

## Designing with Rubber

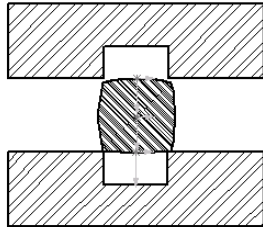
### Molding Processes

#### Compression Molding

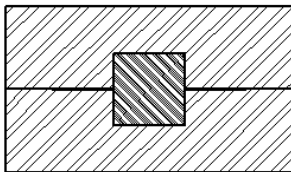
Compression molding is the process of placing a pre-load of a rubber material or compound directly in the mold cavity and compressed to the shape of the cavity by the closure of the mold.

- Compression Molding Process:

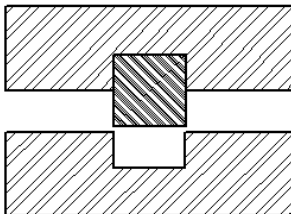
1. A piece of uncured rubber material or compound is placed in the mold.



2. The mold is closed and held under hydraulic pressure while the rubber material or compound cures.



3. When the mold opens the part can be removed. The excess rubber, called flash, is trimmed from the part.



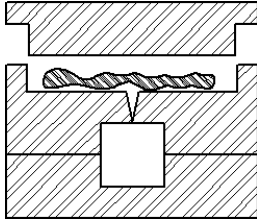
## Designing with Rubber

### Transfer Molding

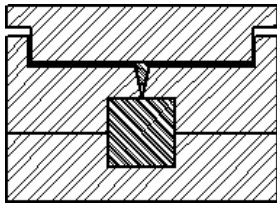
Transfer molding is the process in which the rubber material or compound is placed in the mold “pot”, located between the mold top plate and the press plunger, and the material or compound is squeezed from the “pot” through gates or sprues into the mold cavity.

■ Transfer Molding Process:

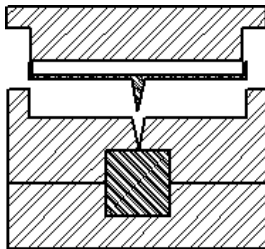
1. A piece of uncured rubber material or compound is placed into a portion of the mold called the “pot”. The press plunger fits tightly into the “pot”.



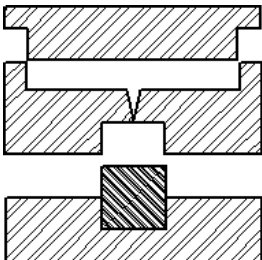
2. The mold is closed and under hydraulic pressure the rubber material or compound is forced small holes called gates or sprues into the cavity. The mold is held closed while the rubber cures.



3. The press plunger is raised up and the “transfer pad” of rubber material or compound is removed from the “pot” and thrown away.



4. Mold is opened and the part is removed from the cavity. The flash and the gates or spurs removed or trimmed from the part.



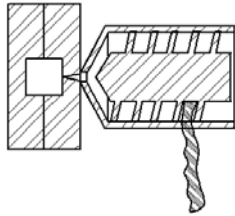
## Designing with Rubber

### Injection Molding

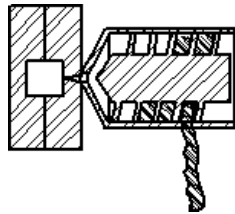
Injection molding is the process in which the rubber material or compound is heated, and while the material or compound is in a flowable state in the injection barrel, the material or compound is forced or injected into the mold cavity.

■ Injection Molding Process:

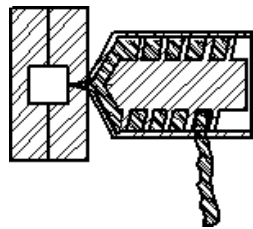
1. The uncured rubber material or compound is fed into the injection barrel in the form of a continuous strip or ribbon.



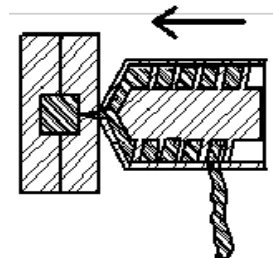
2. The uncured rubber material or compound is worked and warmed by an auger screw in the temperature-controlled barrel.



3. As the rubber material or compound accumulates in front of the auger screw, the auger screw is forced backwards. When the auger screw has moved back a specified amount, the injection press is ready to “shoot” or inject the rubber material or compound into the mold cavities and / or runner system.



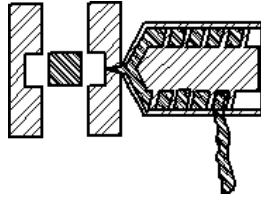
4. With the mold closed under hydraulic pressure, the auger screw is pushed forward. This forces the rubber material or compound into the mold cavities and / or runner system. This process like the action of a hypodermic syringe.



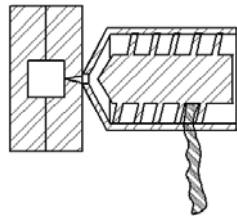
## Designing with Rubber

### Injection Molding

5. While the rubber material or compound cures in the heated mold, the auger screw turns again to refill the injection barrel.



6. The mold opens and the part can be removed. The injection press is ready to make its next shot as soon as the mold closes.



### Rubber Glossary

- **Accelerator:** A substance, which hastens the vulcanization of an elastomer, causing the vulcanization process to take place in a shorter time or at a lower temperature.
- **Adhesion:** The tendency of rubber materials or compounds to bond or adhere to a contact surface.
- **Agging:** The characteristic of rubber to undergo changes in physical properties with age or lapse of time.
- **Antioxidant:** An organic substance that inhibits or retards oxidation.
- **Antiozonant:** A substance which retards or prevents the appearance of cracks from action of ozone when the elastomer is exposed under tension, either statically or dynamically, to air containing ozone.
- **Bond:** The term commonly used to denote the attachment of a rubber material or compound to attach or adhere to a substrate like metal, plastic, fabric, etc.
- **Bond, Mechanical:** Physical attachment of rubber material or compound to a substrate accomplished through holes, depressions, projections, riveting, etc.
- **Bond, Chemical:** Adhesion of a rubber material or compound to a previously primed (with adhesive) substrate surface using heat and pressure to vulcanize the rubber material or compound to the substrate in the same process.
- **Bond, Cold:** Adhesion of a previously vulcanized rubber material or compound to another material or substrate using suitable contact cements or adhesives.
- **Closure Dimension:** Dimensions of a molded rubber part that are affected by flash thickness and mold closure variation. Also called axial dimension.

## Designing with Rubber

### Rubber Glossary Cont. . .

- **Compound:** A term applied to a mixture of polymers and other ingredients to produce a usable rubber formulation, material, or compound.
- **Compression Set:** The amount by which a rubber specimen fails to return to its original shape after release from a compressive load.
- **Conductive Rubber:** A rubber material or compound capable of conducting electricity. Generally used in rubber products used to conduct static electricity.
- **Creep:** The progressive relaxation of a rubber material or compound while it is under stress. This relaxation eventually results in a permanent deformation or “set”.
- **Cross-Linking Agents:** A chemical, or chemicals, used to “bond” the polymer chains together to form a thermoset rubber component.
- **Cross-Section:** A rubber component as view if cut at right angles to the molding or parting line, showing the internal structure of the component.
- **Damping:** The quality of a rubber material or compound to absorb forced vibration energy.
- **Deflashing:** Any process used to remove the waste edge from a molded rubber part.
- **Durometer:** An instrument for measuring the hardness of a rubber specimen; measures the resistance to penetration of an indenter point into the surface of the rubber specimen. Also, a numerical scale of rubber hardness. i.e. Shore A Durometer.
- **Durometer, Dual:** A rubber part or component with two distinct rubber hardnesses.
- **Elongation:** The percent increase in the original length of a rubber specimen when it breaks. Also known as ultimate elongation.
- **Fixed Dimension:** Dimensions on a rubber part or component not affected by flash thickness or mold closure variation. Also known as the radial dimension.
- **Flame Resistance:** The resistance to burning of a rubber material or compound that will not combust under ordinary conditions.
- **Flash:** Excess rubber material left on a rubber part or component after molding. Flash is the result of the rubber material or compound migrating through the mold surface finish and mating surfaces. Can be removed by tear trimming, cryogenic deflashing, tumbling, and other post molding operations.
- **Flex Resistance:** the ability of a rubber part or component to withstand dynamic bending stress.
- **Flex Strength:** The ability of a rubber part or component to flex without permanent distortion or breaking.
- **Gas Permeability:** The degree to which a rubber material or compound resists permeation of gases under pressure.
- **Gates:** The openings in a transfer or injection mold that ensure the even flow of the rubber material or compound into the mold cavity. Also known as a sprue.
- **Gate Mark:** A raised spot or small depression on the surface of a transfer or injection molded rubber part or component where the gates or sprues interface with the mold cavity. Also known as a sprue mark.

## Designing with Rubber

### Rubber Glossary Cont. . .

- **Hardness:** Resistance to a disturbing force. Measured by the relative resistance of a rubber material or compound to an indenter point of several standard hardness testing instruments.
- **Heat Aging:** A test for degradation of the physical properties of a rubber material or compound because of exposure to high temperature conditions.
- **Homogeneous:** A rubber part or component without metal, plastic, or fabric substrates.
- **Insert:** Typically, a metal, plastic, fabric, or other substrate to which a rubber material or compound is mechanically or chemically during the molding process.
- **Low Temperature Flexibility:** The ability of a rubber part or component to be flexed, bent, or bowed at low temperature without cracking.
- **Modulus:** Tensile stress at a specific elongation. Usually 100% elongation for rubber materials and polymers.
- **Mold Cavity:** Hollow space, or cavity, in the mold used to produce the desired form or shape of the rubber part or component being molded.
- **Mold Finish:** The uninterrupted surface produced by the intimate contact of the rubber material or compound with the mold and cavity surface at vulcanization.
- **Mold Register:** The accuracy of the mold alignment or fit of the mold sections or plates.
- **Nominal Dimension:** Nearest fractional equivalent to an actual decimal dimension.
- **Oil Resistance:** The ability to formulate a rubber material or compound to be molded and vulcanized to resist the swelling and deteriorating effects of various types of oils.
- **Oxidation:** The reaction of oxygen on a rubber material or compound, usually detected by a change in the appearance and feel of the rubber part or component surface, or by a change in the physical properties of the rubber material or compound, or a combination of both.
- **Ozone Resistance:** The ability of the rubber material or compound to withstand and resist the deteriorating effects of ozone.
- **Parting Line:** The line on the surface of a molded rubber part or component where the mold plates meet.
- **Permeability:** The rate at which a liquid or gas, under pressure, passes through a rubber material or compound by diffusion and solution.
- **Permeation:** The diffusion of a liquid or gas through a rubber part or component.
- **Plasticizer:** A substance added to a rubber material or compounds to decrease stiffness, improve low temperature properties, and improve processing.
- **Post Cure:** The second step in the vulcanization process for selective specialized elastomers. Provides stability of the rubber material or compound in its molded shape and drives off decomposition products resulting from the vulcanization process.
- **Pot:** The chamber in the transfer or injection mold, where the rubber material or compound is placed before it is transferred or injected into the mold cavity.

## Designing with Rubber

### Rubber Glossary Cont. . .

- **Rebound:** a measure of the resilience of the rubber material or compound. Usually measured as a percentage of the vertical return of a body.
- **Register:** The accurate machining of the plates in a mold.
- **Resilience:** Ability of a rubber part or component to return to its original size and shape after deforming forces are removed.
- **Shrinkage:** The ratio between a mold cavity size and the size of the rubber part or component molded in the cavity. Decreased volume of a rubber component usually caused by extraction of soluble constituents by fluids followed by air-drying.
- **Sprue:** the primary feed channel that runs from the “pot” of a transfer mold and “runners” of an injection mold to the mold gates in single and multiple cavity molds.
- **Sprue Marks:** Marks left on the surface of a rubber part or component. Normally elevated or depressed after removal of the sprue or gate on a vulcanized part produced in a transfer or injection mold.
- **Surface Finish:** A numerically averaged value of surface roughness. Measured in units of microinches or micrometers.
- **Tear Strength:** The force required to rupture a rubber sample of a stated geometry.
- **Tear Resistance:** Resistance to growth of a cut or nick when tension is applied to the cut rubber specimen. Measured as pounds per square inch thickness.
- **Temperature Range:** Maximum and minimum temperature limits in which a rubber material or compound will function in each application.
- **Tensile Strength:** The force (in pounds per square inch) required to cause the rupture of a specimen of rubber material or compound.
- **Total Indicator Reading (TIR):** System that measures the roundness of a rubber part or component in relationship to the centerline of the rubber part or component.
- **Undercut:** A groove on either the outside or the inside of a molded rubber part or component.
- **Vibration Dampening:** The ability of a rubber material or compound to absorb vibration or shock energy.
- **Vulcanization:** A thermosetting reaction involving the use of heat and pressure, resulting in the increased strength and elasticity of rubber materials or compounds.
- **Weather Resistance:** The ability of a rubber material or compound to withstand weathering factors such as oxygen, ozone, atmospheric pollutants, erosion, temperature cycling, and ultraviolet radiation.

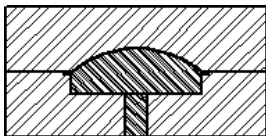
## Designing with Rubber

### General Guidelines for Selecting or Identifying Rubber Materials or Compounds

- Will the rubber part or component be used to seal a fluid or transmit a fluid?
- Will the rubber part or component be used to transmit energy or absorb energy?
- Will the rubber part or component be used to provide structural support?
- Does the environment where the rubber part or component operate, or function expose the rubber part or component to water, chemicals, fuels, hydraulic fluids, or solvents?
- Will the environment the rubber part or component is exposed to be wet or dry?
- Will the rubber part or component be exposed to oxygen, ozone, or sunlight?
- What is the temperature range of the environment the rubber part or component will be exposed to?
- Will the rubber part or component be exposed to constant pressures or pressure cycles?
- Will the rubber part or component be under dynamic stress that could cause potential deformation?
- Will the rubber part or component be required to stretch without breaking?
- Will the rubber part or component require resistance to deformation?
- Will the rubber part or component require resistance to compression set under heavy loads?
- Will the rubber part or component require a resistance to dimensional changes or be resistant to being brittle when exposed to heat or fluids?
- Will the rubber part or component require abrasion resistance?
- Will the rubber part or component require impact resistance?
- Will the rubber part or component require vibration-dampening performance?

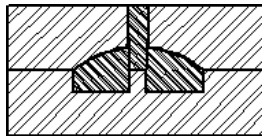
### Rubber Part & Component Design

Compression



Direct Body Feed

Flush Pin Feed

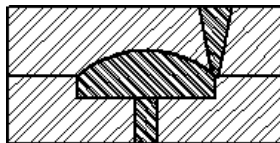
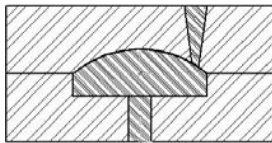


Edge Gate Feed

O-Ring Feed



Lead-In Feed

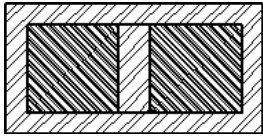




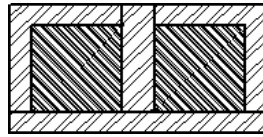
## Designing with Rubber

### Rubber Part & Component Design

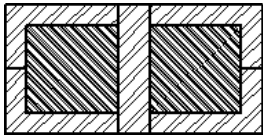
Mold Design  
Square Cross-Section  
Preliminary



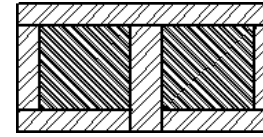
Mold Design Two  
Plate Mold  
Bottom Plate Parting Line



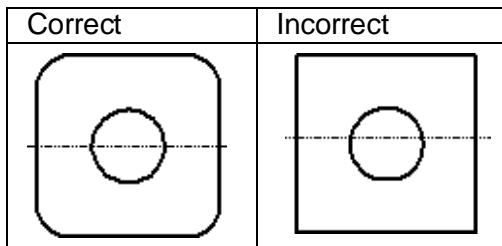
Mold Design Two  
Plate Mold  
Middle Parting Line



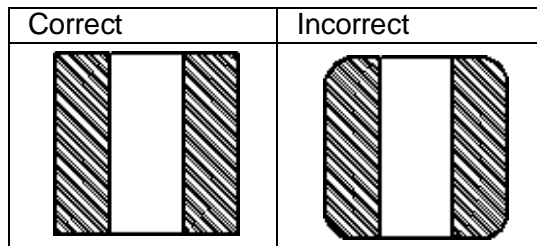
Mold Design Three  
Plate Mold Two  
Parting Lines



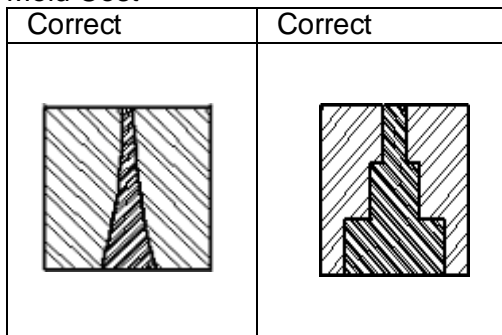
Radius Corners Top  
View  
Lower Mold Cost



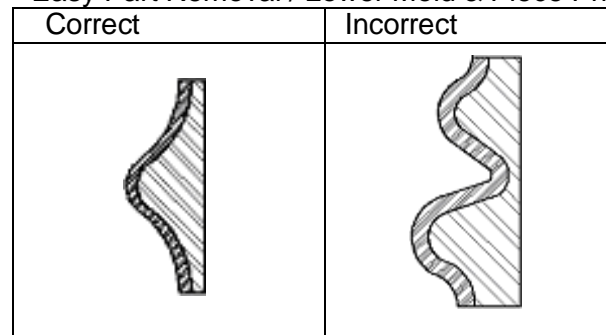
Square Corners  
Side View  
Lower Mold Cost



Core Pins for ID  
Side View – Tapered or Stepped Lower  
Mold Cost



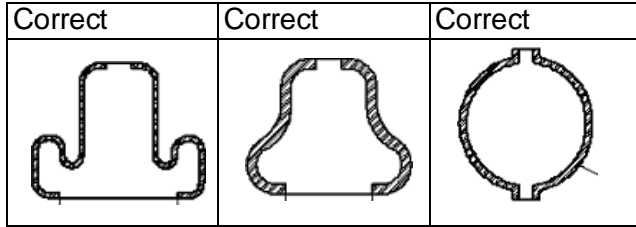
Bellows / Convolved Side  
View  
Easy Part Removal / Lower Mold & Piece Price



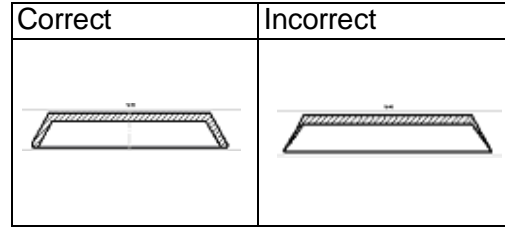
## Designing with Rubber

### Rubber Part & Component Design

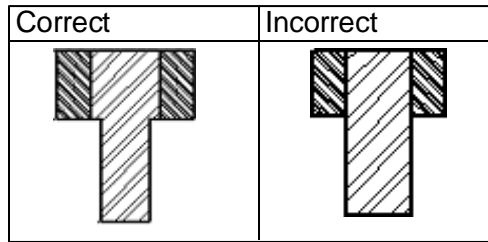
Boot / Bulbs Side View  
Easy Part Removal / Lower Mold & Piece Price



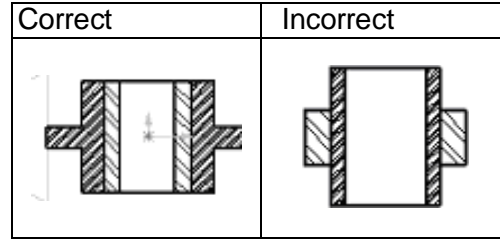
Components w/ Sharp Edges Side View  
.015" Flat on Edge / Lower Mold & Piece Price



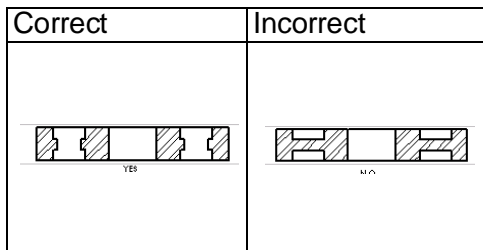
Components w/ Substrates Side View  
Stepped Flange / Lower Mold & Piece Price



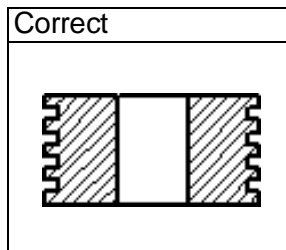
Components w/ Substrates Side View  
Insert Encapsulated / Lower Mold & Piece Price



Components w/ Substrates Side View  
Insert Encapsulated / Lower Mold & Piece Price



Substrates / Inserts Side View  
Ribs & Projections Enhance Mechanical & Chemical Bonding



Substrates / Inserts Top View  
Through Holes Enhance Mechanical & Chemical Bonding

