NOTES

BRIEF contributions in any field of instrumentation or technique within the scope of the journal should be submitted for this section. Contributions should in general not exceed 500 words.

A simple and fast transimpedance amplifier for microchannel plate detectors

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(Received 21 November 2000; accepted for publication 8 April 2001)

A simple and fast transimpedance amplifier to couple a microchannel plate detector with an oscilloscope with a low impedance input has been developed. The amplifier protects the connected electronic equipment from destructive high voltage bursts. Examples of the detection of electrons are shown. The influence of the amplifier on pulse shape and intensity is discussed. © *2001 American Institute of Physics.* [DOI: 10.1063/1.1376137]

Microchannel plate (MCP) detectors have been widely used in time-of-flight mass spectrometers. In a standard setup the resulting pulses are observed and digitized by a capacitive coupled oscilloscope with a low impedance (50 Ω) input. This requires high bandwidth and impedance matching in every component of the circuit. The low impedance input is necessary to conserve the pulse shape, but it could lead to impedance matching problems due to the ill defined impedance of the collector (anode) of the detector. Although it is in principle possible to build a collector (anode) with 50 Ω impedance, an electronic matching is the easier and cheaper solution, especially in the event an additional amplifier is necessary.

If MCP detectors were used to detect negative charged particles, another problem occurs. At this use the high voltage (to operate the channel plates) is connected directly to the electron collector of the detector. This circuitry risks damaging the electronics directly connected to the capacitor, because short high voltage bursts could pass through the coupling capacitor. Therefore small coils have traditionally been used to couple the detectors to the electronics.[1] But this coupling method cannot be used for measuring time-of-flight photoelectron spectra, as it would falsify the base line of the spectrum [cf. Fig. 2(a)].

Since we had to use the same detector to detect positive and negative particles in our experiment,[2] we developed a simple and fast capacitive coupled transimpedance amplifier, which also protects the other electronic parts from high voltage bursts.

Figure 1 shows the circuit diagram. The amplifier is designed to be used with a high input impedance and a low output impedance (50 Ω). $C1$ is the coupling capacitor. It separates the signal from the high voltage of the microchannel plate detector. Therefore a high voltage type should be applied. To obtain a small leakage a ceramic capacitor is useful. The resistors $R1$ and $R2$ determine the operating point of the amplifier $U1$ and the input impedance of the circuit. The diodes $D1$ and $D2$ operate as protection diodes.

The amplifier $U1$ is an ultrawideband monolithic op amp (CLC 449, National Semiconductor Corp.) with high input impedance and a low output impedance. It is used here as a noninverting amplifier with a gain of two. With the wiring shown here the small-signal bandwidth of the amplifier is 1.1 GHz and the slew rate is 2500 V/μs. $R5$, $R6$, and $C2-C5$ were used as a filter circuit for the operating voltage of the amplifier. $R3$ and $R4$ determine the gain of the amplifier. The ratio of $C1$ and $R2$ determine together with $R4$ the input impedance and therefore the ''quality'' of the impedance matching. Suitable rf construction techniques were used to build the amplifier. The connection between the collector of the detector and the coupling capacitor was kept very short (<10 cm).

Figure 2 show two anisole time-of-flight photoelectron spectra as examples for the detection of negative charged

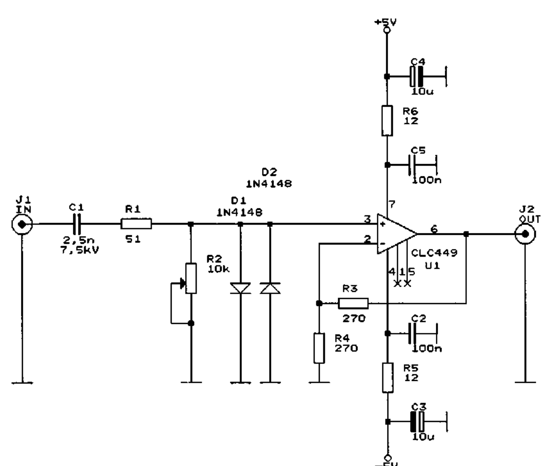

FIG. 1. The circuit diagram.

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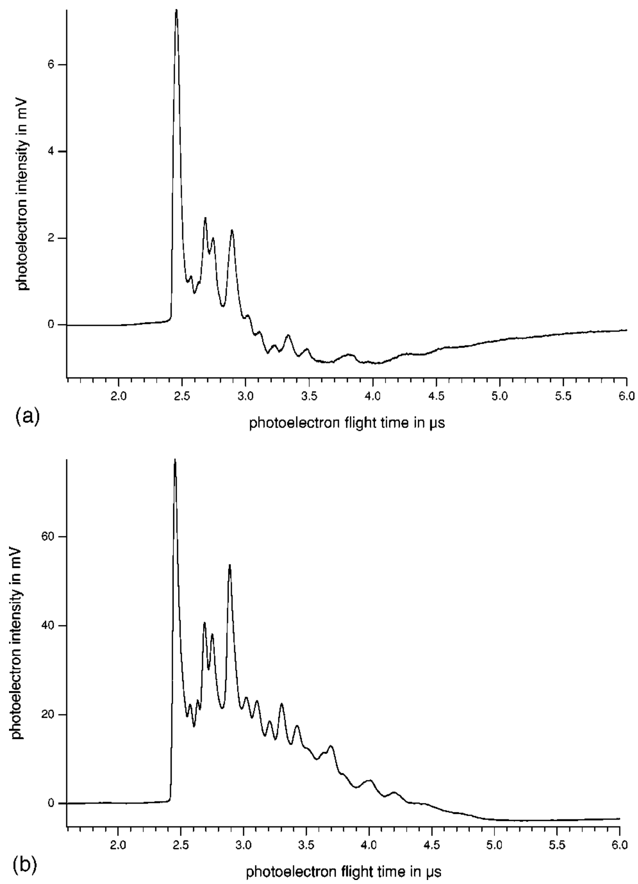

FIG. 2. Time-of-flight photoelectron spectra of anisole.

particles. The spectrum in Fig. 2(a) was recorded with a coil coupled oscilloscope, the spectrum in Fig. 2(b) with the impedance transducer described above. The electrons were produced by resonant two photon ionization (10 Hz laser source) of aromatic molecules in a molecular beam (the experiment is described, for example, in Ref. 2). We use a homemade detector with two microchannel plates (Galileo) as described in Ref. 3. Signal pulses resulting from particles striking the detector were monitored with an oscilloscope (LeCroy 9370) having a 50 Ω input impedance.

The baseline of the spectrum in Fig. 2(a) is strongly affected by the coupling method. This leads to a false signal intensity ratio. For example, the signal intensities of the three signals in the range of 2.5–3.0 μs are almost equal. By contrast, the spectrum recorded using our transimpedance amplifier [cf. Fig. 2(b)] demonstrates an almost flat base line and the correct signal ratios. The small undershot of the base line in Fig. 2(b) could be removed by a further improvement of the impedance matching by adding a trimmer after $C1$. The comparison of Figs. 2(a) and 2(b) shows the effectiveness of our setup. The combination of a capacitive coupling and the described amplifier is a simple and suitable solution for the detection of time-of-flight photoelectron spectra with MCP detectors.

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