Swaging Plastic Medical Device Parts

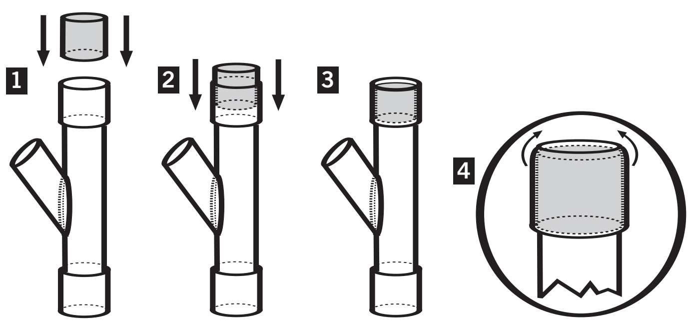
An Investigation of *Eastman* Copolyesters and Polycarbonate Performance

Swaging, or cold forming, is a joining technique that offers unique possibilities to part designers and fabricators. Swaging involves bending and crimping a plastic part without heat to join two parts. This assembly method can save energy and avoid the use of chemicals, adhesives, and mechanical fasteners.

SWAGING EXAMPLES

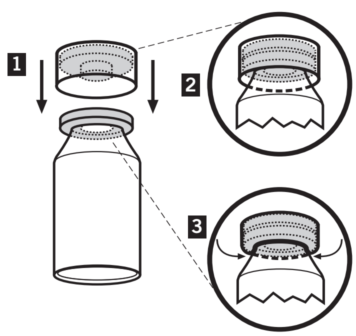
Figures 1 and 2 show typical medical device applications that employ the swaging technique.

Figure 1



Swaging used to assemble an intravenous therapy connector, with a rubber septum held securely through swaging of the connector.

Figure 2



Swaging used to seal a container, such as one used for drug administration. A plastic vial is closed with a molded polymer cap, which is subsequently permanently deformed to seal the contents. The cap slides onto the neck of the vial, and the bottom edges are crimped around the neck to secure the closure.

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MATERIAL REQUIREMENTS FOR SWAGING

When swaging is being considered as a joining technique, the material selected must maintain the desired performance after undergoing joining, including retention of the bend. A successful swaging operation requires a tough, ductile material that can be deformed at room temperature beyond the yield point, and further deformation past yield causes permanent deformation. If clarity, toughness, and chemical resistance are also required, *Eastman* copolyesters are the material of choice.

Polycarbonate and *Eastman* copolyesters are sufficiently ductile for swaging operations; however, polycarbonate does not retain the bend as well as copolyesters. Unmodified styrenic and acrylic polymers are not recommended for cold swaging, because they fracture at relatively small deformations and stress-whiten substantially upon bending.

SWAGING SIMULATION

To simulate a swaging application, Eastman conducted a study. *Eastar* Copolyester MN211, *Eastar* Copolyester MN006, and a general-purpose polycarbonate were molded into 0.125 × 0.5 × 5 inches (0.3175 × 1.27 × 12.7 cm) bars. These samples were deformed on a three-point bending apparatus in a mechanical testing frame. The samples were bent at 73°F (23°C), with a crosshead rate of 20 inches (50.8 cm) per minute to a 90° bend angle, and immediately unloaded at the same rate.

Figure 3 shows the yield point, in degrees, and the deformation cycle. Due to the lower yield point of copolyesters compared to that of polycarbonate, less of the energy is needed to reach yield point, and more of the energy is spent in the permanent deformation phase to achieve higher bend retention and better swaging for copolyesters.

Figure 3

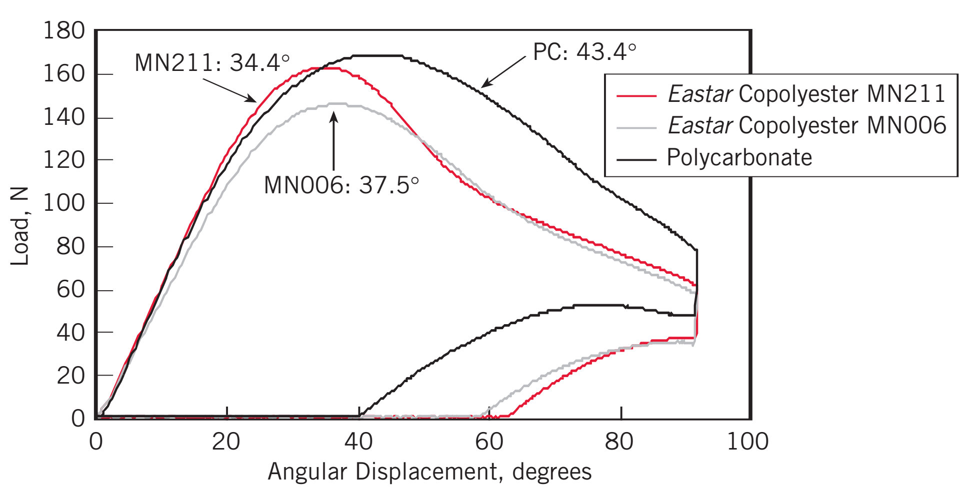
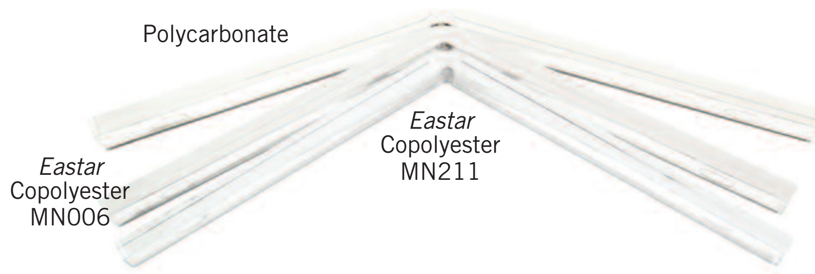


Figure 4 is a photograph showing the bend retention of the three materials. Both *Eastar* copolyesters show much greater retention of the bend relative to polycarbonate.

Figure 4

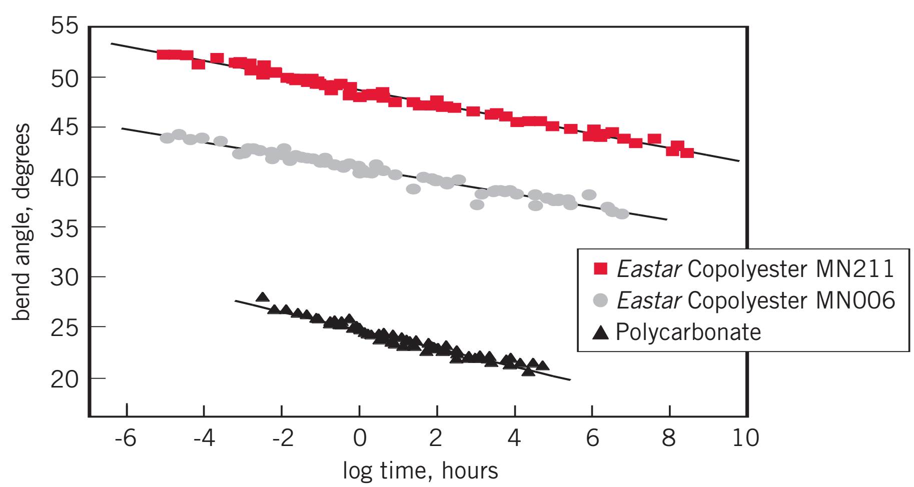


LONG-TERM BEND RETENTION

To determine long-term bend retention, accelerated testing was used to predict recovery of swaged parts over extended time periods. Bent samples prepared by the technique described above were placed in ovens at elevated temperatures, and the angle of the bend was measured at those temperatures as a function of time. These isothermal data were assembled and shifted according to the well-known principles of time-temperature superpositioning.[1]

Figure 5 shows smooth mastercurves of bend recovery at 113°F (45°C) for the three materials. The mastercurves predict long-term recovery behavior of swaged samples and demonstrate the excellent retention of cold-formed bends in *Eastman* copolyesters relative to polycarbonate over very long periods of time—in this case, extrapolated to over 10,000 years.

Figure 5



The studies and results discussed here demonstrate that *Eastman* copolyesters are ideally suited to swaging operations. In addition, they provide excellent clarity, toughness, chemical resistance, and flexible sterilization options for medical devices.

Contact Eastman to explore the possibilities of swaging of medical device components and discover what *Eastman* copolyesters can deliver in your application.

[1]M. L. Williams, R. F. Landel and J. D. Ferry, *Journal of the Amercian Chemical Society*, 77, (1955), p. 3701; J.D. Ferry, *Viscoelastic Properties of Polymers*, 2nd edition, John Wiley Interscience, New York, (1970); F. Povolo and N. Fontelos, *Res. Mechanica,* 22, (1987), p. 185.

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