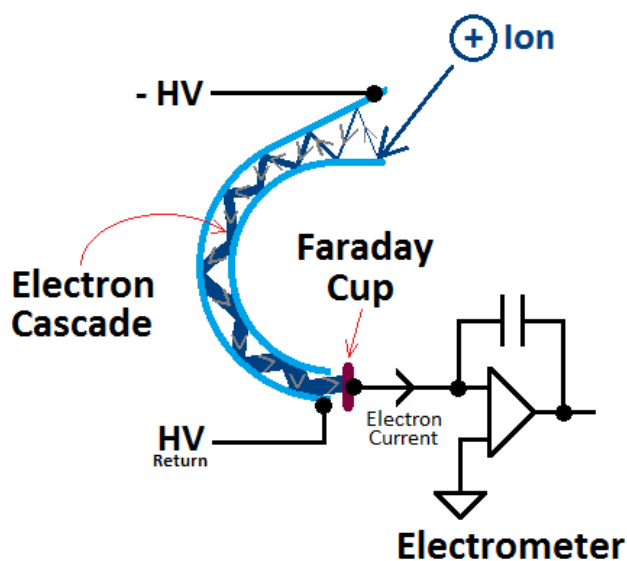


Application Note Number 50: Advantages of an Electron Multiplier

Abstract: An electron multiplier converts the charge of an ion into a much larger electron current. This increase in signal intensity allows for faster scan speeds and an increase in the ultimate sensitivity of the RGA.

The Extorr XT Series RGA uses a continuous dynode electron multiplier. It has a curved channel coated with resistive leaded glass that forms a continuous voltage divider along the length of the channel. A high negative voltage is applied to the mouth of the multiplier that attracts positive ions and also produces a bias voltage along the channel that becomes increasingly positive toward the output end.



When an ion strikes the mouth of the multiplier, two or three secondary electrons are emitted from the resistive glass surface. These electrons are accelerated into the bent channel by the bias field and each one produces two or three additional secondary electrons. Every collision with the channel wall causes an increase (gain) in the number of secondary electrons. The electron cascade continues through the channel and the resulting electron current is collected by the Faraday Cup at the output end of the multiplier. The entire process from the ion striking the mouth of the multiplier to the electrons reaching the Faraday Cup takes less than a microsecond. The magnitude of the high voltage controls the multiplier gain. To determine the gain, the height

of a mass peak is first measured using the Faraday Cup. The multiplier is then enabled and the height of the same peak is observed as the multiplier voltage is increased. When the mass peak is the same height as measured on the Faraday Cup, the multiplier gain is equal to 1. When the peak is 10 times larger than on the Faraday Cup, the multiplier gain is equal to 10, and so on. A multiplier gain of 10^3 is used for most applications. The increase in the current supplied to the electrometer allows the scan speed of the RGA to also be increased by 10^3 for the same signal to noise ratio. For measurements which must be taken rapidly, the high speed electron current amplification of the multiplier is a great advantage.

The multiplier also increases the ultimate sensitivity of the RGA but it is limited by the shot noise that is generated from detecting individual ions. The uncertainty in collecting N ions in a given time interval is \sqrt{N} . So, practically speaking, the multiplier gives only about a factor of 100 increase in sensitivity.

Multipliers also have several disadvantages. First, they must be operated in a high vacuum at pressures of 10^{-6} Torr and below. Using the multiplier at higher pressures greatly decreases its useful lifetime. The gain of the multiplier decreases over time and must be checked regularly using the Faraday Cup. As the multiplier ages, the high voltage must be increased to produce the same gain. Eventually, the voltage needed is greater than the maximum output of the high voltage power supply and the multiplier must be replaced. Finally, the gain of the multiplier is not the same for all ions. High mass ions, which travel at lower velocities, generally produce fewer secondary electrons than lower mass ions. For this reason the gain of the multiplier is usually measured at a low mass peak such as m/z 18 or m/z 28.