Mass Spectroscopy

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Mass Spectroscopy- Any of various devices that use magnetic fields, electric fields, or both to determine the masses of isotopes in a sample by producing a mass spectrum. Two types of mass spectroscopes are the mass spectrograph and the mass spectrometer.

Methods of separation of ions.

As ionization methods and ways of spatial separation of ions there is quite a lot.

Fig. 1 is a diagram illustrating the working principle of so-called magnetic mass spectrometer in which ions are separated by a magnetic field ionization by electron impact.

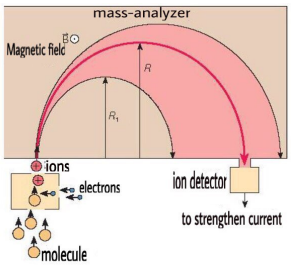

Figure 1:

The mass spectrometer requires the creation of it is very pure vacuum. The pressure of the residual gas in the apparatus is usually about $10^{-7} - 10^{-10}$ mmHg.

The neutral molecules of the gas coming to the ionization chamber, where they are exposed to ionizing collision with electrons. In this part of the molecules (about 0.1 percent) is transformed into ions by the schemes presented above. The electric field formed by the accelerating potential difference U, according to the kinetic energy of the ions. Using the law of conservation of energy, we obtain:

$$qU = \frac{mv^2}{2}$$

On the ion, flying at a speed υ in the mass analyzer, the Lorentz force:

$$F = q\upsilon B$$

In this case, the magnetic induction vector directed to us, and the angle between B and υ is equal to 90 At the same time, F is the centripetal power:

$$F = \frac{m\upsilon^2}{R}$$

and hence:

$$q\upsilon B = \frac{m\upsilon^2}{R}$$

As a result, the ion of mass m and charge z will move in a magnetic field of a circular arc radius R, defined by the relation:

$$R = \frac{m\upsilon}{qB}$$

or

$$R = \frac{1}{B}\sqrt{\frac{2mU}{q}}$$

Therefore, changing of U or B, you make move a circle of radius R, which is located on the line in the detector entrance slit, or other ions of the mass or charge quantity. Writing the dependence of the ion current of m / z, get a set of peaks, called mass spectra.

Another way to separate ions in mass - to create a momentary impulse of a constant electric field. Getting speed

$$\upsilon = \sqrt{\frac{2qU}{m}}$$

ions reaches the collector during

$$t = \frac{L}{\upsilon} = \sqrt{\frac{m}{2qU}}$$

where L - length of the analyzer. Thus, because of the difference in the masses, ions produced velocity inversely proportional $\sqrt{m}$.

Ion forms a "package", in which the flying head light ions, while it severe short, and therefore, the ions reach the collector at different times. This is the principle of separation of ions into the mass TOF mass spectrometry, the main advantages of which are virtually unlimited range of masses and the very fast time of registration of the mass spectrum of the order of $10^{-3}c$.

In the mass spectrometer ion cyclotron resonance ion moves under the action of two fields: the strong static magnetic and electric alternating (Fig.2).

The magnetic field ion moves in a circle with angular frequency

$$\omega = \frac{qB}{m}$$

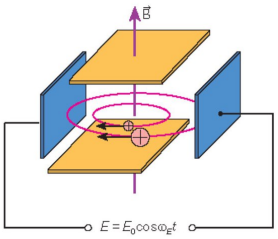

Figure 2: ion moves under the action of two fields

determined by the mass of the ion and the magnetic induction. The electric field varies with angular frequency wE by law

$$E = Ecos * \omega Et$$

In case of equal frequencies E and V (recall that the latter depends on the ion mass) resonance occurs, which manifests itself in a noticeable absorption of the energy of the electric field. This extremely compact mass spectrometer (cell of some species does not exceed the size of the lumps of sugar), has a very high sensitivity, resolution and mass range. It is interesting to note that the ions in the cell can be held at their circular orbits several tens of hours. Negative ions, which may also be produced during the ionization cell rotating in the opposite direction will also recorded in the mass spectrum at a frequency of the electric field corresponding to their mass.