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A PULSED Cs ION GUN FOR TIME OF FLIGHT MASS SPECTROMETRY

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A pulsed ion gun has been built at the I.P.N. for surface analysis of organic and inorganic solid layers. The secondary ion mass analysis is made by time of flight measurements. In the spectrometer, MeV ions emitted from a ^{252}Cf radioactive source can also be used to bombard to same targets. The principle of the apparatus is similar to the Manitoba system [1] but the ion source and the geometrical arrangement are different.

The Cs ion source is Ionex source. The Cs is vaporized inside a small metallic container electrically heated, and diffuses through a porous tungsten surface. A thermo-ionisation is achieved during the diffusion process. The Cs^+ ions are then accelerated by the difference of potential maintained between the tungsten surface (at the voltage) and the extractor (at ground). The acceleration voltage can be varied between 5 and 50 kV. The intensity of the extracted beam is precisely defined by the temperature of the container which is permanently measured and regulated. A collimator of diameter ϕ = 0.5 mm is placed behind the extractor and the beam is focused by a gridless Einzel lens in a plane containing a 50 µm wide slit at a distance of 400 mm from the extractor. The profile of the beam behind the slit has been measured. It is shown that 80 % of the total intensity passing through the collimator is transmitted through the 50 µ wide slit.

A voltage of 1000 volts is applied on deflection plates in a time of 50 nsec in order to sweep rapidly the beam through the slit. The repetition rate can be varied between 10 HZ and 5000 KHZ. A very stable and reproductive beam current is obtained with this ion gun which has been connected to one of the time of flight mass spectrometers in operation at the Institut. The average number of Cs+ ions per pulse bombarding the targets in the mass spectrometer can be varied between 0.1 ion per pulse to 10000.

In order to study the beam properties, a set of channel plates (with the surfaces normal to the beam direction) has been placed behind the slit (at 50 cm). The time of flight of the beam can therefore be measured

between the start signal given by the electronic deflecting pulse and the stop signal given by the channel plates. The width of this time of flight peak gives the total time spread of the beam which is ∿2.7 nsec FWHM (Fig. 1). For this measurement the beam intensity was low (<1 ion/pulse) and the time of flight distance was (for practical reasons) 63 cm. A shorter TOF distance should give a smaller width. When mounted on the reflex time of flight mass spectrometer the distance between the deflection plates and the target will be 11 cm. The output pulse height signals from the channel plates can be used to determine the number of ion per pulse. It is possible to measure the detector response to one Cs ion impact, two Cs ion impacts... The total direct beam current is measured before the slit and we have assumed a Poisson distribution of the number n of ions per pulse (for low intensity). Figure 2 shows the pulse

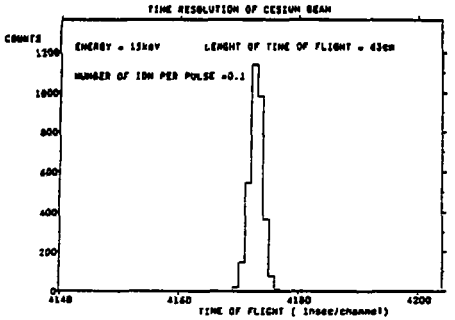

Fig. 1:Time of flight spectrum of the pulsed ion beam. The time width is 2.7 nsec. The distance of TOF was 63 cm.

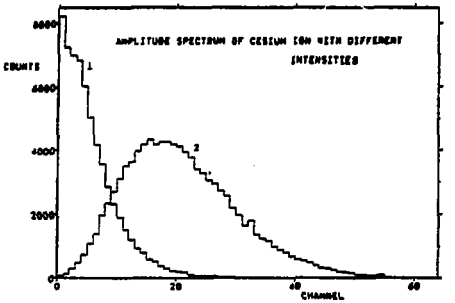

Fig. 2:Amplitude response of microchannel plates bombarded by the primary ion pulsed beam. The centroide of the bution gives the average number of ions per pulse. The measurement is made with a new CDC-TDC electronic module.

height responses of the detector for the two values of n = 0.02 and n = 6. In several cases the direct measurements of the number of ions per pulse is extremely useful. The measurements have been made with a new time digital converter built at the Institut which combines the time measurement and the detector pulse height analysis within the dead time (20 nsec) of the TDC.

When the pulsed beam bombards a target, the number of secondary ions emitted from the surface depends on the number of ions per pulse. Since many ions with different masses are emitted it is necessary to use a multistop TDC to record the secondary ion time of flight mass spectrum. A multiplicity distribution is presented in Fig. 3 for an organic layer of somatostatine

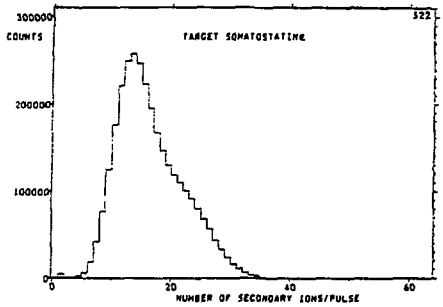

Fig. 3 : Distribution of the number of stop events per start event (pulsed beam of Cs^+ ions)

it is shown that more than 30 ions are sometimes associated with one beam pulse (3000 primary ions per puloc in this case).

Mass spectra of several compounds have been measured with a TOF mass spectrometer having a short time of flight distance (13 cm). Fig. 4 shows a mass spectrum of phenylalanine and Fig. 5 shows part of a spectrum of an organic molecule in the mass region between 1400 and 2200.

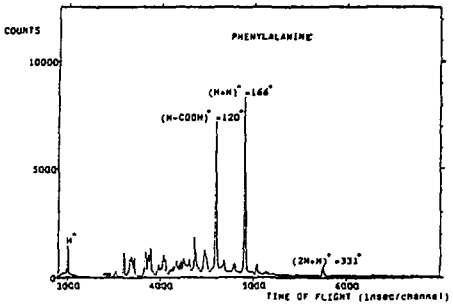

Fig. 4 : Mass spectrum of the organic compound phenylalanine.

In the near

future the ion gun will be used with another TOF mass spectrometer (TOF distance around 1,8 m) including an electrostatic mirror giving (with a ^{252}Cf ion source) a mass resolution above 7000 [2].

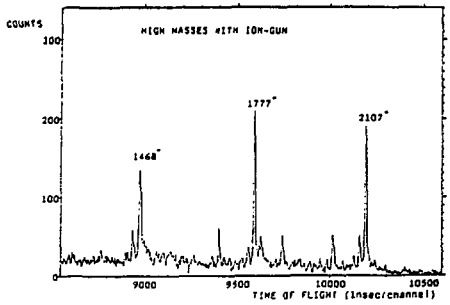

Figure 5
Part of a mass spectrum of an organic compound in the mass range region between 1400 and 2100.

This apparatus could not have been built without the participation of the staff of the mechanic and electronic workhops. Many thanks are due for their efforts and efficiency.

References

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