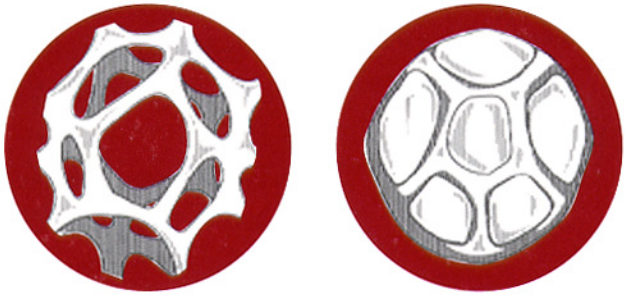
## Open Cell Sponge

Sponge rubber is made by incorporating into the compound a gas-producing chemical such as sodium bicarbonate, which expands the mass during the vulcanization process. Sponge rubber is manufactured in sheets, molded strips and special profiles. Sheets and parts cut from sheets will usually have a surface impression since sheets are usually molded against a fabric surface, which allows air to be vented during the expansion of the sponge. Molded strips will have open cells exposed at the ends of the parts unless otherwise specified. Die cut parts will have open cells on all edges. On parts where open cell surfaces cannot be tolerated, this should be so specified.

*Illustrations below provide an excellent representation of open cell and closed cell structures.*

*Open Cell* *Closed Cell*



## Closed Cell Sponge (Expanded)

Closed cell rubbers are made by incorporating gas-forming ingredients in the rubber compound or by subjecting the compound to high-pressure gas such as nitrogen. Expanded rubbers are manufactured in sheet, strip, molded and special profile shapes by molding or extruding.

Closed cell sheets are generally made rectangular and of sufficient thickness to be split into several layers for die cutting. From this use is derived, for economic reasons, the term "skin one side or no sides, our option." Closer tolerances can usually be maintained on split sheets (no skin surfaces) than on sheets with a natural skin.

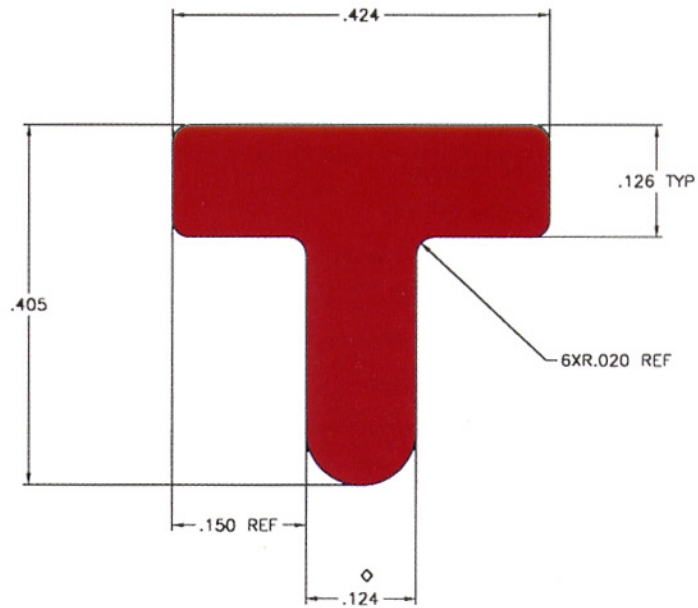
Characteristics of extruded closed cell rubber are:

- The surface of the extruded section has a natural skin that is clean and smooth.
- It is produced in continuous lengths.
- A great variety of complex and irregular cross-sections may be produced.

Air chambers or hollowed out designs may be utilized, giving the advantage of reduction in weight and cost of material. The design engineer, by properly designing the cross-section with maximum air chamber space, can generally achieve considerable advantage in terms of performance and compression deflection.

Molded closed cell parts are manufactured similar to open cell molded sponge. They require venting of trapped air and the necessary use of inert dusting powder, which is difficult to remove completely from the surface of the finished part. Long, complicated sections may require vents or multiple splices.

Distinct advantages of closed cell products are their low water absorption characteristics, providing a tight seal, and the ability to conform to curves, corners and varying cross-sections without bridging or creasing. This is attributable to the closed cells that do not collapse, losing air as in open cell sponge, and yet deforming sufficiently to conform tightly to irregular surfaces. Its thermal value is utilized in insulation applications.




## Cellular Silicone Rubber

Cellular silicone rubber in sheet, molded or extruded forms can be manufactured in similar processes used for other cellular rubbers. A post-cure period in a hot-air oven is usually used to insure complete vulcanization. Because dimensions can undergo some change during this post-cure, wider dimensional tolerances must be allowed, particularly on molded items. Cellular silicone rubber is almost always produced with a closed cell structure.

## Cellular Fluoroelastomer Rubber

Historically, fluoroelastomer compounds (such as Viton®) have only been available as dense extrusions and as dense or sponge molded parts. Today, these high-tech rubbers can be extruded as continuous sponge—which can deliver the enhanced sealing characteristics associated with fluoroelastomers at a more cost-effective price. Also, as with other sponge seals and gaskets, fluoroelastomer sponge extrusions require less closing force than do their dense counterparts to deliver an effective seal.

# CLASSIFICATION OF FLEXIBLE CELLULAR MATERIALS

All of Lauren Manufacturing's sponge products are identified by a three character classification ***(Example: 2A2).*** The three characters represent type, class and grade, and are defined as follows:

**Type**

Type 1 = Open Cell
Type 2 = Closed Cell

Class A = Non-oil resistant
(Example: EPDM)
Class B = Oil resistant, low swell
(Example: Nitrile)
Class C = Oil resistant, medium swell
(Example: Neoprene)
Class D = Extreme temperature resistant
(Example: Silicone)

**Grade**

Grade ratings represent compression deflection, or the amount of force in pounds per square inch to deflect the sample 25% of its height. They are listed as follows:

Grade 0 = less than 2 psi
Grade 1 = 2 to 5 psi
Grade 2 = 5 to 9 psi
Grade 3 = 9 to 13 psi
Grade 4 = 13 to 17 psi
Grade 5 = 17 to 25 psi

**Suffix**

Suffix numbers that follow the suffix letters denote different testing parameters or conditions for that suffix. Once testing is complete, a Line Call Out is assigned to the compound according to the Basic and Suffix Requirements the compound has met.

| Suffix Letter | Test Required |
|---|---|
| A | Heat resistance |
| B | Compression set |
| C | Ozone or weather resistance |
| D | Compression deflection resistance |
| E | Fluid resistance |
| F | Low temperature resistance |
| G | Tear resistance |
| J | Abrasion resistance |
| K | Adhesion capability |
| L | Water absorption |
| M | Flammability resistance |
| N | Impact resistance |
| P | Staining resistance |
| R | Resilience |
| W | Density |
| Z | Any special requirements |

*Example Line Call Out for Sponge*

ASTM D-1056 2C2 A1 B2 E1 Z
(Z = Material passes FMVSS 302)

## COMPRESSION SET TEST

Compression set is the amount, measured in percentage, by which a standard rubber test piece fails to return to its original thickness after being subjected to a standard compressive load or deflection for a fixed period of time. The set test is used to determine the quality of rubber compounds and their applicability to certain types of usage.

If the material has good compression set resistance, it will recover sufficiently when the load is released to effect a repeated seal. It is not necessary for a material to have 100% recovery to produce an effective, repeatable seal. If the seal is under constant compression, material recovery is not as important.

Due to the special characteristics of the closed cell structure, the compression set test has an entirely different effect on closed cell materials versus open cell materials and requires an entirely different interpretation. The differences in application and interpretation of the compression set test on open and closed cellular materials are shown in the comparative tabulation listed below.

| **Open Cells** | **Closed Cells** |
|---|---|
| Air is free to pass through open cells. There is no effect of the 158°F (70°C) test temperature on the air pressure in the cells. | Air is not free to pass through the closed cells. The 158°F (70°C) test temperature causes an increase in air pressure in the closed cells. |
| All of the compressing pressure is on the rubber during the test. | Part of the compressing pressure is on the rubber, but part of it is on the air in the cells during its test. |
| There is no air diffusion effect through the cell wall structure. | During the time that the closed cell structure is under pressure, in the test there is some air diffusion through the thin cell walls. (This is the same diffusion effect that occurs when air pressure decreases in an automobile tire over a period of time, even though there is no specific leak in the tube. This effect is a basic characteristic of the rubber or synthetic polymer. It cannot be changed significantly by the cellular rubber product manufacturer.) |
| The rubber is free to recover immediately after the test. Air can go back into the open cells immediately. | The rubber is not free to recover after the test. Air can not go back into the closed cells immediately. |
| The sample retains the compression set after the test. | The sample continues to recover after the test period is over. |
| The compression set test result indicates the state of cure of the rubber sample. An undercured sample shows a high compression set. | The compression set test result does not necessarily indicate the state of cure of the sample. It is more an indication of the amount of air that has diffused from the closed cells and has not yet diffused back. |
| On samples that are otherwise equivalent, the test results are not affected greatly by the thickness of the sample. | On samples that are equivalent in other respects, the test results are greatly affected by the thickness of the sample tested. This is because of the diffusion effect as noted above. |
| The compression set test result is not directly affected by the hardness of the open cell sponge. | The compression set test result is affected by the hardness of the sample, harder materials showing lower percentages of set. This is because in the harder material, the rubber portion supports a relatively higher amount of the total pressure in comparison with the air cells. |

*The information presented here on the compression set test was extracted from the RMA Handbook (RMA Table 29).*

## COMPRESSION DEFLECTION TEST

The Compression Deflection (C/D) test, as outlined in ASTM D-1056, measures the force it takes to compress a standardized test specimen 25% of its height. The reported result is expressed in kilopascals or pounds per square inch. Sponge compounds, whether open or closed cell, are then classified by grades. Each grade is based on a specific range of firmness of the sponge as expressed by the Compression Deflection test. Digits 0 through 5, as seen in this brochure, denote these grades.

It is important to understand why C/D is a more useful tool than a durometer reading. A durometer gauge, which uses a very small pointer, only provides single point readout on the sample where no significant deflection of the sample actually occurs. Depending on the cell structure of the sponge compound, the durometer readings could have a very wide span. C/D on the other hand, is geared to provide engineers with some standardization of load force for any given compound. They can then determine which grade of sponge will work to give the closure force necessary for a given application.