POSTER ABSTRACT

Compact Ambient Pressure Pyroelectric Ion Source for Harsh Environment Mass Spectrometry

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We present the construction and implementation of a compact, low power ambient pressure pyroelectric ionization source (APPIS) for harsh environment mass spectrometry. In the present implementation, APPIS comprises a z–cut lithium niobate or lithium tantalate crystal with an attached resistive heater mounted with the -z face exposed in front of the atmospheric pressure inlet of an ion trap mass spectrometer. The source will work with any instrument possessing an atmospheric pressure inlet. This source is simple and robust and might prove useful in applications where unattended operations in harsh environments, long service lifetimes, and durability are desirable characteristics. Positive and negative ion formation alternately result from thermally cycling the crystal over a narrow temperature range, typically less than 30 K from ambient. Both cations and anions can be produced from a single face of the crystal, but not detected at the same time. At a fixed temperature, the net charge of the crystal face due to polarization is compensated by charged species of the opposite sign that accumulate at the interface. A decrease in temperature leads to an increase in polarization and a net surplus of negative compensating charges on the -z face. Anions are detected at this time. As the crystal is heated, the decrease in polarization results in a net surplus of positive charge on the -z face. Cations are detected at this time. Ionization of 2–(butylamino) ethanethiol or diethyl phosphoramidate, simulants for the CBW agents VX and Tabun, respectively, results in the detection of singly protonated monomers or dimers of each in the positive ion mass spectrum. Ionization of 1,1,1,3,3,3–hexafluoroisopropanol or benzoic acid results in observation of the singly deprotonated species and their clusters in the negative ion mass spectrum. Processes in which ion formation occurs directly on the highly charged crystal surface may contribute to the observed signal, as well as observed electrical discharges on the crystal surface. Video observation of the crystal z faces during temperature cycling reveals localized electrical discharges on the face of the crystal. An inductive pickup was used to investigate a correlation between discharging and ion production. A significant fluence of ions is observed during periods of electrical quiescence, suggesting the possibility of protonation and deprotonation occurring due to reactions of molecular species at the crystal face, with release of ions to the gas phase.