Low-temperature chemistry of acetonitrile, acrylonitrile and isobutyronitrile induced by highly-charged fission fragment impact

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Synopsis We report investigations of the low-temperature chemistry of acetonitrile, acrylonitrile and isobutyronitrile under impact of highly-charged fission fragments from ^{252}Cf decay. On the basis of plasma desorption mass spectroscopy, the experiments revealed several reaction products, positive and negative ions, including cationic and anionic clusters. Our emphasis was on identifying the ionic species that are formed in common or are prevalent, and the evolution of the abundances related to the alkyl and vinyl substituents within the three nitriles.

Several nitriles were detected in the interstellar medium, within our solar system, in cometary comae, in asteroids, on saturnian satellite Titan and on Jupiter moon Europa [1]. Nitrile chemistry is particularly relevant in planetary objects, closely related to the possible formation of prebiotic and complex organic molecules by high-energy cosmic rays [2,3].

We explore the condensed phase nitrile chemistry induced by the collision of high-mass fission fragments from the ^{252}Cf decay with kinetic energies at 100 MeV range and average charge 20+. The experimental goal was two fold, first, to identify positive as well negative ion formation and the evolution of their abundances within the three nitriles, and second, to detect the processing of larger molecular cluster species by ion desorption within the nitriles.

The formation of fragments that are not preformed on isolated molecules is observed for CH_3CN, C_2H_3CN and *i*-C_3H_7CN. Each ionic group extends up to higher masses, increasing the $C_xH_mN^+$ series. Desorption of anions following heavy ion impact showed an enhanced efficiency in comparison to cation emission, due to the high electron affinity of the cyano radical. Representative mass spectra of the desorbed positive ionic clusters are shown in Figure 1. The emission of the $(RCN)_nH^+$clusters was described by a cluster emission model based on fast and slow regimes [4].

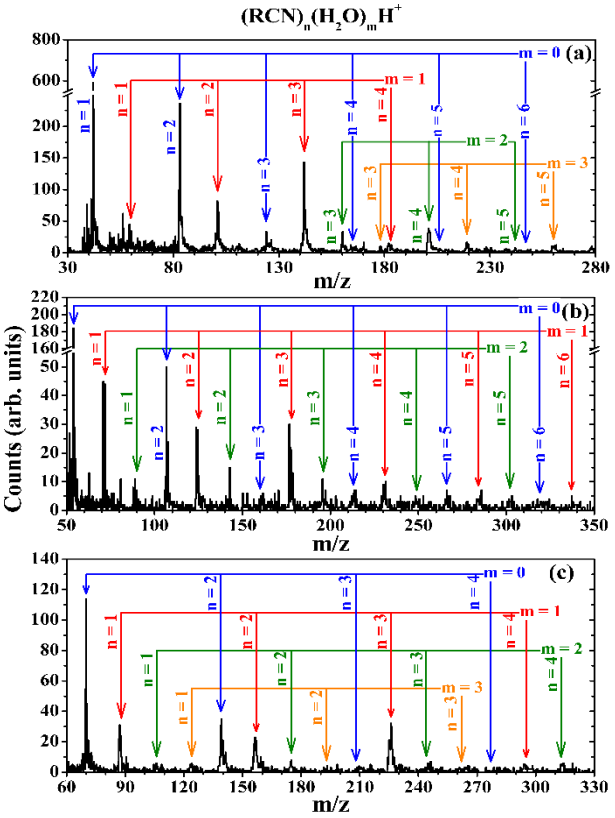

Figure 1. ^{252}Cf-PDMS mass spectra of $(RCN)_n(H_2O)_mH^+$clusters emitted from condensed (a) CH_3CN, (b) C_2H_3CN and (c)*i*-C_3H_7CN ices at 60 K.

References

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