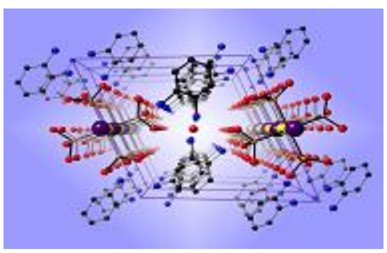
ELASTO PROXY INC. The Art of Sealing

Compound Selection: Blended Materials and Distinctive Polymers

Do people say that you look like your father? How about your mother? Maybe you resemble both of your parents, but in different ways. Human genetics can be complex, but so can polymer chemistry.

Like DNA strands, long-chain polymeric molecules consist of base units (monomers) and groups. The double-helix structure of DNA is well-known, but the tangled configurations of polymer molecules are difficult to describe. That's not the hard part, however. The real challenge is creating a plastic alloy from them.

Because of their complex structures, many polymers do not lend themselves to blends. Human history includes a Bronze Age and an Iron Age, but have you read any books that call our current era the Age of Long-Chain Polymer Blends?



Through advances in material science, however, mixers are able to create compounds from rubbers such as silicone and EPDM. Blending these long-chain polymers is challenging, but imparting the best characteristics from each is essential.

Let's look at the advantages – and disadvantages – of silicone and EPDM. Next, we'll learn how mixers make silicone/EPDM blends, and how creating a blend for an application means getting the recipe for rubber just right.

Silicone Rubber

Silicone resists ozone, sunlight, oxidation, and weathering while providing excellent electrical insulation and flexibility at low temperatures.

Although silicone is valued for its low compression set and superior color stability, this synthetic rubber is best known for its usefulness at high or low service temperatures. Silicone is more expensive than EPDM, but silicone seals generally last longer.

Silicone isn't ideal for all applications, however. Because of its chemical properties, this type of rubber isn't recommended for use with acids, alkalis, solvents, oil, or gasoline. Silicone lacks strong resistance to abrasion and tearing, too. Although many excellent silicone compounds are available, pure silicone isn't the right choice for applications that require high tensile strength.

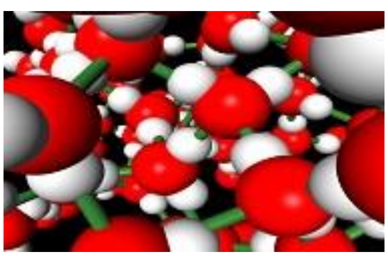
EPDM Rubber

EPDM also has its strengths and weaknesses. A popular polymer, this synthetic rubber is used in belts, hoses, and O-rings for the automotive and mass transit industries.

With its excellent resistance to aging, ozone, and weathering, EPDM also provides strong resistance to acids, alkalis, and some solvents. EPDM parts are color stable, remain flexible at low temperatures, and resist both water and steam.

EPDM isn't perfect however. In fact, this synthetic rubber is no match for mineral oils or aromatic hydrocarbons. EPDM compounds aren't recommended for applications involving petroleum derivatives then. Though suitable for use as a high voltage insulation material, EPDM can conduct electricity if carbon black is added to improve weathering.

Blending Silicone and EPDM



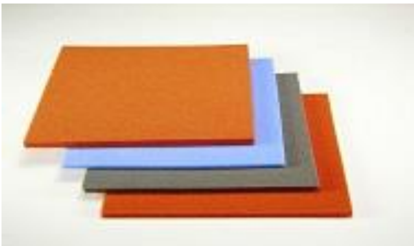
To produce blends with the best properties of silicone and EPDM, compounders add the two rubbers in proportions such as 50:50 or 70:30 to a two-roll mixing mill. Typically, dicumyl peroxide is used as the vulcanizing agent.

After the materials are compression-molded into sheets and cured, the mixers test the blends and measure properties such as dielectric strength, tensile strength, and percentage elongation at break.

According to test results published by the IEEE, increasing the proportion of silicone improves a blend's electrical insulation. By increasing the weight percentage of EPDM, mixers can boost mechanical strength instead.

As with other compounds, there are tradeoffs. For example, silicone-modified EPDM blends can withstand higher temperatures than EPDM alone, but provide less temperature resistance than pure silicone. EPDM/silicone blends are tougher than silicone, but not as tough as EPDM alone.

Foam Rubber vs. Sponge Rubber



Polymer chemistry is challenging, but material science isn't just for chemists. Different rubbers have different characteristics, and compound selection begins with a thorough understanding of application requirements.

In order to ask for the right rubber, however, you need to know what it's called. When it comes to material selection, seemingly small but subtle differences can have significant consequences.

Did you know that there's a difference between foam rubber and sponge rubber? Sure, the two terms are often used interchangeably. Unless you work in the rubber and plastics industry, the sponge next to your kitchen sink may seem similar enough to the foam mattress pad on your bed.

Both substances are soft and squishy, right? Upon closer examination, however, saying that foams are identical to sponges is like saying that doing the dishes is the same as getting a good night's sleep.

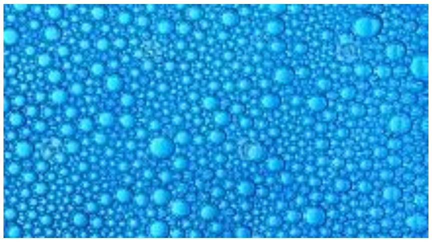
Distinctive Polymers

For technical buyers, choosing the right material is a lot more important than finding the right analogy. The memory foam from a mattress might help with after-dinner cleanups, but a polymer kitchen sponge is a better choice.

For safety-related applications, selecting the right rubber material may also mean meeting requirements for flame, smoke, and toxicity (FST). In the mass transit industry, for example, some silicone foams meet FST standards but many carbon black foams do not.

What's so different about these foams, and how does foam rubber compare to sponge rubber anyway? Let's take a look at how these polymers are made, and consider how raw materials, chemical reactions, and production processes can affect the characteristics of foam and sponge rubber.

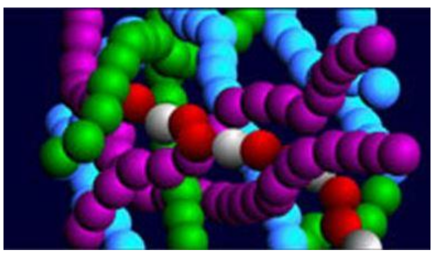
How Foam Rubber Is Made



The differences between foam and sponge rubber begin with ingredients and end with molecular structure. Foam rubbers use a blowing agent, typically a gas or a chemical that produces a gas, to create a mass of small bubbles in a liquid mixture.

Typically, this mixture contains polyols, polyisocyanates, water, and chemicals or additives such as flame retardants, fillers, and colorants. There are many different types of blowing agents, and foaming is used for both rubber molding and rubber extrusion.

The polyols and polyisocyanates in foam rubber are liquid polymers that, when combined with water, produce a heat-generating or exothermic reaction. By using specific types and combinations of liquid polymers, a material compounder can create flexible or rigid foam rubbers.

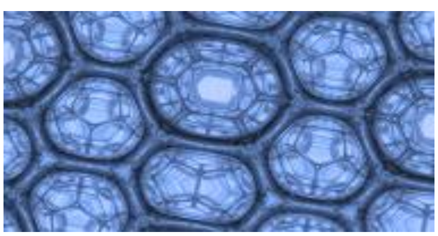


During polymerization, molecules from the polyols and polyisocyanates crosslink to form three-dimensional structures. The compounder can control foaming by adjusting the amount of water, or by using surfactants.

The importance of blowing agents in the production of foam rubber cannot be overstated. Although you can do the dishes without a sponge and get a good night's rest without a mattress pad, a compounder cannot create foam rubber without a blowing agent.

Typically, flexible foams use the carbon dioxide gas formed by the reaction of water with the polyisocynate. Most rigid foams use hydrofluorocarbons (HFCs) and hydrochlorofluorocarbons (HCFCs), gases with higher levels of toxicity and flammability than found in chlorofluorocarbons (CFCs).

How Sponge Rubber Is Made



Sponge rubber may be similar to foam rubber, but the two are not one and the same. For starters, there are two main types of sponge rubber: open-cell and closed-cell.

Open-cell sponge rubber contains open, interconnected pockets that permit the passage of air, water, and other chemicals when the material is not compressed.

Closed-cell sponge rubber contains balloon-like cells that hold nitrogen gas and thus prevent the passage of these substances at low pressures.

To produce open-cell sponge rubber, sodium bicarbonate is added to other ingredients in a heated mold. As the uncured sponge rises like a cake, the baking soda creates open, interconnected cells.

To make closed-cell sponge rubber, a chemical powder that decomposes under heat and pressure is added. The nitrogen gas that's released helps to give closed-cell sponge rubber its strong compression set and recovery characteristics.

Although nitrogen is a gas, it doesn't produce a foam like the gaseous blowing agents used with foam rubber. Foaming is specific production process, and foam rubber contains mostly open cells. Although some of the cells in foam rubber are closed, these rubber materials would not pass ASTM tests for water absorption, a standard requirement for closed-cell materials.

How Can We Help You?

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