AB SCIEX Uses Pro-Dex Controllers in a New Dimension of Selectivity and Sensitivity Instrument for Analytical Chemistry Research within a Quadrupole Mass Spectrometry

Beaverton OR- Electrospray Ionization, when combined with mass spectrometry, provides an unparalleled value.

In the most general sense, electrospray is a method of generating a very fine liquid through electrostatic charging. Electrospray uses electricity instead of gas to form droplets. In electrospray, a liquid is passed through a nozzle. The charged liquid in the nozzle becomes unstable as it is forced to hold more and more charge. Soon the liquid reaches a critical point at which it can hold no more electrical charge and at the tip of the nozzle it blows apart into a cloud of tiny, highly charged droplets.

When electrospray is used as a soft ionization method for chemical analysis, the more generally accepted term is “electrospray ionization” (ESI). Ionization is the process of generating a gas phase ion from a typically solid or liquid chemical species. It is called “soft” because the molecules being ionized do not fall apart or break-up during the process. Ionization is a critical event in mass spectrometry as only ions can be accurately measured. Once the ion’s mass is known, the chemical composition can be determined. When combined with mass spectrometry, the value of ESI is unparalleled, especially in the analysis of large biological molecules such as proteins and DNA.

The quadrupole MS (mass spectrometer) is used for all types of chemical analyses, ranging from environmental analysis to the analysis of petroleum products, forensic, agriculture, trace metals and biological materials (including the products of genetic engineering). A quadrupole MS system can provide other information as well, for example, qualitative and quantitative analysis. This range makes it the de facto standard system among mass spectrometers.

How does a mass spectrometer work within AB SCIEX Quadrupole MS?

The AB SCIEX Triple Quad 5500™ and QTRAP® 5500 are high sensitivity instruments. For greater or higher resolution systems, AB SCIEX’S Triple TOF
5600™ provides very high resolution and mass accuracy. All these instruments stem from the quadrupole technology.

As the name suggests, quadrupole MS systems contain four parallel cylindrical metal rods (electrodes with a hyperboloidal interior surface) inside a vacuum chamber. Ions generated in the ionization unit are accelerated in the z-direction by relatively weak voltage of only a few dozen volts. Theses ions pass through a tiny orifice and enter the quadrupole area. Voltage of the same polarity is applied to diagonally-opposite poles and opposite voltage polarity is applied to adjacent poles. When a combination of direct current voltage \( U \) and high-frequency alternating current voltage \( V \cos \omega t \) is applied to each pole (\( \omega \) is frequency and \( t \) is time), an electric field with a rapidly varying phase is generated within the quadrupole.

Consequently, ions passing through this electric field oscillate in the x and y directions. When a given set of conditions (for \( u, v \) and \( \omega \)) are applied, certain ions in a specific mass-to-charge ratio (m/z) range maintain a stable oscillation and pass through the quadrupole to reach the detector.

**Characteristics of Quadrupole MS**

Since Quadrupole MS systems are compact and easy to use, they are also operationally easier to maintain and are less expensive. Mass Spectrometers require high vacuum levels, whereas quadrupole MS systems are able to separate ions at lower vacuum levels than other mass separation methods. This makes the Quadrupole MS the best suited for interfacing with chromatographs.

Pro-Dex motion controllers with integrated stepper drive were selected by AB SCIEX organization for their SelexION™ instrument technology. A new dimension in selectivity, the SelexION™ instrument is an effective ion mobility separation tool for improving data quality in the quantitative and characterization of challenging samples requiring advanced analytical selectivity.

These highly advanced analytical applications include explosives, drugs, chemical warfare agents, toxic and industrial components, sulfur contained chemicals, and other organic and inorganic substances.
Dr. Bradley Schneider, Ph.D, for the SelexION™ development, says the success of SelexION™ technology to facilitate great scientific research hinged upon its reputation for providing an ion mobility separation tool that has the reproducibility, robustness and ease of use to deliver highly selective and sensitive quantitative and qualitative analyses time after time. This high standard comes from the world’s leader in Mass Spectrometer, AB SCIEX, for whom failure is not an option. After 3 years of developing the scientific solution to control a highly customized liquid delivery pump, Dr. Bradley Schneider undertook an extensive search to select and integrate the right motion control solution to control a highly customized pump. Precision, support and simplicity of integration with ease of use and reliability were critical when the Pro-Dex system was selected for their project. In the end, Dr. Bradley Schneider selected a Pro-Dex controller with interface for USB/RS232 and integrated stepper drive that used a high micro-stepping resolution, all packaged into a Chromate enclosure to ensure EMI for CE testing.

Pro-Dex controllers provided extreme step and direction accuracy with an on board “0” backlash compensation which greatly attributed to the precision for controlling the custom pump. This was very important to AB SCIEX because slippage within the system will cause inaccuracy for the overall performance, and not meet the 120 to 2000 uL/min flow rate, and a precision flow of 0.5%.

The Pro-Dex motion controller adds advanced control within the AB SCIEX SelexION™ Technology that gives way to a new solution to selectivity challenges in quantitative bioanalysis. One of the key SelexION™ technology innovations is the introduction of a chemical modifier; this technology adds a new dimension to selectivity and dramatically increases peak separation power when needed. The modifier device is an effective ion mobility spectrometry tool that improves data quality in the quantization and characterization of challenging samples requiring advanced analytical selectivity.

Chemical modifier adds new dimensions:

- ability to add a chemical modifier to increase peak separation power when needed
- stability and reproducibility - proven for regulated bioanalysis guidelines
- technology can be used to solve selectivity challenges while maintaining rugged bioanalytical performance
- adds differential ion mobility spectrometry to AB SCIEX Triple Quad™ 5500 and QTRAP® 5500 Systems with a compact, easily interchangeable unit
- easy to mount/dismount - can be setup in less than 2 minutes without the need to break vacuum and does not require any tools
A clear difference with the AB SCIEX SelexION™ technology

A clear difference
Eliminate high chemical noise in bioanalysis for pharmaceutical drug discovery and development.

Background checked
Reducing background interferences from co-eluting peptides in complex digested matrices.

Injection of clenbuterol at 5 pg/ml in urine (a) High chemical noise makes the detection impossible. (b) Differential ion mobility separation (DMS) increases selectivity and eliminates the high background producing a 10X improvement in signal-to-noise.

Stable isotope labeled synthetic peptides generated for quantitation of a therapeutic IgG in digested human plasma showed much cleaner MRM signals at the same on-column amount when a mobility separation was performed. This yielded a ~5x improvement in the LLOQ achieved on column.

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Pro-Dex, Inc. – OMS
Over the past 30 years Pro-Dex OMS has well over ½ million axes of motion control in use around the world. Pro-Dex OMS provides the experience, proven reliability and performance that gain the trust and confidence of design engineers worldwide.

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