

§10.1.1 Principles

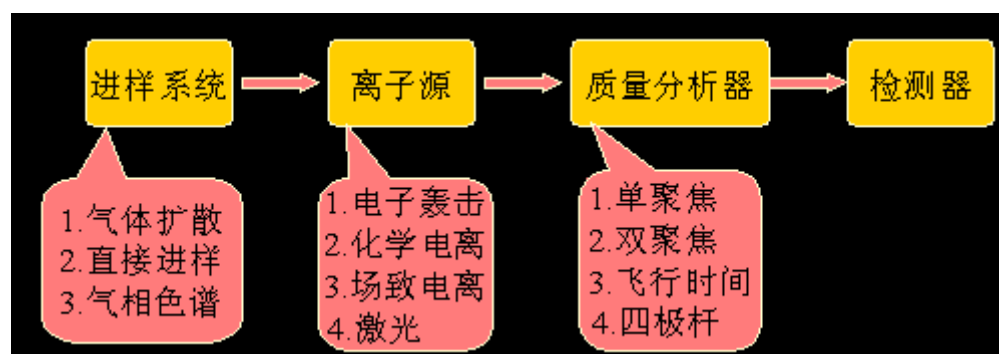
Mass spectrometer is an instrument, which is designed to ionize gaseous molecules, separate the ions produced on the basis

of their mass- to- charge ratio, and record the relative number of different ions produced.

Mass spectrum is a plot of the data obtained from the mass spectrometer. It is a plot of the relative intensity of ions versus the mass/charge ration. Mass spectrum analysis is an important structure analysis method of organic compounds.

1. Key parts of mass spectrometer

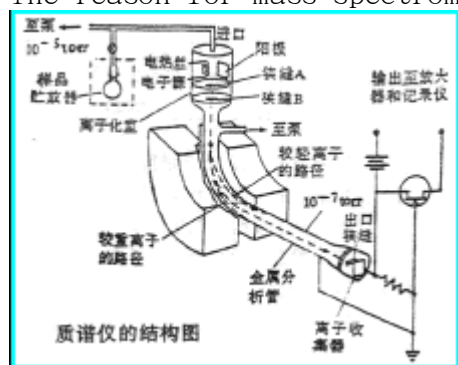
Sample inlet, ion source, mass analyzer, and detector



Mass spectrometer works at very high vacuum.

Ion source ($10^{-3} \sim 10^{-5}$ Pa), mass analyzer (10^{-6} Pa)

The reason for mass spectrometer to work at ultrahigh vacuum:



- (1). Filament of ion source may be damaged by oxygen

- (2). Lead to discharge
- (3). Cause other ion-molecular reaction, alter the decomposition model and make the spectrum

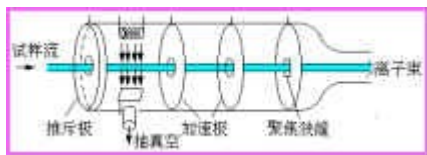
more complex

2. Principles of mass spectrometer

Principles of mass spectrometer :

After the molecule enters the ionization chamber, it will be bombarded into parts with different mass/ion ratio (with positive charge),

and then these parts will be accelerated by the acceleration electro field and arrive at the detector according to their different in mass.



1. Principle and structure of ionization chamber:

The structure of the ionization chamber is shown in the following figure. It is composed by a

hot electron emission electrode, acceleration electrode and focusing system.

- 2. Principle of mass analyzer

The kinetic energy of ion after acceleration is:

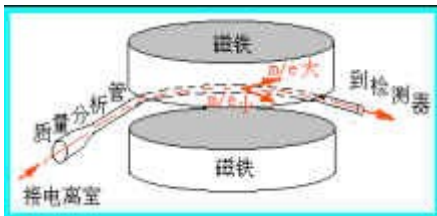
$$(1/2)m\nu^2 = e V$$

$$\nu = [(2V) / (m/e)]^{1/2}$$

When interaction with the external magnetic field, the charged ion will move along a curvature.

When the centrifugal force equals the centripetal force, the charged ion will pass the mass analyzer and arrive at the detector.

$$\text{So: } m\nu^2 / R = H0e V$$



$$\text{The curvature radius is: } R = (m\nu) / e H0$$

$$\text{The equation of mass spectrum is: } m/e = (H0^2 R^2) / 2V$$

The curvature radius of the trajectory of the ion in the magnetic field is determined by the

mass -charge ratio, the intensity of the magnetic field and the electro voltage.

By altering the acceleration voltage, the charged parts of the molecule can be separated by their arrival time at the detector.

$$\text{The equation of mass spectrum} = m / \Delta m$$