**Process**

Co-injection molding is a process in which two or more different polymers are laminated together by injection molding. These polymers may be identical except for color or hardness, or they may be of different polymer types. When different polymers are used they must be compatible (e.g., weld together) and melt at approximately the same temperature.

The term co-injection can denote different processes, such as sandwich construction, double shot injection, multi-shot injection or structural foam construction. Whatever its designation, a sandwich configuration has been made in which two or more thermoplastics are laminated together to take advantage of the different properties each contributes to the structure. Most commonly, the skin material is solid while the core material contains a blowing agent. However, any combination of foamed and/or unfoamed skin and core is possible. For heavy walled parts, cooling time may be substantially reduced by running the skin material at a higher melt temperature for a smooth surface and the core material, which essentially determines cycle time, at a lower melt temperature.

There are three basic co-injection molding techniques -- one-, two- and three-channel. In the one-channel system, the plastic melts are shot sequentially into the mold by shifting a valve. Because of the flow characteristics of the melt and the tendency of the skin material to adhere to
the cooler mold surface, a dense solid skin is formed. Thickness of the skin can be controlled by varying the injection rate, melt temperature and flow compatibility of the two materials.

In the two-channel system, sequential or simultaneous injection of both the skin and core materials is possible. This permits control of the skin thickness, especially in the gate areas on both sides of the part. In this type of molding, it is best if profile injection is used. The use of profile injection permits greater control of the surface appearance. The machine can be profiled by the number of velocity settings a machine has. The velocity can be varied from 0.1 to 4 inches per second.

The three-channel system allows simultaneous injection with a direct sprue gate. The skin thickness may be influenced on both sides of the part. With this system, the foamed core progresses farther toward the end of the flow path than that of the one- and two-channel techniques. Parts can also be designed to be lighter in weight.
# Advantages vs. Disadvantages

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material cost savings and lighter weight parts</td>
<td>Machine costs are 25 to 30% higher than for standard injection equipment</td>
</tr>
<tr>
<td>Two different or alike materials can be shot simultaneously into the mold</td>
<td>Good tool makers familiar with tooling requirements are difficult to find in some areas</td>
</tr>
<tr>
<td>Some co-injection machines can be adapted for gas assist, which allows the machine to perform dual functions</td>
<td>Material viscosities must be very similar or part can easily be core-rich or skin-poor</td>
</tr>
<tr>
<td>Allow an outlet for regrind usage on internal core</td>
<td>Sometimes difficult to obtain technical support for equipment problems</td>
</tr>
</tbody>
</table>

## Market Segments

<table>
<thead>
<tr>
<th>Market</th>
<th>Applications</th>
</tr>
</thead>
</table>
| Automotive | Fender skins  
              Interior components          |
| Plumbing | Handles and faucet components  
                             Toilet seat                   |
| Appliance | Door panels  
              Handles                     |
| Housewares | Cups  
                 Thermos bottles         |
**Equipment Suppliers**

**Battenfeld of America, Inc.**
31 James P. Murphy Highway
West Warwick, CT  02893
*Contact* - Ed Matola, VP Sales and Marketing
(401) 823-0700

**Krauss Maffei Corporation**
7095 Industrial Road, P.O. Box 6270
Florence, KY  41022-6270
*Contact* - Virginia Mattmann, Sales Coord.
(606) 283-0200

**Cincinnati Milacron / Ferromatik Milacron**
4701 Marburg Avenue
Cincinnati, OH  45209
*Contact* - Robert Hare, General Manager
(49) 7644-780 (overseas)

**Nestal Machinery, Inc.**
72 Lake George Street
Devens, MA  01433
*Contact* - Dan Morris, Sales Manager
(508) 772-5100

**Engel Canada**
545 Elmira Road
Guelph, Ontario
N1K 1C2
*Contact* - Kurt Fenske, VP Sales and Marketing
(519) 836-0220

**Nissei America, Inc.**
1480 N. Hancock Street
Anaheim, CA  92807
*Contact* - Rick McGranahan, Sales Manager
(714) 693-3000

**NOTE:**

The following supplier specializes in multi-gate systems for co-injection and two-shot molding.

**Kortec, Inc.**
3 Crafts Road
Gloucester, MA  01930-2135
*Contact* - Paul Swenson
(508) 283-6543
**Process**

The two-shot (or two-color) process requires a machine with two independent injection units, each of which shoots a different material. The first material is injected through a primary runner system, as in a normal injection molding cycle. During this injection, the mold volume to be occupied by the second material is shut off from the primary runner system. The mold is then opened and the core plate rotated 180°. The mold is again closed and the second runner system connected to the volume to be filled. After sufficient part cooling, the mold is opened and the part is ejected. The injection of the first material through the primary runner system and the second material through the secondary runner system occurs at the same time.

This process also enables two dissimilar materials to be mechanically bonded. If the first shot totally solidifies before the second material is injected, a crack will usually form between the two, due to the differential shrinkage.

The two-shot process can also be accomplished with an indexing system (a round table rotating around a horizontal axis) with a primary and secondary station. While the first injection is accomplished at station #1, the second injection is accomplished at station #2. Each injection station is run by an independent injection unit. This allows injection speeds and pressures to be controlled for each material being utilized. The two-shot or two-color process can also be performed by either indexing the mold in the machine or with a rotary table.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cycle times are fairly fast</td>
<td>Dual injection unit needed either vertical or 90° from main injection unit</td>
</tr>
<tr>
<td></td>
<td>(requires more floor space)</td>
</tr>
<tr>
<td>Not very labor-intensive</td>
<td>Mold costs are somewhat high</td>
</tr>
<tr>
<td>Excellent for high volume production</td>
<td>Good mold builders may be hard to find in some areas</td>
</tr>
<tr>
<td>Molding flexibility of two rigid materials,</td>
<td>Capital for machine is approximately 20% higher than for standard equipment</td>
</tr>
<tr>
<td>two soft ones or a combination</td>
<td></td>
</tr>
<tr>
<td>Single mold produces finished part</td>
<td>Sometimes where barrels are in tandem, mold balancing is much harder and tools</td>
</tr>
<tr>
<td></td>
<td>end up being 6, 10 or 12 cavity</td>
</tr>
<tr>
<td>Machine can be utilized for standard molding</td>
<td></td>
</tr>
<tr>
<td>or two-shot</td>
<td></td>
</tr>
</tbody>
</table>
## Market Segments

<table>
<thead>
<tr>
<th>Market</th>
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</tr>
</thead>
<tbody>
<tr>
<td>Automotive</td>
<td>Knobs</td>
</tr>
<tr>
<td></td>
<td>Interior panels</td>
</tr>
<tr>
<td></td>
<td>Under-the-hood covers</td>
</tr>
<tr>
<td>Consumer</td>
<td>Toys</td>
</tr>
<tr>
<td></td>
<td>Industrial grips</td>
</tr>
<tr>
<td></td>
<td>Hand and power tools</td>
</tr>
<tr>
<td>Appliance</td>
<td>Handles</td>
</tr>
<tr>
<td></td>
<td>Interior panels</td>
</tr>
<tr>
<td></td>
<td>Sweeper components</td>
</tr>
<tr>
<td></td>
<td>Cooking utensils</td>
</tr>
<tr>
<td>Medical</td>
<td>Syringe components</td>
</tr>
<tr>
<td></td>
<td>Metering pump components</td>
</tr>
<tr>
<td>FDA</td>
<td>Food containers</td>
</tr>
<tr>
<td></td>
<td>Toothbrushes</td>
</tr>
<tr>
<td></td>
<td>Sealing devices</td>
</tr>
</tbody>
</table>

## Equipment Suppliers

Any machine supplier will build a two-shot machine. Listed here are true two-shot machine manufacturers.

**Battenfeld of America, Inc.**
31 James P. Murphy Highway  
West Warwick, CT  02893  
*Contact* - Ed Matola, VP Sales and Marketing  
(401) 823-0700

**Krauss Maffei Corporation**
7095 Industrial Road, P.O. Box 6270  
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(519) 836-0220

**Nissei America, Inc.**
1480 N. Hancock Street  
Anaheim, CA  92807  
*Contact* - Rick McGranahan, Sales Manager  
(714) 693-3000
**Process**

A solid preform (plastic or metal) is placed into a mold and the polymer is shot around it. Preforms are usually produced with a plain exterior, without serrations or knurls. They are bonded by melting of the outer skin, which creates a weld between the insert and outer skin material. The generation of a satisfactory weld requires that the preform material and overmolded polymer be compatible. Normally, a mechanical means, such as flow through slots, enhances the bonding.

When two materials are not of the same polymer type and thus incompatible, it is necessary to use an adhesive on the preform surface prior to molding the second material. Utilizing adhesives, suitable bonding can be achieved. If the preform is metal, it will require cleaning and degreasing prior to applying adhesives.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Machine costs are in mid-range</td>
<td>Most insert molding is run on shuttle type equipment</td>
</tr>
<tr>
<td>A good bond can be achieved when like materials are used</td>
<td>Labor-intensive loading and loading of tool</td>
</tr>
<tr>
<td>Low cost tooling</td>
<td>Most crystalline materials must set for 24 hours prior to insert molding</td>
</tr>
<tr>
<td>Best utilized when molding couplings on hoses or wire connectors</td>
<td>Dissimilar materials will require secondary operations and equipment, adhesives and ovens</td>
</tr>
<tr>
<td></td>
<td>Inserts must be handled carefully or adhesion issues may occur</td>
</tr>
<tr>
<td></td>
<td>Cycle times are relatively long</td>
</tr>
<tr>
<td></td>
<td>Unless dedicated press for each step, down time for mold changeovers</td>
</tr>
</tbody>
</table>
**Market Segments**

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<tbody>
<tr>
<td>Appliance</td>
<td>Hose end connectors</td>
</tr>
<tr>
<td></td>
<td>Fill tubes</td>
</tr>
<tr>
<td>Automotive</td>
<td>Wire and vacuum connectors</td>
</tr>
<tr>
<td></td>
<td>Air ducts</td>
</tr>
<tr>
<td>Audio</td>
<td>Speaker surrounds</td>
</tr>
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</table>

**Equipment Suppliers**

**Battenfeld of America, Inc.**
31 James P. Murphy Highway
West Warwick, CT 02893
*Contact* - Ed Matola
VP Sales and Marketing
(401) 823-0700

**HPM Corporation**
820 Marion Road
Mt. Gilead, OH 43338
*Contact* - Randall Parker
(419) 946-0222

**Cincinnati Milacron / Ferromatik Milacron**
4701 Marburg Avenue
Cincinnati, OH 45209
*Contact* - Robert Hare, General Manager
(49) 7644-780 (overseas)

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545 Elmira Road
Guelph, Ontario
N1K 1C2
*Contact* - Kurt Fenske, VP Sales and Marketing
(519) 836-0220

**Van Dorn Demag Corporation**
11792 Alameda Drive
Strongsville, OH 44136
*Contact* - David Walters, National Sales Manager
(216) 238-8960

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