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 $^{58}Ni^{11+}$ 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, N_2:CH_3COCH_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 N_2:CH_3COCH_3 ice in laboratory [1].

Therefore, N_2: CH_3COCH_3 ice (1:1) was irradiated with 40 MeV $^{58}Ni^{11+}$ ions, and FTIR spectra were obtained at certain fluences. Figure 1 shows spectra of N_2: CH_3COCH_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 ± 0.4 x 10^{-13} 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].

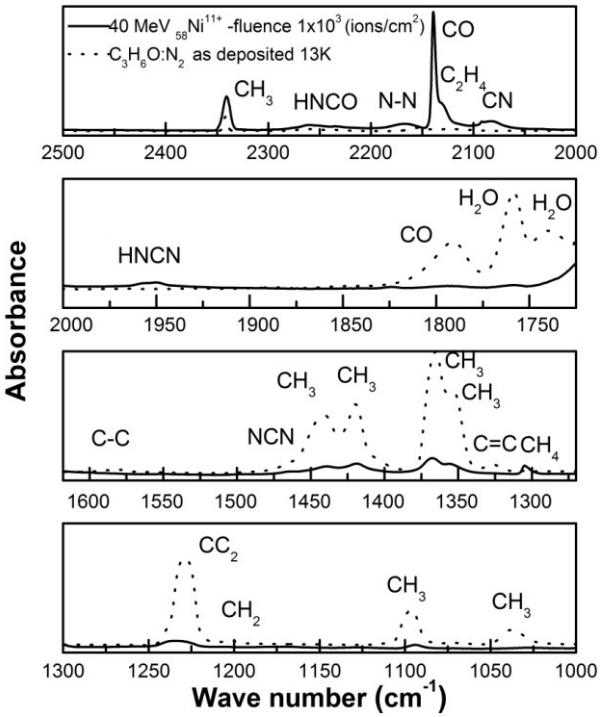

Figure 1. FTIR spectra of N_2: CH_3COCH_3 before (dotted line) and after (solid line). Some corresponding vibrational modes are indicated.

References

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