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Mass Spectroscopy: What is it and what are its Types?

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ABSTRACT

Mass spectroscopy or mass spectrometry is the process of analyzing samples of an element or mixture in order to determine the mass to charge ratio of its components on a mass spectrum.

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Introduction

Mass spectroscopy or mass spectrometry is the process of analyzing samples of an element or mixture in order to determine the mass to charge ratio of its components on a mass spectrum. The technique takes advantage of the fact that two charged particles with the same mass to charge ratio will follow the same path across uniform electric and magnetic fields.

Using this principle, a mass spectrometer can be designed. The instrumentation works by splitting molecules into their constituent ions. The ions are charged particles; hence they get accelerated via an electric field.

Then, if the moving ions are subjected to a magnetic field, they'll deflect by a certain amount depending on their mass and charge. Heavier particles exhibit less deflection than lighter particles with the same charge. The charges are then collected on a detector plate, essentially a sensor that detects ions that impact it and converts it into quantifiable information. The information can then be represented on a graph showing the relative abundance of ion in relation to its mass to charge ratio of the sample.

Types of Mass Spectroscopes

MALDI-TOF

MALDI-TOF or Matrix-assisted laser desorption ionization-time of flight is a commonly used MS technique. It requires the use of lasers to create ions. This enables molecules to undergo a soft ionization resulting in lower fragmentation of molecules when detected. The rest of the process is the same.

MALDI-TOF works on a range of molecules with high accuracy and turnaround time at a lower cost of operation. The only caveat is that it is not as sensitive, requiring larger samples to detect molecules.

Figure 1.

A molecule model with reflection on a dark surrounding

Triple Quadrupole

The triple quadrupole is a type of tandem mass spectroscopy where multiple mass spectrometers, in this case 3 joined in series, are used to analyze samples. Commonly, this type of spectroscopy is used to study complex biological organic molecules like proteins.

In triple quadrupole mass spectrometry, the sample can be ionized by a number of techniques and enters the first spectrometer. Here, it is filtered, and only particles with a certain mass to charge ratio allowed to pass to the collision cell - the second mass spectrometer. Here fragmentation of the sample occurs via an interaction with an inert gas that produces a specific daughter cell. The ions then travel into the third spectrometer, which acts as another filter but this time for fragmented daughter ions.

Depending on the combination of spectrometers, ionizers, and detectors used for the triple quadrupole technique, one can obtain accurate results with faster response time. However, the system is prone to overloading, which leads to a limited lifetime.

Hybrid Linear Ion Trap Orbitrap

This is another type of tandem mass spectroscopy. The equipment uses a linear quadrupole ion trap and an Orbitrap in combination with the mass spectrometers. The linear quadrupole ion trap is used for capturing charged particles in a linear electric field acting as a filter.

The orbitrap acts as a detection component, making molecules orbit around an electrode. This interaction of charged particles with the electrode generates a current. The current's frequency determines the mass to charge ratio in the resulting spectrum via its Fourier transform.

This type of mass spectrometry is readily used in bioinformatics for studying complex natural molecules that take part in cellular reactions.