or copper to establish the linearity of the energy scale and its position.

Detectors. Both single channel and multichannel detectors are used in ESCA and Auger spectroscopy. The most common single channel detector is the channel electron multiplier. The channel electron multiplier functions much like the PMT used in optical spectroscopy (discussed in Chapter 5). The major difference is that electrons constitute the signal that is being amplified, not photons. The channel electron multiplier consists of a continuous dynode surface inside a tube as depicted in Fig. 14.7(a). Channels may be straight tubes as shown or curved. The surface is a thin film conductor with a high resistance. When a voltage is supplied across the input and output, a potential gradient

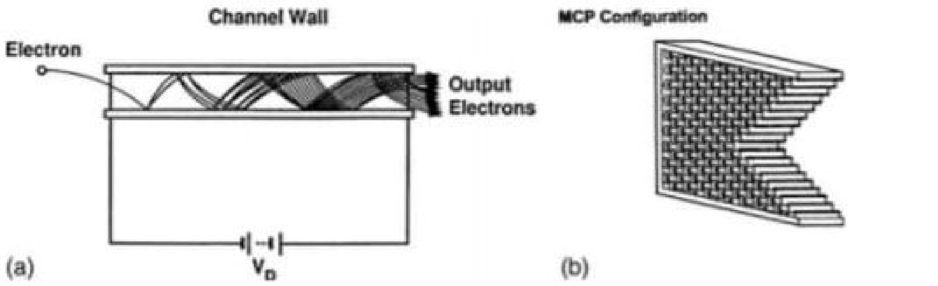

Figure 14.7 (a) A schematic channel electron multiplier. A thin film conductive layer inside the tube serves as a continuous dynode surface. (b) A schematic microchannel plate configuration. [Both figures courtesy of Hamamatsu Corporation, Bridgewater, NJ (www.usa.hamamatsu.com).]

exists along the channel direction. The dynode surface and potential gradient permit electron amplification throughout the channel. An incoming electron strikes the inner wall and secondary electrons are emitted. These are accelerated by the potential gradient and travel a parabolic path until they strike the opposite wall, releasing more electrons. An ejected photoelectron from the sample enters at one end and an amplified pulse of electrons exits at the other end. Gains of up to 10^5 are possible with a 1 kV supply voltage. This detector is very efficient at counting electrons, even those with very low energy. Like the PMT, the detector can be saturated at high electron intensity.

Multichannel electron detectors of various types can be placed to cover the exit plane of the analyzer. CCDs (discussed in Chapter 7), phosphor-coated screens and position-sensitive detectors are some of the multichannel devices in use. One type of position-sensitive detector consists of a **microchannel plate (MCP)** electron multiplier. The MCP [Fig. 14.7(b)] consists of a large number of very thin conductive glass capillaries, each 6–25 μm in diameter. The capillaries are fused together and sliced into a thin plate. Each capillary or channel works as an independent electron multiplier, exactly as the single channel electron multiplier described earlier, thereby forming a 2D electron multiplier. Used in conjunction with a phosphor screen, 2D imaging of surfaces is possible.

Electrons are detected as discrete events and the number of electrons for a given time and energy is stored and then displayed as a spectrum.

Magnetic Shielding. The ejected electrons have low energy. They are affected significantly by local magnetic fields, including the earth's and those of any stray electrical impulses as generated by wiring to lights, equipment, elevators, and so on. These stray fields must be neutralized in the critical parts of the instrument in order to obtain useful data. One method is to enclose the critical regions with high-permeability magnetic alloy, which shields the sample from stray magnetic fields. Another method is to use Helmholtz coils, which produce within themselves a homogeneous field. This field may be made exactly equal and opposite to the earth's magnetic field. A feedback system to the coils can also be used; this senses variations in local magnetic fields and varies the current in the Helmholtz coils, neutralizing transient magnetic fields as they arise. This system not only neutralizes the earth's magnetic field but also local fields as they are generated.

Electron Flood Gun. In practice, when the sample is irradiated, electrons are ejected. An electron takes with it a negative charge, leaving the sample positively charged. Depending on the conductivity of the sample, this positive charge builds up at a steady but unpredictable rate on the surface of the sample, changing the work function of the sample itself and therefore the net energy of the ejected electrons. In practice, this