Designing for Success

Molded Components

At Specialty Silicone Fabricators, we take pride in the success of our partnerships. A key part of this success can be attributed to our desire to collaborate with our customers. The first step in this process is to discuss the key characteristics of the project and how best to utilize our knowledge and experience in manufacturing silicone rubber components for the healthcare marketplace.

By addressing a few key items during the design stage of a silicone rubber component, we can achieve a mutual understanding of the process. Designers should be aware that properties and processing characteristics of silicone rubber differ from those of thermoplastics or other rigid materials.

General Silicone Properties
Silicone rubber is a thermoset (heat cure) material available in durometers from 5 Shore A to 90 Shore A. For molded product success, we recommend staying between 20-70 Shore A durometer. There are two main categories of silicone rubber; high consistency rubber (HCR) and liquid silicone rubber (LSR). For all medical component applications there are two classifications: Short Term (less than 29 days indwelling) and Long Term (greater than 29 days indwelling). For applications requiring radiopacity, various materials are available that can be blended into the raw material prior to processing. For applications requiring color, pigments are available.

Many HCR's require a post cure to drive off volatile compounds to stabilize the properties of the rubber. All extrusions are made from HCR. In its raw form, HCR has the consistency of modeling clay. Because of higher viscosity, HCR's flow characteristics are not conducive to fill complex part geometries or thin sections.

Typical properties for 50 durometer high consistency silicone*:
Tensile strength 1,470 PSI
Elongation 900%
Tear strength 260 PPI (pounds per inch)
* Properties shown are reference and vary according to durometer & manufacturer.

Because of lower viscosity, LSR can produce more detailed part geometries. LSR is the material used in the liquid injection molding (LIM) process and is suitable for faster, semi-automatic processing. In its raw form, LSR has the consistency of toothpaste and does not typically require a separate post cure.

Typical properties for 50 durometer liquid silicone*:
Tensile strength 1,470 PSI
Elongation 630%
Tear strength 260 PPI (pounds per inch)
* Properties shown are reference and vary according to durometer & manufacturer.

Please call one of our Product Development Engineers for assistance in determining the material that is right for your application. For technical information we suggest contacting the material suppliers directly at 1-800-394-4284.

Designing for Success

Typical Project Model: Quote to Production Process

1. Customer request for quote (RFQ)
2. Proposal review: customer objectives, acceptance criteria, and manufacturability.
3. Finalize collaboration of design
4. Quote/no quote decision. (Tooling and part quote)
5. Customer acceptance/purchase order
6. Mold construction
7. Mold proving (production/product evaluation)
8. Evaluation sampling or first articles
9. Customer approval
10. Tool qualified and/or production ready

Part Tolerances

The most misunderstood aspect of molded silicone rubber part design is the application of tolerances. Due to the flexible & compliant nature of silicone rubber, it is not usually necessary to hold a silicone rubber part to stringent tolerances as used with other materials. Silicone rubber fabricators recommend using the Rubber Manufactures Association (RMA) tolerance tables for rubber parts when initially designing your components. These guidelines are a good starting point for determining tolerances based on actual part size and application. To insure repeatability, consistent manufacturability and lowest part cost, you should consider using the maximum possible tolerance on your product.

A typical silicone shrink rate is 2.5%. Lot to lot, silicone can, and does, vary in shrink rate by up to .5%. By comparison, a typical thermoplastic shrink rate is .6% and seldom varies by more than .1%. The following tables are the established RMA standards for rubber products. Depending on material selection, part geometry, and molding method "A1" tolerances may not be attainable. Even though the mold is built to anticipate shrinkage, there remains an inherent variability which must be allowed for by an adequate dimensional tolerance.

Drawing Designation "A1" High Precision

Inches		Millimeters	
Above Incl.	± Tolerance	Above Incl.	± Tolerance
0 - .40	.004	0 – 10	.10
.40 - .63	.005	10 – 16	.13
.63 - 1.00	.006	16 – 25	.16
1.00 - 1.60	.008	25 – 40	.20
1.60 - 2.50	.010	40 – 63	.25
2.50 - 4.00	.013	63 – 100	.32
4.00 - 6.30	.016	100 – 160	.40

SOURCE - R.M.A. HANDBOOK

Designing for Success

Drawing Designation "A2" Precision

Inches		Millimeters	
Above Incl.	± Tolerance	Above Incl.	± Tolerance
0 - .40	.006	0 – 10	.16
.40 - .63	.008	10 – 16	.20
.63 - 1.00	.010	16 – 25	.25
1.00 - 1.60	.013	25 – 40	.32
1.60 - 2.50	.016	40 – 63	.40
2.50 - 4.00	.020	63 – 100	.50
4.00 - 6.30	.025	100 – 160	.63
6.30 & over multiply by	.004	160 & over multiply by	.004

SOURCE - R.M.A. HANDBOOK

Drawing Designation "A3" Commercial

Inches		Millimeters	
Above Incl.	± Tolerance	Above Incl.	± Tolerance
0 - .40	.008	0 – 10	.20
.40 - .63	.010	10 – 16	.25
.63 - 1.00	.013	16 – 25	.32
1.00 - 1.60	.016	25 – 40	.40
1.60 - 2.50	.020	40 – 63	.50
2.50 - 4.00	.025	63 – 100	.63
4.00 - 6.30	.032	100 – 160	.80
6.30 & over multiply by	.005	160 & over multiply by	.005

SOURCE - R.M.A. HANDBOOK

Drawing Designation "A4" Basic

Inches		Millimeters	
Above Incl.	± Tolerance	Above Incl.	± Tolerance
0 - .40	.013	0 – 10	.32
.40 - .63	.016	10 – 16	.40
.63 - 1.00	.020	16 – 25	.50
1.00 - 1.60	.025	25 – 40	.63
1.60 - 2.50	.032	40 – 63	.80
2.50 - 4.00	.040	63 – 100	1.00
4.00 - 6.30	.050	100 – 160	1.25
6.30 & over multiply by	.008	160 & over multiply by	.008

SOURCE - R.M.A. HANDBOOK

Designing for Success

Tooling Options – Molded Products
Molds for silicone rubber are different than molds for thermoplastics. With its extremely low viscosity, LSR will flow into very small gaps (.0002"). Mold tolerances for a thermoplastic are typically ± .001". Molds for silicone rubber have to be made to exacting tolerances (typically ±.0002").

There are three methods used to mold silicone rubber: liquid injection molding (LIM), transfer molding, and compression molding. It is beneficial to understand the relationship between volume requirements, component geometry, tolerances, component target cost, and molding method. Often material, component geometry or volume requirements dictate the molding method and mold class used. The table below is a guide to mold classification for silicone rubber and should be used as reference only:

Class	Description	Cycle life
4	Prototype	< 1,000 cycles
3	Low Volume Production	< 10,000 cycles
2	Medium Volume Production	< 100,000 cycles
1	High Volume Production	< 500,000 cycles

There are many factors that affect cycle life such as the molding method, use of hand loaded inserts or core pins, and part configuration. With its high elasticity, silicone rubber allows some freedom to design components with large undercuts and various geometries not available when using thermoplastics. It is important to understand how these design elements affect manufacturability and component price as silicone rubber components are typically not ejected by "normal" means.

Part Surface Finish
Texture or finish of silicone rubber molded parts can impact the manufacturability. While a "clear" appearance on a component is achievable, silicone rubber tends to stick to highly polished mold surfaces. A typical mold finish is a "light EDM" finish or a bead blasted finish equivalent to SPI D-1. These finishes, when applied to the mold, produce a fine matte (translucent) finish on the silicone rubber component and aid in part removal from the mold.

Inspection
Our standard practice with parts from new production tooling is to inspect the first article parts, segregated by cavity, to all measurable dimensions as listed on the blueprint unless otherwise specified. After first articles, it is important that critical or inspection dimensions be designated on the drawing to facilitate the appropriate inspection level for production parts. Typically, non-contact measurement methods are employed because silicone is a flexible and compliant material that may not be self-supporting in thin cross sections. It may be determined that some blueprint dimensions will not be inspected during first article and apply to the tooling only.

Designing for Success

Acceptance Criteria - Visual
It is important to specify the method by which visual inspection is to take place. A typical specification will denote focal distance, environment and equipment (if applicable). An example could be: Product to be viewed from a distance of approximately 18" with the unaided eye, having original or restored 20/20 vision, under normal work space lighting.

Flash
We suggest using the largest specification that allows your part to function properly. Setting a flash specification should be done carefully. A very tight tolerance could create the need for a secondary operation to remove the flash which would increase the cost of the part.

In some molding operations flash is typically controlled with overflow grooves or tear rings. Without further processing, parts will generally have between .001"- .020" flash at the parting line right out of the mold depending on component geometry, number of cavities, material, etc.

LIM style processing generally yields less flash as it is a more controlled process. Dependant on your specification some parts, based on component geometry, number of cavities, material, specification, etc., may still require secondary flash removal.

Embedded/Particulate
Generally, raw material is supplied filtered through 400 mesh screen which allows particles approximately 0.016" to pass. Through additional processing this specification can be reduced.

As the designer, it is up to you to determine the criteria that will allow your final component to function properly and meet your cost objectives. The information contained in this document is general in nature and is neither intended to, nor does it refer to, any particular product or device and shall not be interpreted as cooperation or recommendation between yourself and Specialty Silicone Fabricators.