

Switched Ferroelectric Plasma Ionizer (SwiFerr): A Robust Ion Source for Mass Spectrometry in Harsh Environments

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We describe a novel ion source, the switched ferroelectric plasma ionizer (SwiFerr), for ambient analysis of trace substances for use in autonomous and portable instrumentation. The device takes advantage of the high electric field resulting from polarization switching in ferroelectric barium titanate (BaTiO_3). The source comprises a [001] oriented barium titanate plate with a metallic rear electrode and a metallic grid front electrode. When a high voltage AC waveform is applied to the rear electrode with the front grid electrode remaining at ground potential, the resulting electric field on the face of the crystal promotes electron emission and results in plasma formation between the sample face and the grounded grid at ambient pressure. Interaction with this plasma and the resulting reagent ions effects ionization of trace neutrals in the device. The source consumes less than one watt of power under normal operation, and ionizes molecules with acidic and basic functional groups easily. SwiFerr has proven quite versatile for ambient analysis of both vapor phase and solid phase samples, including solvents, amines, organic acids, and pharmaceuticals. Ionization of vapor phase samples of the amines triethylamine, tripropylamine, tributylamine and pyridine results in observation of the singly protonated species in the positive ion mass spectrum with good sensitivity in the low ppm range. Aerodynamic sampling of powdered samples was used to record mass spectra of the pharmaceuticals loperamide and ibuprofen. The source, which requires no reagent gases or solvents, lends itself easily to miniaturization and incorporation in field portable devices used for the rapid detection and characterization of trace substances and hazardous materials in a range of different environments.