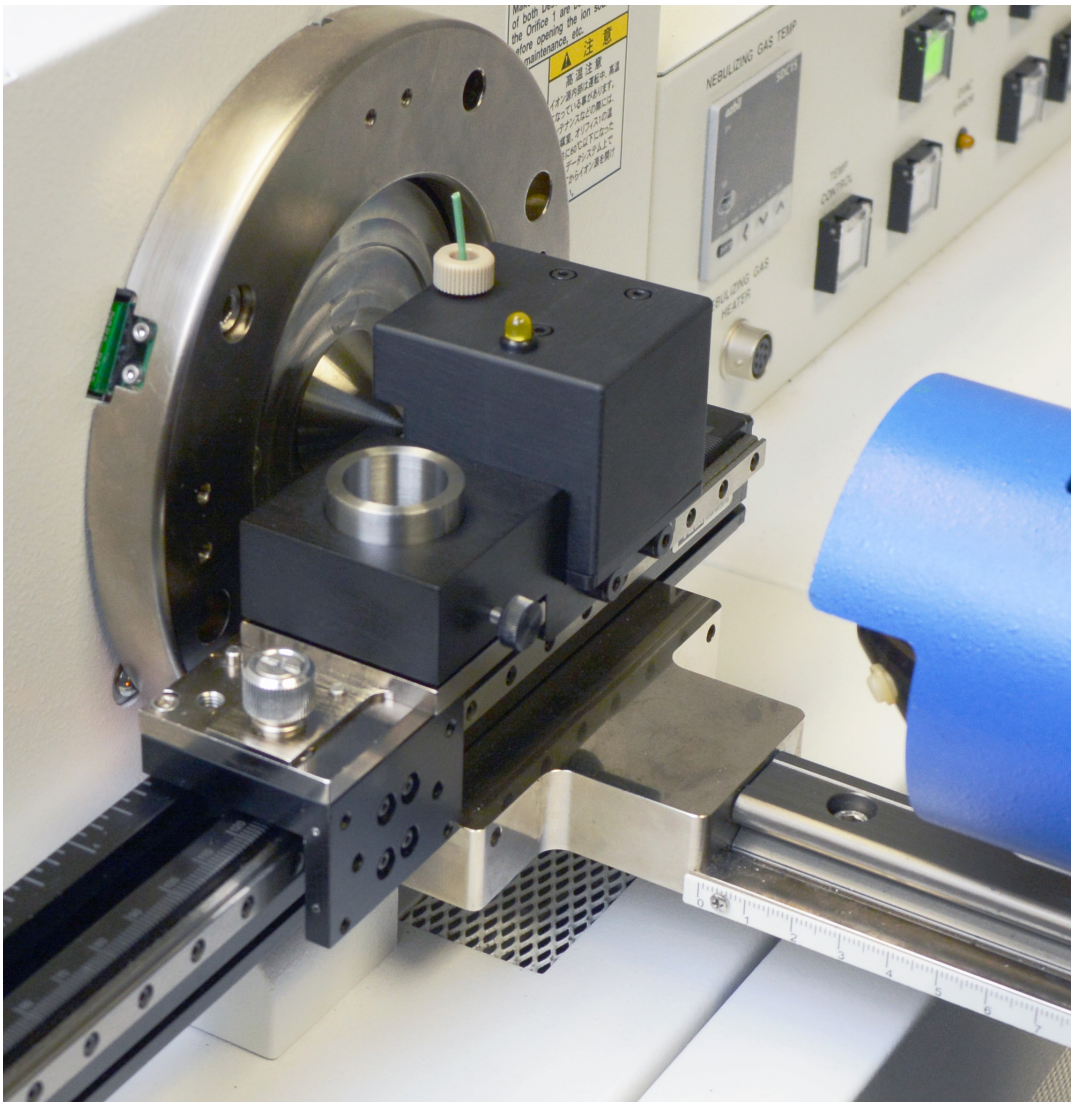
Scientific/Metrology Instruments
High-Performance
Time-of-Flight Mass Spectrometer

PaperSpray® Accessory for AccuTOF™-LP and AccuTOF™-DART® Systems



PaperSpray[1,2] Principle

Samples and a polar solvent such as methanol are deposited onto a porous substrate such as filter paper or chromatography paper cut into a triangle. When a high voltage (typically ~3000V) is applied, Electrospray Ionization (ESI) occurs at the tip of the paper triangle. PaperSpray is simpler than ESI and does not require a pump, spray needle, desolvating gas or precise alignment.

References

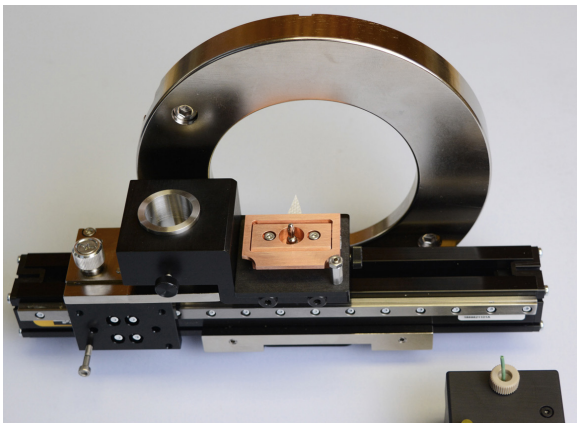
J. Liu, H. Wang, N. E. Manicke, J.-M. Lin, R. G. Cooks, Z. Ouyang. Development, Characterization, and Application of Paper Spray Ionization. Analytical Chemistry, 2010, 82, 2463.

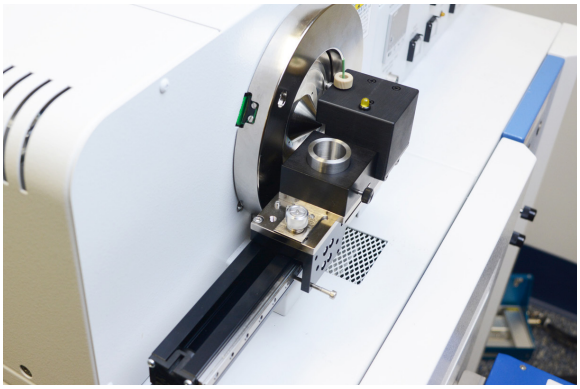
R. B. Cody, A. J. Dane. Paper spray ionization for ambient inorganic analysis. Rapid Communications in Mass Spectrometry, 2014, 28, 893.

J. Liu, N. E. Manicke , X. Zhou, R. G. Cooks, Z. Ouyang "Paper Spray" (book chapter) in M. A. Domin, R. B. Cody Ambient Ionization Mass Spectrometry, Royal Society of Chemistry, 2015.

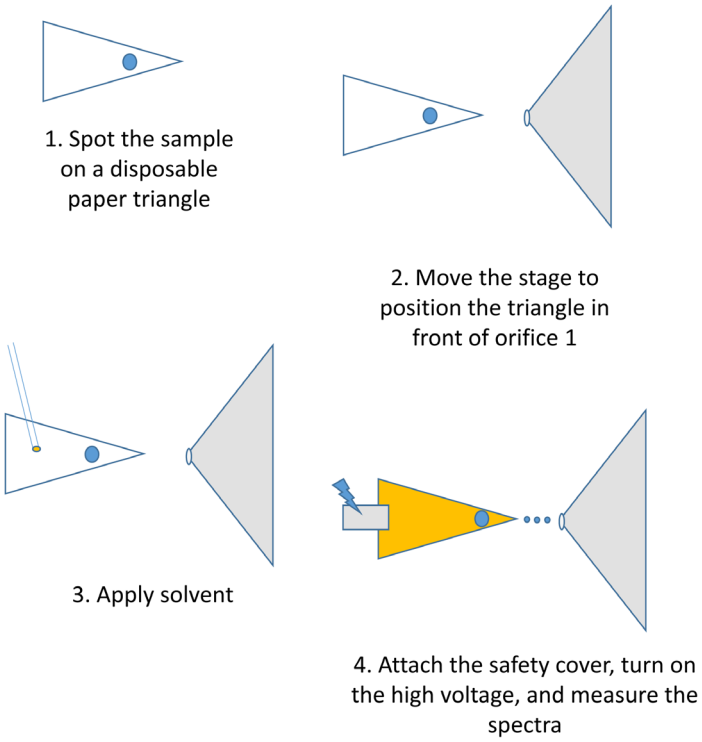
PaperSpray Ionization

- Rapid and convenient ambient analysis of compounds that can be analyzed by electrospray ionization.
- No pump
- No tubing or connectors
- No spray needle or gas connections
- Disposable paper triangles eliminate sample carryover problems





Simple Operation



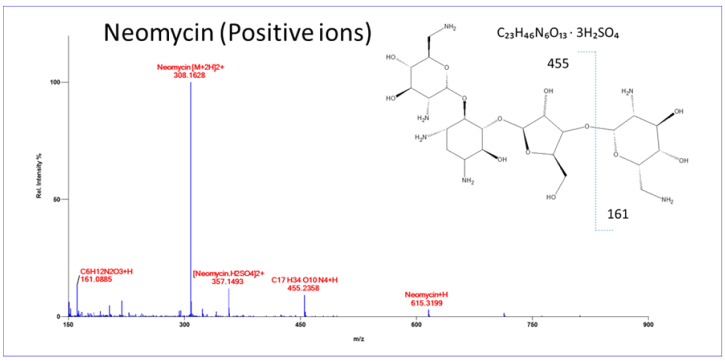
Features

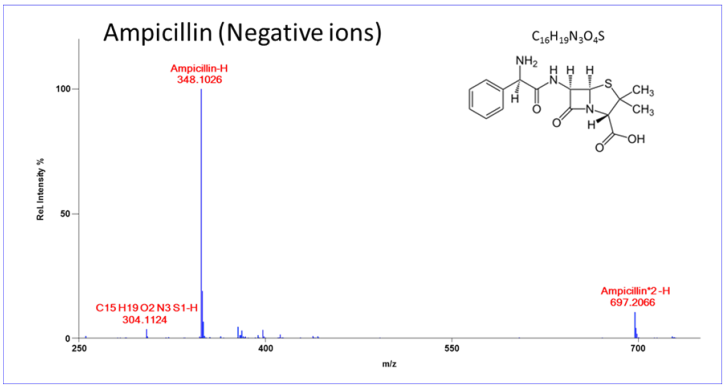
- Open-air ambient ion source for rapid analysis
- Positive-ion and negative-ion analysis
- In-source fragmentation for structural analysis and isomer discrimination
- No additional power supply required
- Uses the AccuTOF front-panel connectors
- Fully adjustable x,y,z stage
- Safety cover with interlock
- High voltage on/off safety switch and LED indicator
- PEEK tubing connection for solvent supply

Typical Applications

- Polar and highly charged compounds that are not suitable for DART analysis
- Cationic and anionic compounds with fixed charges such as quaternary amines, polysulfonated compounds
- Thermally labile compounds such as glycosides, phospholipids
- Polymers
- For example, EO/PO block and random copolymers can be analyzed without the risk of contamination and sample carryover.
- Inorganic compounds and metals
- Peptides, digests and small proteins

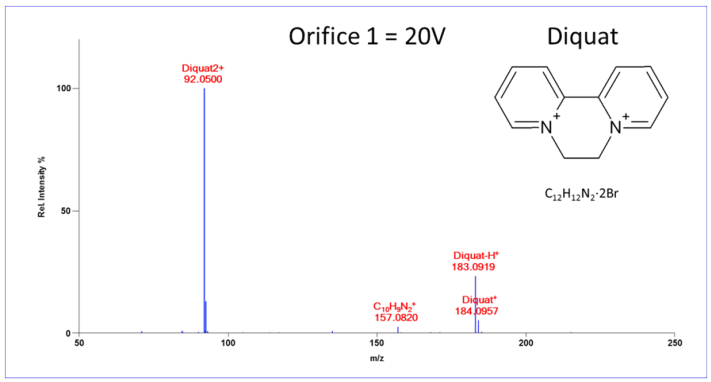
Positive and Negative Ion Spectra of Antibiotics

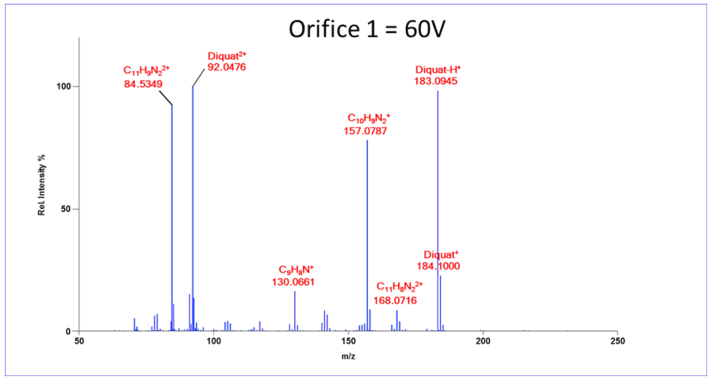




The positive-ion PaperSpray mass spectrum of neomycin with an orifice 1 voltage of 25V (top) shows peaks for both double-charge and single-charge neomycin and smaller peaks for neomycin sulfate and fragments resulting from loss of an aminoglycoside. The negative-ion PaperSpray mass spectrum for ampicillin show deprotonated ampicillin and dimer and a small fragment corresponding to loss of CO_2.

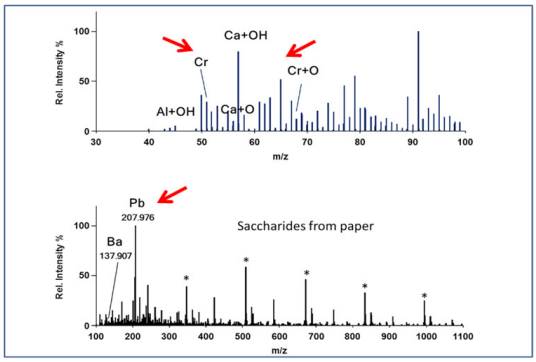
In-Source Fragmentation





In-source fragmentation can be generated on-the-fly by varying the orifice 1 voltage under computer control to provide structural information or to distinguish isomers. Even relatively stable structures can be fragmented this way. The positive-ion PaperSpray mass spectrum (top spectrum) at orifice 1= 20V of the herbicide diquat dibromide shows a dominant peak corresponding to the double charge diquat cation and smaller single charge peaks. Increasing the orifice 1 voltage to 60V results in increased fragmentation (bottom spectrum) and an increase in the relative abundance of single charge peaks.

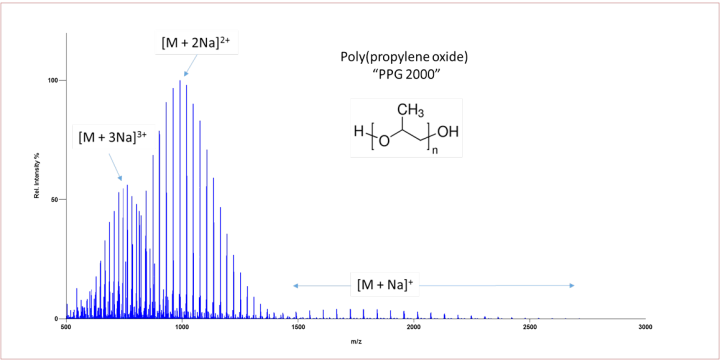
Inorganic Analysis



PaperSpray can be used to detect soluble inorganic compounds including metal ions and atomic species[1]. AccuTOF-DART PaperSpray analysis shows Pb and Cr from lead chromate pigment on a 1948 "Gold Star Mothers" postage stamp. Dilute aqueous nitric acid was spotted onto a small triangle cut out of the stamp (upper left corner). Orifice 1 was set to 180V to break up oxide and hydroxide cluster ions for the atomic species.

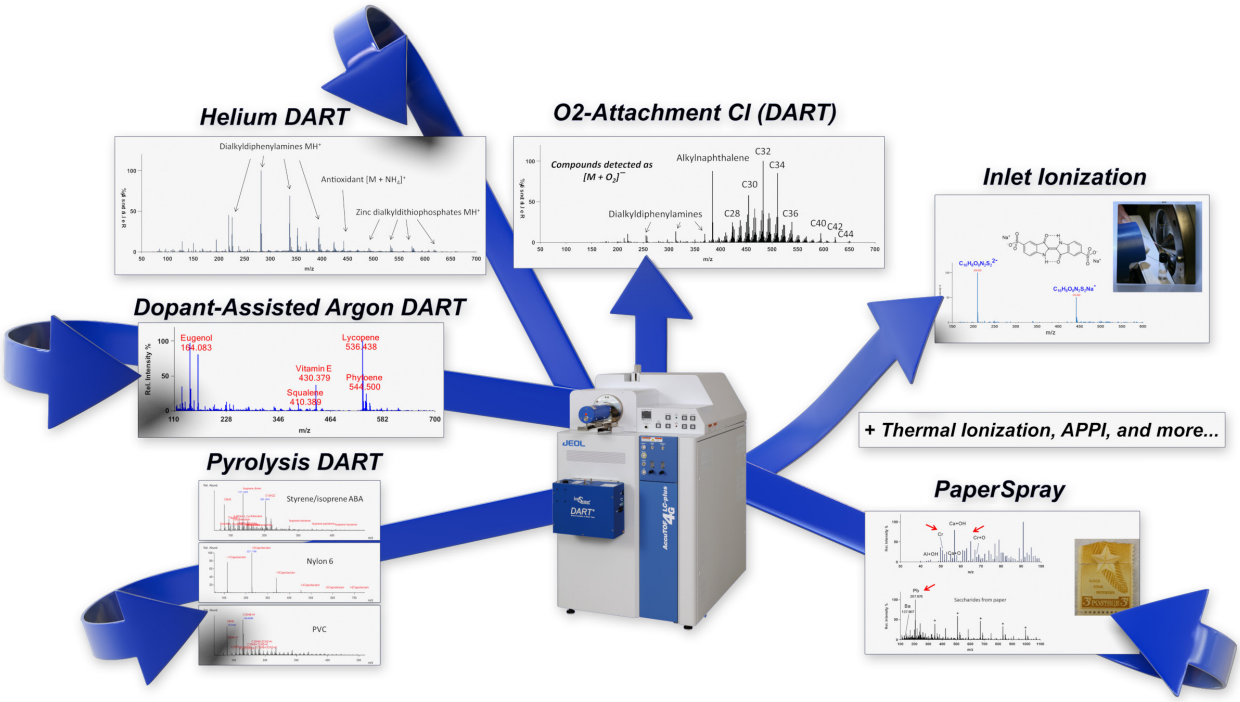
[1] R. B. Cody, A. J. Dane. Paper spray ionization for ambient inorganic analysis. Rapid Communications in Mass Spectrometry, 2014, 28, 893.

Polymers



Soluble polymers such as EO/PO homopolymers, block and random copolymers can persist in the tubing used for Electrospray Ionization (ESI). PaperSpray eliminates problems of sample cross-contamination and carryover, permitting rapid analysis of complex samples. Software analyses of the data obtained by PaperSpray analysis distinguish block and random copolymers, obtain molecular weight distributions, and determine endgroup compositions. The PaperSpray mass spectrum of poly(propylene oxide) shows overlapping distributions for sodium adducts with one, two, and three charges.

PaperSpray Adds Versatility to the AccuTOF-DART "Ambient Ionization Toolbox™"



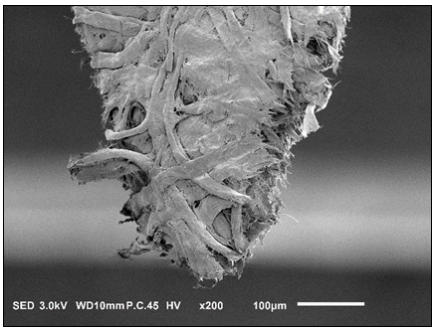
For the AccuTOF™-LC, LP, and DART® Systems

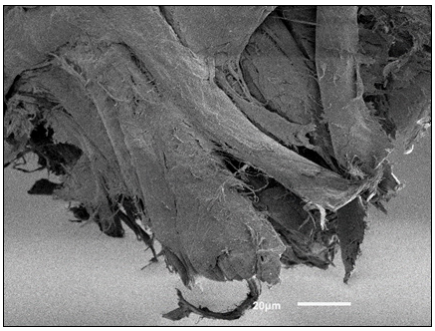
For the AccuTOF™-LC, AccuTOF™-LP and AccuTOF™-LP 4G systems

- Flange and manual rail provided for stand-alone operation
- Complementary to the ESI source and the optional APCI, DualSpray, CoronaSpray, and nanoESI sources.

For the AccuTOF™-DART® system

- Complements the DART ion source
- Can be mounted on the DART SVP linear rail
- No need to remove the DART ion source to use PaperSpray
- No additional interface hardware required





Scanning electron microscope (SEM) images of the apex of a triangular piece of filter paper used for PaperSpray ionization. The secondary electron detector images were obtained for gold sputter-coated paper at 3 kV with the JEOL IT100 Scanning Electron Microscope.

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