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Multi-Channel Dynode Detector Array

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ABSTRACT

This disclosure describes a multi-channel dynode detector array for detecting ions exiting a quadrupole mass filter. The solution described provides a cheaper, but lower resolution, detector while still providing capability to perform constrained deconvolution for generating a mass spectrum.

KEYWORDS

- Dynode
- Multi-Channel
- Mass spectrometry
- Mass spectrometer
- Quadrupole

BACKGROUND

A mass spectrometer is an analytical instrument used to measure the mass-to-charge ratios (m/z) of ions of a sample-under-analysis, or an analyte. Typically, the analyte is separated into components via a chromatographic instrument (e.g., via liquid chromatography, gas chromatography, or capillary electrophoresis), the separated components are introduced into an ion source of the mass spectrometer for ionization, and the resulting ions are subject to transport, confinement, and separation by the components of the mass spectrometer for analysis. The analysis can include generating a mass spectrum depicting a plot of intensity (i.e., relative abundance) as a function of the m/z. The mass spectrum is useful for the identification, quantification, and structural elucidation of the sample, for example, peptides, proteins, and related molecules.

The analysis is facilitated by detection of the ions by a detector such as a dynode. In some mass spectrometry techniques, the two-dimensional position (e.g., an x-y position on a plane of the detector) of ions exiting a quadrupole mass filter is used to improve a resolution of the mass spectrometer and, therefore, increase the ability to distinguish between different peaks in the mass spectrum. However, the type of detector in the aforementioned technique uses a large grid array of detectors, providing high performance at a high economic cost and lifetime durability concerns.

DESCRIPTION

As described herein, a multi-channel electron multiplier is defined by an array of smaller channel electron multipliers. The array is created by cutting ceramics into appropriate shapes for the array, and coating the surface of the ceramic to enable the array as a channel multiplier.

For example, Figure 1 below shows a 15-channel array multiplier.

Figure 1

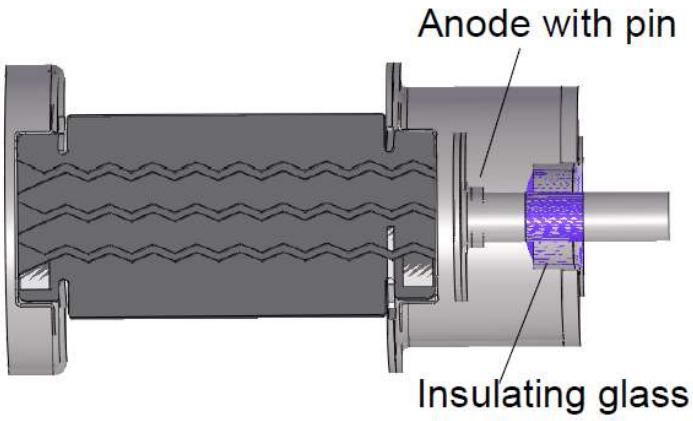

Figure 2

In the 15-channel array multiplier of Figure 1, exit dynode current from each of the 15 channels are summed together via a common collector on an exit side. The exit side can be implemented with discrete anodes and electrometers for each of the 15 channels

An ion to electron conversion dynode before the 15-channel array can also be implemented using a metal channel dynode arranged before the 15-channel array multiplier. This is depicted in Figure 3 below.

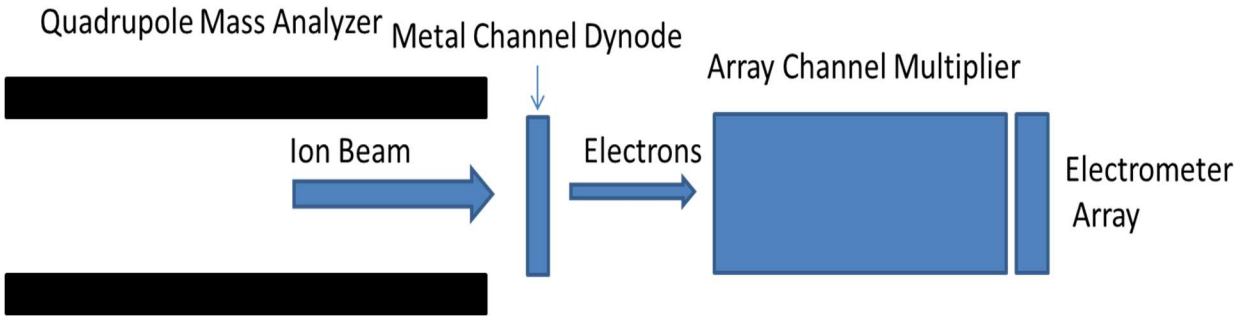

Figure 3

Figure 4 below depicts the metal channel dynode from different perspectives (along the axis defined by the ion beam and a side profile). Due to the relatively large hole sizes, manufacturing methods such as plunge electrical discharge machining (EDM) can be used to economically produce the metal channel dynode.

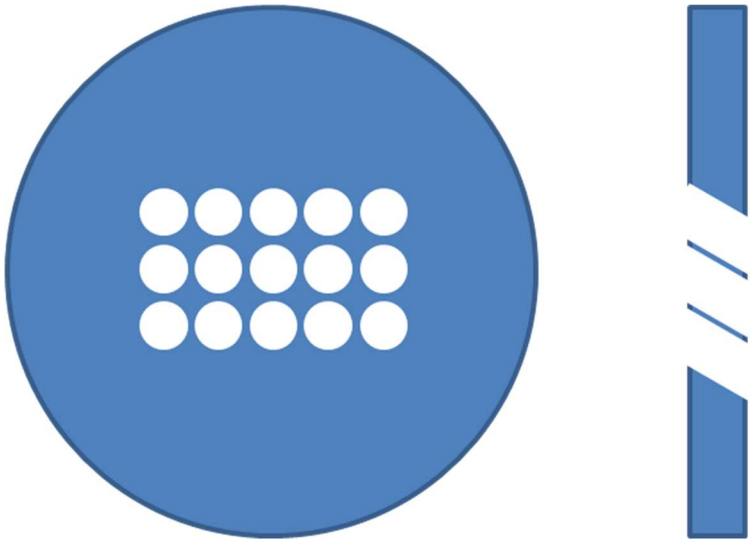

Figure 4

Where along the x-y plane that the ions hit the detector is determined (e.g, which of the 15 channels is employed to detect ions), and the resulting positional information is used to improve the mass resolution, providing more accurate mass spectra.

CONCLUSION

Thus, an improved multi-channel dynode detector array is described. The examples above involve mass spectrometers, but other analytical instruments can be used. Per the techniques of the disclosure, the multi-channel dynode detector is more economical while improving resolution of the mass spectrometer.