RMC Boeckeler

Ultramicrotomy of Food Packaging Foils

Introduction

Food packaging in plastic foils is an enormously important industry. The foils are themselves composed of multiple layers which each have an important function. Cross sections of these foils are often imaged at high resolution to aid in the development of improved foils and for quality control. These cross sections are best prepared with a microtome or ultramicrotome. Because many of the components of these foils are soft at room temperature, cold sectioning with cryomicrotomes or cryoultramicrotomes often produce the best results. However, not all laboratories have such equipment and thus need to produce acceptable results with room temperature equipment. We present here a simple procedure for resin embedding of food packing or other plastic foils to cut with an ultramicrotome.

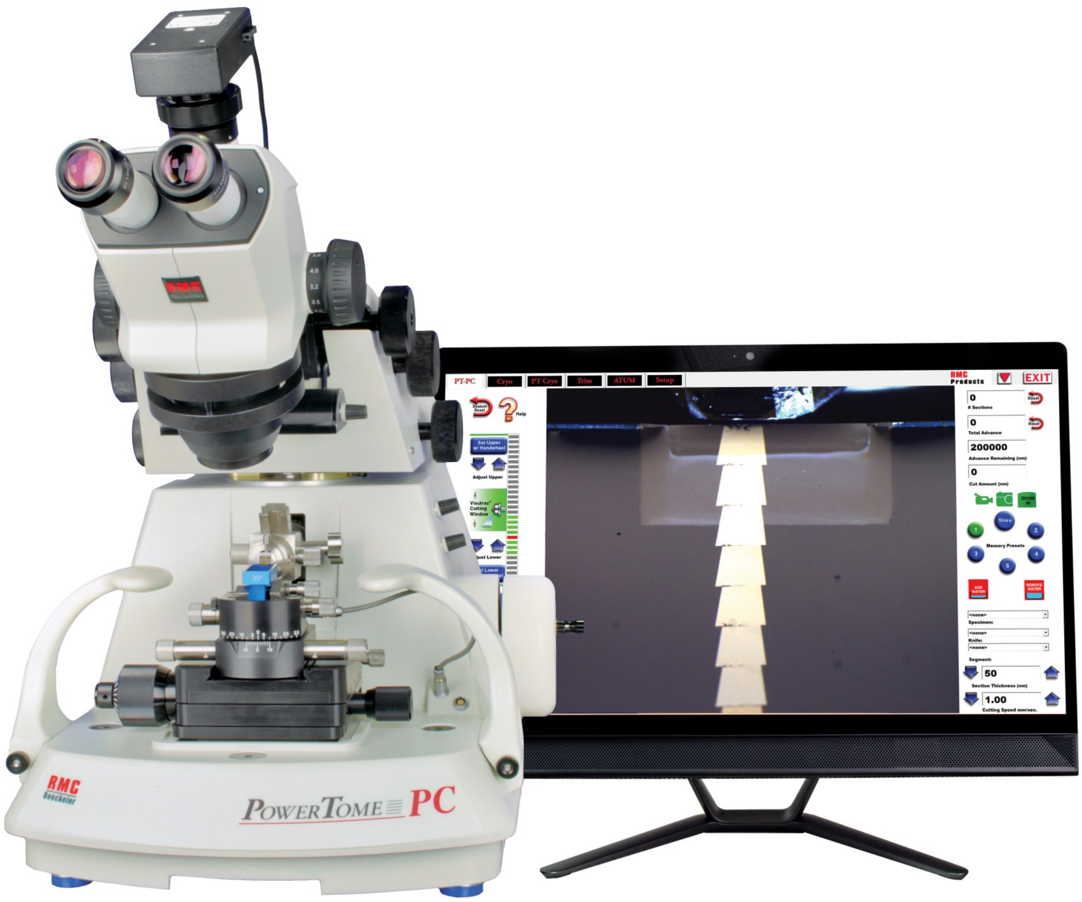

Figure 1.
The RMC Boeckeler PowerTome PCZ.

Instrumentation

The RMC Boeckeler PowerTome PCZ (PT PCZ) was used to section a specimen embedded in a hard epoxy resin. This PT PCZ ultramicrotome is equipped with a touchscreen PC and a trinocular microscope with high definition camera. The PowerTome can be controlled and programmed by the touchscreen and/or controller. A camera is useful to visualize the sectioning of the sample in a way that allows several people to view this process. The camera can also capture images and videos to be used in training, reporting, and documentation. Furthermore, the built-in measuring tool enables measurement of block face and sample dimensions by using the image displayed on the touchscreen.

Procedure

An ordinary snack food bag was cut with scissors into 2mm wide pieces about 8mm long, which came to a point. For embedding, flat silicone molds were used which had multiple cavities of 7mm width. Standard steel washers, 5.5mm in diameter, were washed in acetone and one was placed into each cavity. The food packaging samples were placed on top of each washer with the pointed end near the narrow end of the cavity. A second washer was laid on top of each sample to hold it in position (Figure 2). A thoroughly mixed, low viscosity epoxy resin (UltraBed Kit, Electron Microscopy Sciences) was poured into each mold. The molds were then transferred to an oven and the resin was polymerized for 24 hours at 60°C. This technique resulted in the pointed tip of the foil sample being suspended above the bottom of the sample block and surrounded by resin on all sides. The blocks were trimmed to about 1 x 1 mm on an RMC PT PCZ ultramicrotome with a Diatome diamond Trim Tool. The block face was oriented so the foil sample was positioned nearly vertically (Figure 3). 90nm sections were cut at room temperature using a Diatome Ultra diamond knife with water in the trough and sections were collected on copper grids.

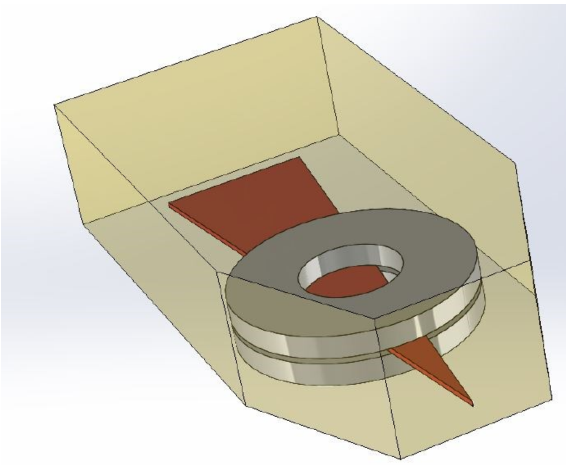

Figure 2.
The packaging foil is supported above the floor of the mold by two metal washers. This permits accurate alignment of the foil in the mold and allows for the resin to surround the foil on all sides.

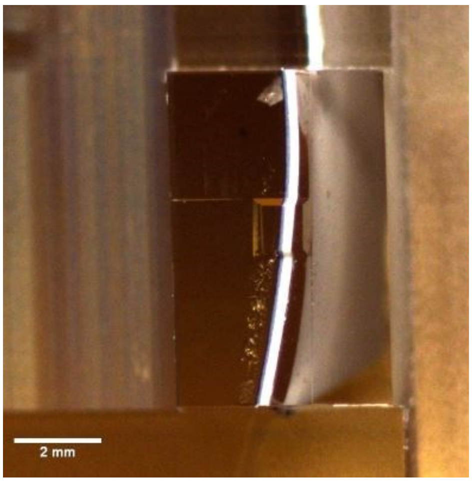

Figure 3.
The block was trimmed with a diamond trim tool using the automatic trim function of the PT PCZ ultramicrotome. The resulting block face was about 1 x 1 mm. The thin, dark outer layer of the foil and the thicker white inner layer can be seen.

Results

The snack bag foil was composed of three layers: a thin outer layer which was printed with ink, a thicker inner layer and an adhesive layer which binds the layers together. These three layers were clearly distinguishable in the transmission electron microscope at low magnification (Figure 4). The black outer layer was lower in electron density and contained carbon black particles dispersed uniformly throughout. The inner layer in these unstained sections showed some layering and striations but no pronounced structures. This technique demonstrated that if a thin packaging foil is suspended in a mold and embedded in an epoxy resin, reasonable sections can be obtained by room temperature ultramicrotomy. Although the thin foil is composed of materials which are soft and therefore with low glass transition temperatures (Tg), the hard epoxy surrounding the foil makes ultrathin sectioning possible even at room temperature.

Useful information such as the thickness of the layers and dispersion of carbon particles can be made. To reveal ultrastructural features of the polymers, these sections on grids could be stained by heavy metal staining, for example with osmium tetroxide or ruthenium tetroxide vapor. Using this technique, SEM, scanning probe microscopies, FTIR, and other techniques can also be used on the cut block face or on thicker sections, as needed.

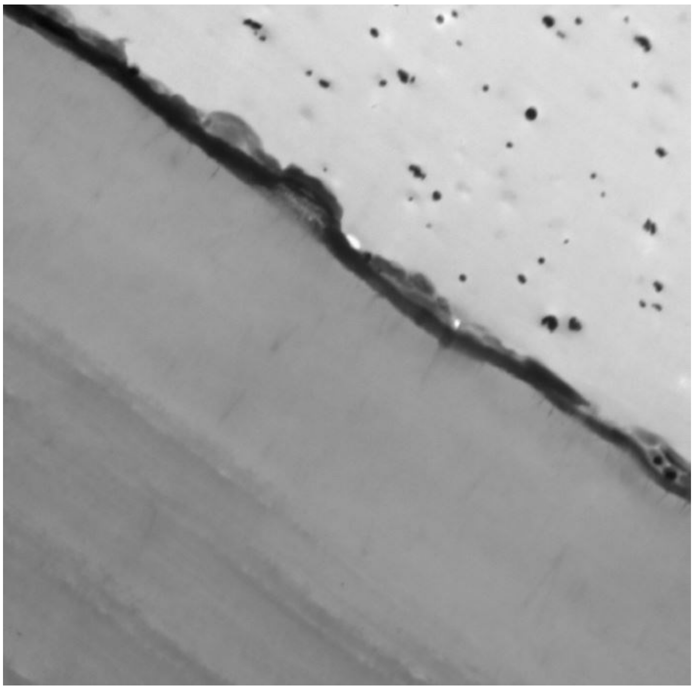

Figure 4.
The three layers of this packaging foil are seen in this micrograph. The layer with dark carbon black particles is the outer layer. The thicker inner layer is below and the thin adhesive layer joins these two layers.

4650 S. Butterfield Drive
Tucson, Arizona 85714, U.S.A.
T +1 520-745-0001
F +1 520-745-0004
E info@boeckeler.com
www.boeckeler.com