330>

Submitted on 1 Jun 2022

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Effects on nitrogen-acetone ice induced by energetic heavy ion collisions

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Synopsis The radiolysis of a mixture of acetone and nitrogen condensed at 13 K by 40-MeV $^{58}\text{Ni}^{11+}$ ions was studied. The bombardment with heavy ions is highly efficient for inducing chemical reactions in ices. The dissociation rate of acetone mixed with nitrogen as a function of the fluence is determined from a sequence of infrared spectra. The formation of new molecular species due to the irradiation is investigated and their cross-sections are calculated

The N_2 molecule, formed by one of the most abundant elements in the Universe, is the most common constituent of Earth's modern atmosphere. It is also a major component of the atmosphere of Saturn's moon Titan and has been detected in trace amounts in the atmospheres of Venus and Mars. In acetone (CH_3COCH_3) the C=O link, which also occurs in several molecules of biological interest, is present. The mixture of these two molecular species, $\text{N}_2:\text{CH}_3\text{COCH}_3$, causes asymmetries in the nitrogen molecule, which enhances the IR absorption and allows its study by FTIR spectroscopy. Moreover, the cosmic ray - ice interaction can be simulated and analyzed by irradiating the $\text{N}_2:\text{CH}_3\text{COCH}_3$ ice in laboratory [1].

Therefore, $\text{N}_2:\text{CH}_3\text{COCH}_3$ ice (1:1) was irradiated with 40 MeV $^{58}\text{Ni}^{11+}$ ions, and FTIR spectra were obtained at certain fluences. Figure 1 shows spectra of $\text{N}_2:\text{CH}_3\text{COCH}_3$ before (dotted line) and after (solid line) irradiation. Daughter molecules resulting from the induced chemical reactions were identified; from the dependence of the molecular abundance, the evolution with fluence of destruction and compaction cross sections of the ice was determined. The average value of $2.2 \pm 0.4 \times 10^{-13} \text{ cm}^2$ was obtained for the average destruction cross-section determined via seven IR bands. At the beginning of irradiation, associated with ice compaction, the presence of N_2 accelerates the process of acetone destruction. However, for high fluences, the structural rearrangement caused by N_2 reduces the radiolysis rate compared to pure acetone [2].

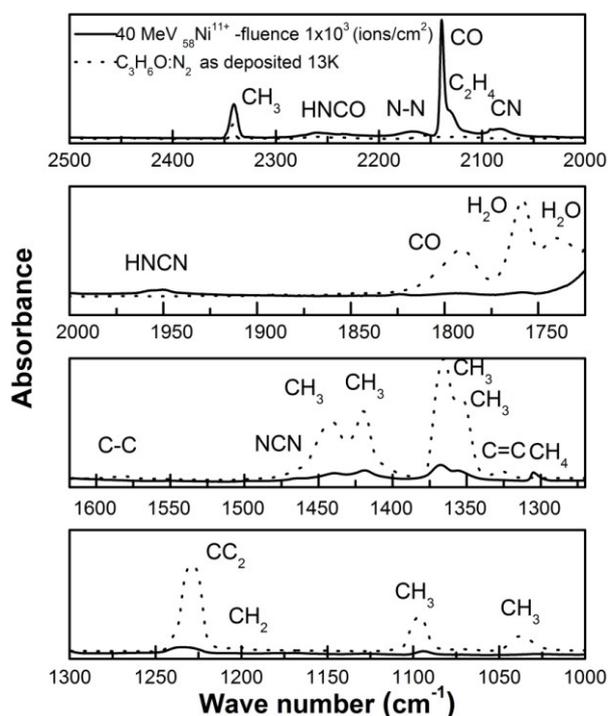


Figure 1. FTIR spectra of $\text{N}_2:\text{CH}_3\text{COCH}_3$ before (dotted line) and after (solid line) irradiation. Some corresponding vibrational modes are indicated.

References

- [1] A. L. F de Barros *et al* 2014 *MNRAS* **438**, 2026–2035
- [2] Diana P. P. Andrade *et al* 2014 *MNRAS* **444**, 3792–3801

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