Mold Making Materials

MOLDMAKING, B.C. - People have been making molds for thousands of years, dating back to ancient Egypt and China. Through the years, a variety of materials have been used to make molds including sand, wax, glue, animal fat, gypsum, alginate, metal, plastic, re-usable vinyl, gelatin and others.

MOLDMAKERS TODAY - Still use a variety of materials, but a majority uses one of four different flexible rubber products for the following reasons: 1) these rubbers reproduce exact detail, 2) flexibility allows for easy removal (demold) from the original model and the cast piece, 3) they generally give long life, allowing for multiple reproductions and 4) because they generally yield many reproductions, which also makes them cost effective.

These rubber products are **latex, polysulfides, polyurethanes**, and **silicones**. The next few paragraphs review these common mold rubbers along with advantages/disadvantages of each.

I. Latex (one component, dehydrating)

Latex is natural rubber extracted from rubber trees found mainly in Southeast Asia. To make this rubber usable as a mold material, the raw rubber is usually processed with ammonia and water. Latex is almost always brushed onto an original model (not poured).

Advantages -- Latex is a one-component system (no weighing necessary) that is ready to use right out of the container. Latex is relatively inexpensive. Latex is an elastic mold rubber and molds are generally thin-walled, strong and exhibit good abrasion resistance. Because of its high elasticity, a feature unique to latex is its ability to be removed from a model like a glove. A latex mold will retain its shape after being repeatedly rolled up and away (and turned inside out) from an original model or casting – like a glove. Because of this feature and its resistance to abrasion, latex is commonly used for making "glove molds" in the reproduction of ornamental concrete (lawn ornaments and statuary). Latex molds are also good for casting wax and gypsum.

Disadvantages -- Low-cost latex products generally shrink – on the order of 10 to 20% depending on product. Making molds with latex rubber is slow and time consuming. Brush-on molds made with latex require as many as 20 brush coats, with 4 hours of drying time between each coat. Time factor for making a brush-on latex mold is ten days or more. Many latex products have an ammonia odor (however, there are new latex products on the market with lower shrinkage and no odor). Latex molds are generally not suitable for casting resins.

II. Polysulfide rubbers (two component, catalytic)

Polysulfide rubbers are two-component systems (base plus curative; A+B) that have been the favorite mold rubber of bronze foundries around the world (for casting wax) for years. They are available for making molds that are poured or brushed on.

Advantages – polysulfide molds are very soft, "stretchy" and long lasting (some molds still in production are over 40 years old), and are good for making molds with severe undercuts and/or very fine detail. Unlike other mold rubbers, polysulfide rubber is not inhibited by sulfur or water based modeling clays. Model preparation is minimal. Once cured, polysulfide molds are good for casting wax (lost wax process) and gypsum plasters.

Disadvantages – the most common polysulfide rubbers with lead curatives have an offensive odor. Newly made polysulfide molds may stain plaster. Polysulfides have poor abrasion resistance (not good for casting concrete), and are not suitable for production casting of resins. Polysulfides (A+B) must be mixed accurately by weight (scale required) or they will not work. They are of moderate cost; higher than latex and urethanes but lower than silicones.

III Polyurethane rubbers (two component, catalytic)

Polyurethane rubbers are two-component systems (base plus curative; A+B) that cover a wide variety of applications at a relatively low cost. They are available for making molds that are poured, brushed or sprayed onto a model.

Advantages - polyurethanes are easy to use, with many having a simple mix ratio by volume (i.e. 1A: 1B) – no scale required. Flexible urethanes are available in a wide hardness range from gel-like to harder than a car tire and everything in between. Urethanes have relatively low viscosity and "de-air" themselves – no vacuum degassing required. Urethanes have good abrasion resistance and are used to cast abrasive materials like concrete. They are less expensive than silicones and polysulfides.

Disadvantages – As silicone rubber has the best release properties, urethane rubber has the worst release properties and will adhere to just about anything. Thorough model preparation (we'll cover this topic later) is essential to successful mold making with urethane rubber. Urethanes are moisture sensitive and may bubble if exposed to too much moisture (making molds outside on a very humid day, for example). Limited shelf life after opening – remaining product may be affected by ambient moisture in the air. (Smooth-On makes a product called "Xtend-It" that greatly extends the shelf life of unused urethanes).

IV. Silicone rubbers (two component, catalytic)

Silicone rubbers are two-component systems (base plus curative; A+B) available in a hardness range of very soft to medium. Silicones can be cured with either a platinum catalyst or a tin catalyst. They are available for making molds that are poured, brushed or sprayed on to a model and have performance characteristics that no other mold rubber has.

(For casting purposes Tin-based silicones can be cast into Platinum-based silicone molds, however, it is not recommended to cast Platinum-based silicones into Tin-based silicone molds.)

Advantages – Silicone rubber has the best release properties of all the mold rubbers, which is especially an advantage when doing production casting of resins (polyurethanes, polyesters and epoxy). No release agent is required, so there is no post-production cleanup. Silicones also exhibit very good chemical resistance and high temperature resistance (400°F / 205°C and higher). High temperature resistance makes silicone the only mold rubber suitable for casting low melt metal alloys (i.e. tin, pewter, lead). The combination of good release properties, chemical resistance and heat resistance makes silicone the best choice for production casting of resins.

Disadvantages - Silicones are generally high in cost - especially platinum-cure. They are also sensitive to substances (sulfur clay for example) that may prevent the silicone from curing (referred to as cure inhibition). Silicones are usually very thick (high viscosity), and must be vacuum degassed prior to pouring to minimize bubble entrapment. If making a brush-on rubber mold, the time factor between coats is long (longer than urethanes or polysulfides, shorter than latex). Silicone components (A+B) must be mixed accurately by weight (scale required) or they will not work. Tin catalyst silicones will shrink somewhat and do not have a long library life.

■ **Tin-Based Silicones**... consist of two components (part B base and part A catalyst), which, after mixing at the proper ratio by weight or volume, cure at room temperature (RTV) to flexible, high tear-strength rubbers. Although the tin-based silicones are usually poured into molds they can be made brushable by adding a thixotropic additive. All these mold rubbers are tin-catalyzed, condensation-cure systems and are not moisture sensitive (Platinum-based silicones are moisture sensitive). They are ideal for molds where easy release or high temperature resistance is required. They are recommended for casting polyester, epoxy and polyurethane resins, waxes, polyvinyl compounds, all gypsum products and low-temperature metals.

■ **Platinum-Based Silicones**... ... are two-component, addition-cure, platinum-catalyzed, high tear-strength, flexible mold compounds. (What a mouthful!) They are recommended as mold material for casting polyester, epoxy, polyurethane, wax and a wide range of other casting materials. They shrink minimally and, unlike the tin-catalyzed silicones, do not produce alcohol upon curing. The only problem with these rubbers is that they are extremely sensitive (not emotionally, but physically). They are moisture sensitive, extremely sulfur sensitive and the mix ratio is not particularly forgiving.

In this class we will be using a Tin-based silicone called Oomoo 25 and a platinum-based silicone putty called Resilpom II.

What Are 2-Component Rubbers?
Polyurethane, Polysulfide and Silicone are all mold rubber “compounds” that come in two parts: (A + B). To make things simple, Smooth-On always packages Part A in a yellow container and Part B in a blue container. All these compounds that we sell are RTV Rubbers (Room Temperature Vulcanization) meaning that they cure at room temperature, vs more commercial materials that need to cure in high temperatures and under high pressure.

Part A is mixed with Part B in some proportion (mix ratio) and either poured, brushed or sprayed onto a model.

Mold Rubber can be applied by pouring, brushing or spraying onto a model.

Liquid Rubber
To better understand and evaluate mold rubber for your own use, you need to know a few important terms:

• **Mix Ratio** - Expresses the correct proportion (in either weight or volume) of Part A to be mixed with Part B before applying. Mix ratios will vary from product to product and are always listed on the technical bulletin for that product. For example:

1A : 1B by volume 1A : 10B by weight
2A : 1B by weight 26A : 100B by weight
1A : 2B by volume 100A : 8B by weight

If a mold rubber requires a scale to weigh out A+B, use an accurate gram scale or triple beam balance. If you are not accurate, the rubber will not cure. If using a mold rubber that is mixed by volume, try to be as accurate as you can in your measurements.

A common mistake that people make is to assume that the mix ratio of one product is the same as another. Read the Technical Bulletin and know the mix ratio for the specific product you are using.

Important: Not all products are packaged the same. The mix ratio of a product will determine how that product is packaged, which can affect your cost.

• **Durometer** - Technically, durometer refers to the hardness of a mold rubber and ranges from a skin soft 0A to a harder-than-a-car-tire 95A.

A rubber’s Shore A hardness generally has bearing on other properties including tear strength, abrasion resistance, etc. Most often, “flexibility” is associated with a rubber’s Shore A Hardness; the lower the durometer, the more flexible the rubber. Conversely, the higher the durometer, the less flexible the rubber.

What “durometer” means to you in selecting a mold rubber: Selecting a rubber with a particular Shore hardness depends mainly on two factors: (1) the configuration of your model and (2) what you are casting into the finished rubber mold.

A model that has deep undercuts and/or severe angles (deer antlers, for example) will pose a problem in both removing the mold rubber from the model and removing the cast piece from the finished mold without breakage. For a model like this, you will want to select a soft and flexible mold rubber with a low Shore A number that will allow you to bend and flex the rubber mold from around the model.

If your model has few undercuts, you can use a harder mold rubber with a higher Shore A number. If your model is relatively simple and you want to do production casting of concrete, you can use a very hard rubber (Shore 80A) that has good abrasion resistance and will give longer mold life.

• **Viscosity** - indicates how well a material flows (or does not flow) and is measured in centipoise (CPS). Water has a viscosity of 1 cps and flows easily. Molasses has a viscosity of 100,000 and is thick.

• 1 cps = Water • 10,000 cps = Honey
• 500 cps = Cooking Oil • 100,000 cps = Molasses
• 2,500 cps = Motor Oil

What viscosity means to you in selecting a mold rubber: Generally, the higher a rubber’s viscosity, the harder it is for the rubber to de-air itself without help (vacuuming). Most silicone rubbers have a high viscosity (20,000 cps to over 150,000 cps) and vacuuming the material after mixing is usually recommended. If the mixed silicone is not vacuumed, you risk air entrapment and bubbles that will be reflected in the cured mold. Polyurethanes have relatively low viscosities (800 - 4,500 cps) and de-air themselves well. Vacuuming the material is usually not necessary.

V. Alginate for Body Casting (one component mixed with water, gels)

Alginate is a gelatinous precipitate that is extracted from brown algae and absorbs up to 300 times it's weight in water. It si a fast-setting mold material used to make casts from living people or delicate/ unstable/ perishable items. (Dental Alginate, which is a different grade than body casting alginate is used to make casts of teeth and gums.)

VI. Other

- **Thermo-rubber** (one component melted, cools)

Elastack™ Molding Compound is a specially formulated synthetic rubber engineered to melt and flow easily. Unlike ordinary rubber, this material flows when heated, making it easy to cast with extreme versatility. It is highly transparent with optical clarity similar to acrylic or glass.

In use, the compound is convenient to use in a wide range of applications. Heating requires no special equipment beyond an ordinary hot plate or stove. At pouring temperature, the melt is easy to pour, paint, or coat to produce castings. Finally, the compound is easy to color by mixing ordinary crayons, or other pigments, into the melt prior to casting.

Unlike typical molding materials, which chemically set and cannot be reprocessed, Elastack Molding Compound can be melted and cast again and again. They are melted at 338^{o}F (170^{o}C)