AutoProbe™

Automated Direct Probe for the Thermo Finnigan TRACE™ MS

Scientific Instrument Services, Inc.

An Automated Direct Exposure MS Probe

AutoProbe™

The AutoProbe is a direct exposure probe designed for automated and unattended injection of samples into the Thermo Finnigan TRACE™ MS. Samples can be analyzed in about three minutes in standard or open access modes of operation.

Features

- **Automated Direct Exposure Probe (DEP or DCI) for the Thermo Finnigan TRACE™ MS**
- **Unattended analysis of samples (2 to 5 minutes per sample)**
- **Fully integrated with Xcalibur™ software**
- **Can be used with Xcalibur ™ "Open Access" software**
- **Probe method integrated into the Xcalibur sample method**
- **CTC PAL Autosampler loads samples onto probe tip**
- **Four sample trays hold 54 or more samples each**
- **Plug in replaceable DEP probe filaments - expected life > 1000 samples**
- **Constant current or three programmed temperature ramps**
- **Samples desorbed at temperatures from 20^{o} C to >1200^{o} C**
- **Automatic filament cleaning via high temperature bakeout**
- **Probe shaft seals - expected life in excess of 2000 injections**
- **Probe seals easily replaced by user**
- **Vacuum gauge in isolation valve prevents insertion of probe into source if seals are leaking**
- **Automatic sequence stops if leaks, broken filament or other problems occur**
- **Automatic repositioning of probe without vacuum leaks if a power outage occurs when the probe is in the MS vacuum**

The AutoProbe integrates a CTC liquid autosampler with an automated Direct Exposure Probe (DEP) for the automated and unattended injection of dissolved or suspended samples directly into the Thermo Finnigan TRACE™ MS source for direct MS analysis. Using this technique, samples can be analyzed in about three minutes without any chromatographic separation. The AutoProbe is fully integrated with the Thermo Finnigan Xcalibur™ software, including system setup, methods setup, system operation and data storage.

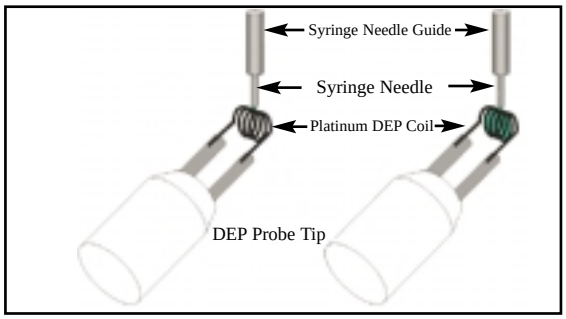
The DEP (or DCI) technique is used for the analysis of samples that are not volatile enough to be introduced into the mass spectrometer via a GC and therefore must be directly introduced into the mass spectrometer source. The DEP technique is normally used for single component samples since minimal separation of samples is possible with this technique and samples with two or more components are difficult to interpret. Alternatively DEP sample analysis is performed utilizing CI (Chemical Ionization) mass spectrometer techniques, which produce less fragmentation in the mass spectrometer. Due to the increased abundance of a molecular ion and reduced fragmentation in the CI technique, it is possible to analyze and interpret mixtures of two or more compounds in a sample.

Theory of Operation

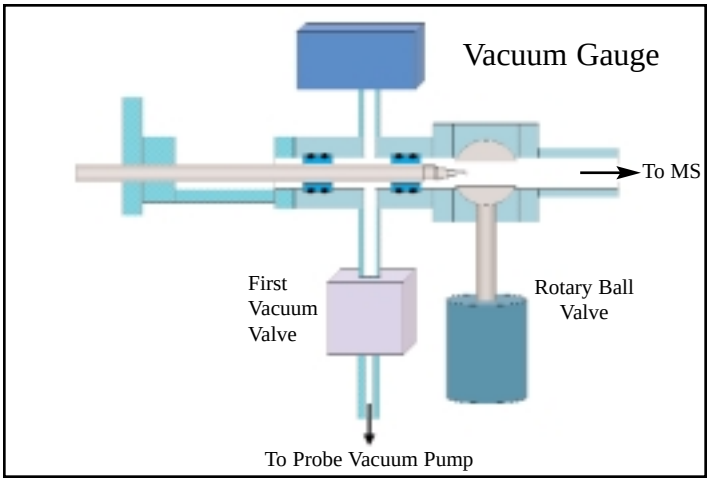
The AutoProbe components are shown below. The probe rod, with replaceable probe tips, is attached to a servo linear actuator which serves as the motor to drive the probe through the isolation valve and into the mass spectrometer source.

A CTC PAL Autosampler is used to accurately load samples onto the DEP probe wire. The automated probe operation permits the unattended analysis of samples at the rate of 2.0 to 5.0 minutes per sample (typically 3 minutes)

The filament coil on the Direct Exposure Probe (DEP) is a platinum wire. Samples for analysis are dissolved in a suitable solvent and 0.125 to 1.0 µl of the solvent containing the dissolved sample is injected onto this filament.



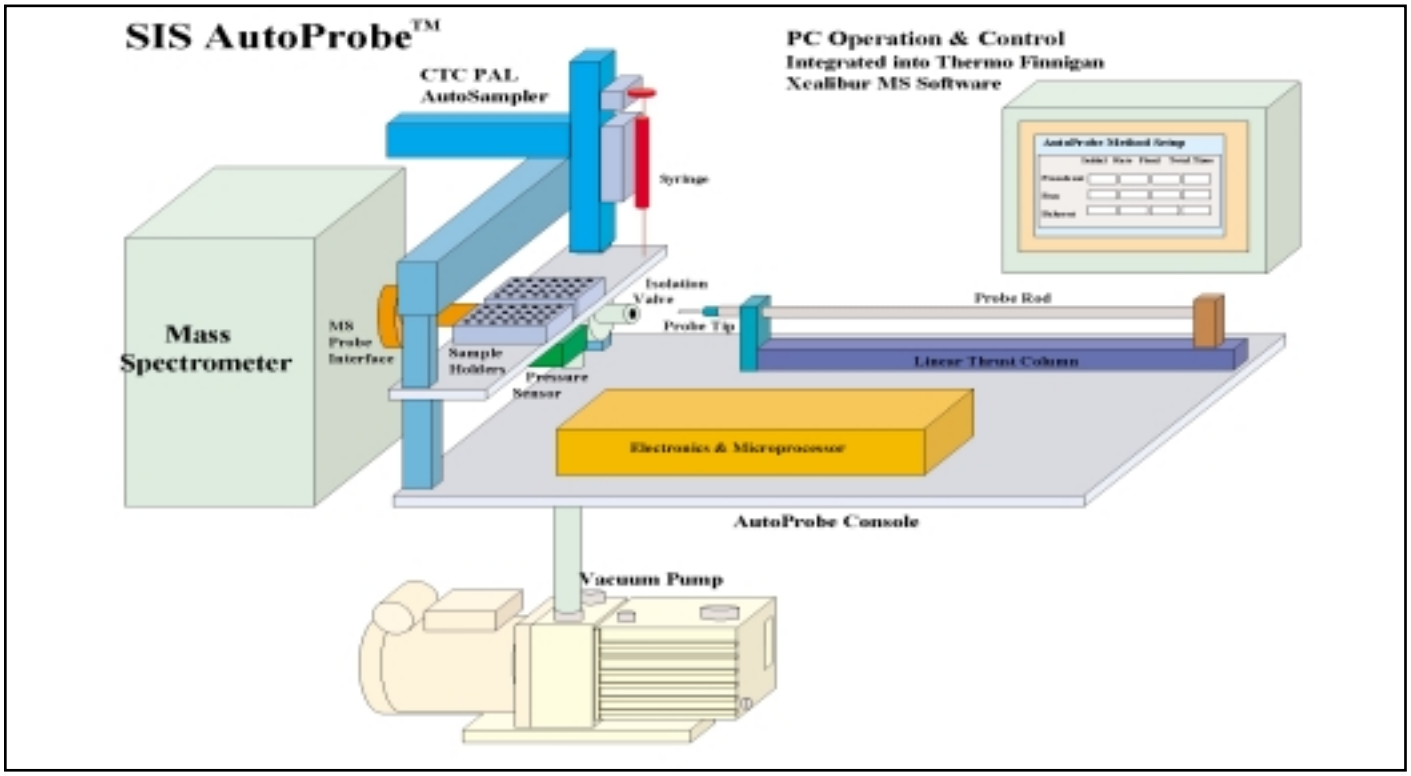
DEP Probe Tip Wire Coil



Automated Isolation Valve

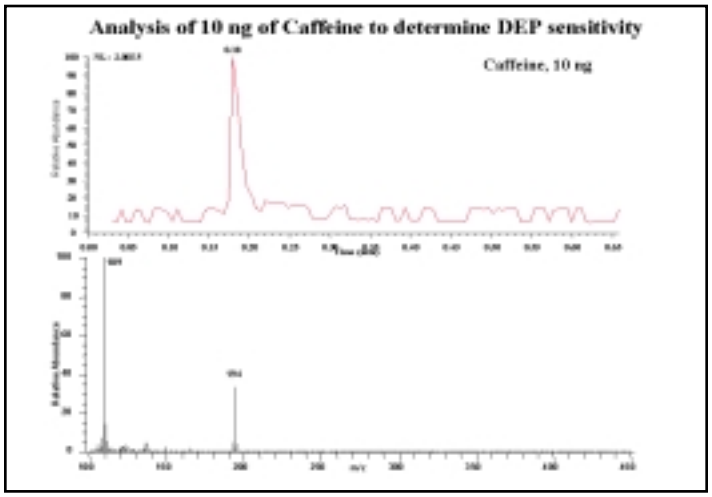
Before the probe tip is inserted into the MS, a small current is passed through the DEP filament wire to evaporate the solvent from the sample.

An isolation valve permits the introduction of the probe into the mass spectrometer without compromising the MS vacuum. When the probe is inserted into the first probe seal of the isolation valve, a vacuum valve opens allowing the accessory vacuum pump to evacuate the probe inlet. A vacuum gauge measures this vacuum, and when the vacuum reaches 200 millitorr, the probe is advanced to the second seal. A pneumatically controlled ball valve opens to permit the probe to be inserted through the isolation valve and into the mass spectrometer. This vacuum gauge acts a safety feature to prevent the probe from being inserted into the MS source should a vacuum problem occur anywhere in the system.



After the probe has been inserted into the mass spec source, a small current (typically 10 to 1000 mA) is passed through the platinum wire to heat the wire and desorb the sample into the mass spec source for analysis. This DEP probe filament can be set to a constant current or the current can be programmed in up to three ramp steps to obtain the optimum results depending on the sample being analyzed.

After the sample analysis is completed, the probe tip is removed from the MS source and a high filament current is passed through the wire coil to burn off any sample remaining on the filament wire coil. This assures that the filament wire is clean and ready for the next sample.

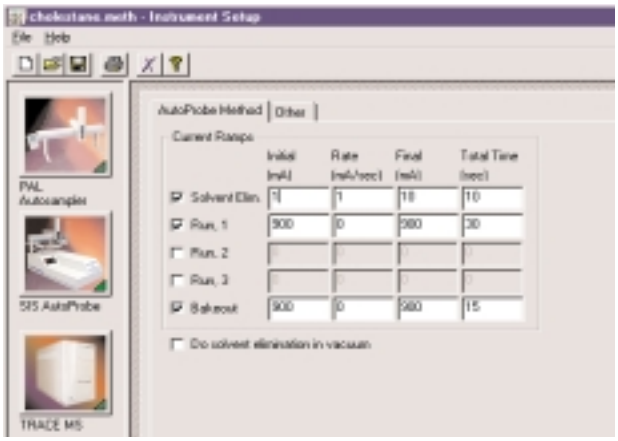


A Typical Sample Analysis is Fast and Sensitive

Direct probe techniques are less sensitive than GC techniques, because the probe peaks in the total ion chromatograph are much wider and therefore less intense than a typical GC capillary peak. However, by utilizing the rapid temperature ramp capabilities of the AutoProbe, sample sizes less than one nanogram have been detected and identified.

AutoProbe Software and PC Control

The AutoProbe is software controlled and is fully integrated within the Thermo Finnigan Xcalibur™ MS software. The AutoProbe is configured in the Xcalibur software as an accessory instrument in the Instrument Setup menu.



AutoProbe Method Setup Screen

The method parameters for the operation of the AutoProbe, including ramp rates and times of system parameters are entered into data screens controlled within the Xcalibur system software and saved as part of the Xcalibur method.

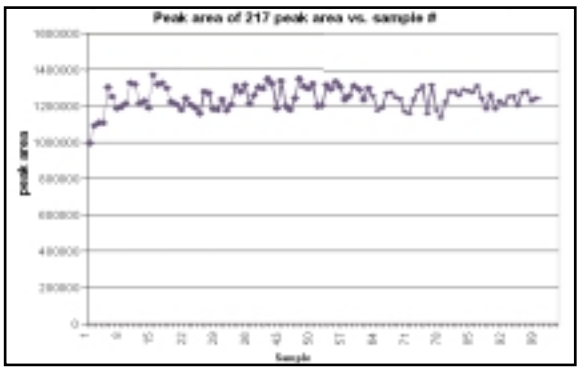
The probe tip coil is heated at three different locations which can be selected and set via the PC screen window. The first step is the solvent elimination step. The second stage of heating is during the actual sample analysis inside the MS source. The DEP coil can either be heated ballistically or it can be ramped to temperature at up to three variable ramps. The final heating of the DEP coil is for the cleaning of the probe tip to assure that sample cross contamination does not occur.

Xcalibur "Open Access" Log In Screen

The AutoProbe is fully integrated into the Xcalibur "Open Access" Mode of operation. The "Open Access" Mode permits the chemist or technician to submit samples directly to the mass spectrometer for analysis. The samples are then analyzed automatically when the system is available and the results reported back to the chemist with little or no interaction of the mass spectrometer operator. This results in increased productivity from the mass spectrometer lab.

Reproducibility

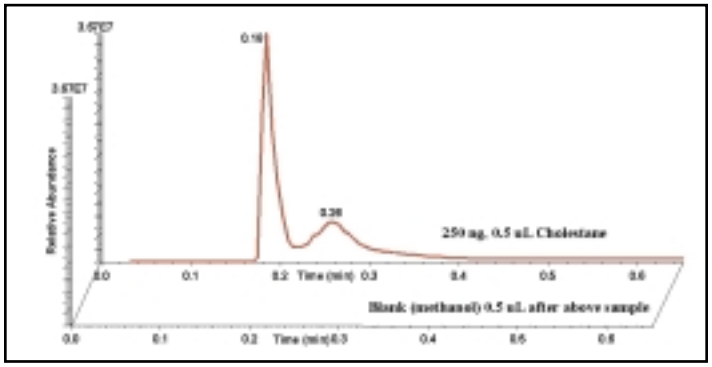
Historically the direct probe techniques are not known for their reproducibility. When manually injecting a sample onto a DEP probe, it is quite difficult to reproducibly apply a sample to a DEP coil and the coil is easily repositioned. These problems are eliminated with the AutoProbe. As a result when the same sample was analyzed more than 150 times as shown below, the areas of the resultant total ion chromatograms were reproducible within 10% or better of each other.



Reproducibility of the DEP Technique

Memory, Background and "Cross Contamination

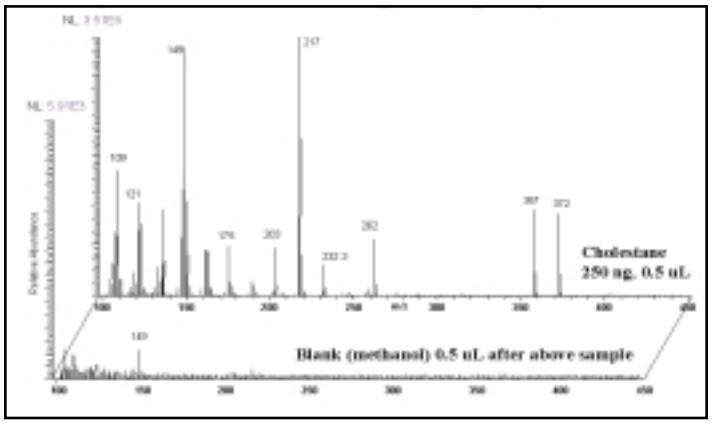
A technique is of little use if "cross contamination" or "memory effects" occur during sample analysis. This problem does not occur in the AutoProbe because the DEP wire is "baked out" at high temperatures between



Background Check After Running Strong Samples

samples. The chromatograms below show the analysis of a 250 ng Cholestane sample dissolved in methanol. This analysis was repeated 5 times. The DEP coil was baked out at 900 mA for 15 seconds after each sample and then a blank clean methanol sample was analyzed. The blank injection produced a flat baseline with no carryover from the previous samples.

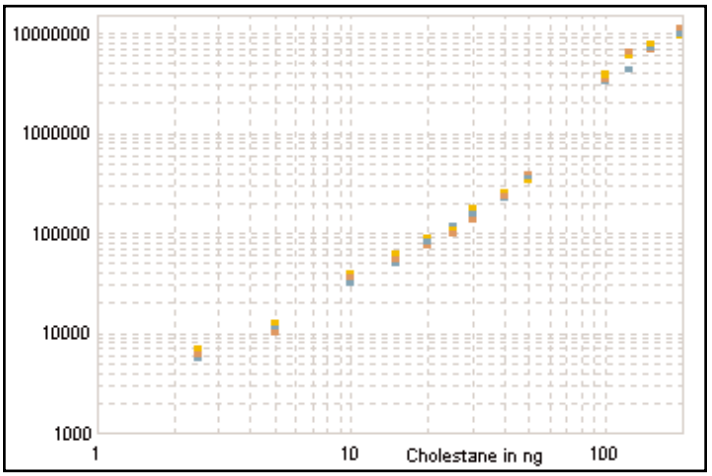
The charts below show the MS data at 0.18 minutes for the 250 ng of Cholestane and the blank methanol sample. Note that the scale on the blank methanol spectrum is 1000 times the scale of the 250 nanogram of Cholestane. No peaks were found in the blank sample that could be attributed to the Cholestane. In this study, as well as many others, it was confirmed that "memory effects" or "cross contamination" problems do not occur with the AutoProbe technique. It is recommended that the high temperature "bake out" be used in all analysis. A blank sample between analysis is optional.



Background MS After Running 5 Consecutive Strong Samples

Quantitation

Quantitation techniques have not been previously accomplished with the DEP probe techniques. This is due to the same reasons discussed under "reproducibility" above. However the AutoProbe overcomes these short comings and the technique has been found to be quantitative as shown below. In this study, as well as several others reported in an application note on our web site, linear calibration curves of pure analytes were achieved with the AutoProbe technique. This reproducibility and quantitation capability is due to the automation of the system with the exact same conditions being applied to each sample and the unchanging geometry of the DEP filament. Since the filament coil is never touched or moved, the sample is injected onto the DEP coil in precisely the same point for every sample. This opens up many new applications for the AutoProbe technique



Typical Calibration Curve for an Analyte Using the AutoProbe

AutoProbe System Specifications & Requirements

Voltages

AutoProbe Console Voltage: 110 VAC
Edwards Vacuum Pump: 110 VAC

Compressed Air: minimum 60 psi

Mass Spectrometer System Requirements

Thermo Finnigan TRACE™ MS System with Xcalibur™Software
Trace MS EI/CI Source for the Manual Probe

Dimensions

Console without CTC PAL Autosampler:
21" wide x 39" Deep x 11" High
Console with CTC PAL Autosampler:
21" wide x 39" Deep x 33" High
Base Dimensions:
37" x 17" x 36" high
height is adjustable from 33" to 46" high(distance to top of base)

Weight

Console Weight: 150 pounds
Base Weight: 70 pounds
Total Shipping Weight: 500 pounds

For additional information call Scientific Instrument Services, Inc. at 908-788-5550

Features:

- Automated Direct Probe MS Analysis
- Interfaces to Thermo Finnigan TRACE™ MS
- Utilizes DEP Probe Technique
- Mass Spec Probe Analysis in 3 minutes
- Fully Integrated with Xcalibur™ Software
- Can be used in "Open Access" operation
- Multi-Step Probe Tip Heating
  - Low Temperature Solvent Removal
  - Programmable Current Heating of Samples
  - High Temperature Ramp for Cleaning

Applications:

- Drug Discovery Confirmation
- Quality Control Analysis
- Open Access MS Analysis
- Sample Purity Verification
- Detection of Sample Contamination
- Sample Profiling

Visit Our WEB site for information on

- AutoProbe Description
- Theory of Operation
- Accessory Equipment and Supplies
- Installation Directions
- Application Notes

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