Objet Geometries

Guide to Basic Post Process Applications

Learn how to save time and costs
and ensure successful product development

OBJET

Warnings

Wear protective gloves when handling printed models before they are washed.
Caustic soda may cause chemical burns, scarring and blindness. Mixing it with water generates heat that could ignite other materials.Take adequate safety precautions; always use nitrile gloves when handling caustic soda and models soaked in it.

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1 About This Quick Start Guide

Using the Quick Start Guide

This Guide to Basic Post Process Applications provides information and complete instructions for performing a variety of post-process applications using models created with Objet 3-D printers. It includes detailed descriptions, using real-world situations to illustrate how to create realistic prototypes quickly, compared to traditional methods. Additionally, this Quick Start Guide provides valuable guidelines, cautions and safety information.

Who Should Use This Guide?

This guide is intended for users who already have knowledge and experience in machine operation, basic handling and proper working procedures.

For More Information

Visit **http://www.2objet.com/** for more details about Objet Geometries Ltd. technologies, products and applications information.

Guide Glossary

Model material – Material used for building models.

Support material – Material used for supporting the structure of models during the printing process.

Sodium hydroxide (NaOH) – known as lye, caustic soda or sodium hydrate, NaOH is a caustic metallic base. Forming a strong alkaline solution when dissolved in a solvent such as water, caustic soda is widely used as a strong chemical base.

Casting – Casting is the process of producing objects by pouring molten material into a cavity called a mold, which is the negative of the object, then allowing it to cool and solidify.

2

Introduction

Using rapid prototype development as the seed stage in realizing and developing your final product requires precise consideration of both the technical quality of the model and the cost/time factors involved.

By creating a compelling 3-D preview of your products you can:

- Produce precise models within hours, before ever going into production.
- Generate better communications and collaboration between everyone involved in the development process.
- Catch design flaws.
- Make appropriate adjustments.
- Create finished products/components with no tooling necessary.
- In-house control.
- Maximize cost and time effectiveness.

In certain cases, in order to achieve the desired appearance, functionality or hardness, the model needs some post-processing work.

This guide is designed to serve as a quick reference for selected post processing applications and to demonstrate (step-by-step) how Objet 3-D models can be:

- **Polished** – For clear parts such as lenses, containers, covers, panels and a variety of other applications.
- **Painted** – For sales samples, photography of finished models.
- **Metal Plated** – To create functional metal prototypes for testing and evaluation of their intended applications without production at the hard tooling level.
- **Sand cased** – For rough metal parts.

3 Post Process Applications

Models Cleaning Procedure using NaOH (Sodium Hydroxide)

An optional treatment of finished models, using inexpensive, commercially available Sodium Hydroxide diluted in water.

Applications & Benefits

- Slightly improves surface finish, eliminates small amount of residue left on surface.
- Improves transparency to some extent.
- Makes separation of support model easier, specially for tight tolerance or moving parts.
- For very complicated parts with longer support removal – greatly decreases time for WaterJet support removal.

Recommendations on when to use

- For models requiring painting or silicon moulds.
- Any model where surface touch/feeling is key factor.

How does it work?

- The product to buy is pure Sodium Hydroxide (known also as caustic soda, or NaOH). It is a chemical commonly used in commercially available products such as cleaners or to unblock drains.
- Available in pure form any hardware store or DIY store.
- It is recommended to replace the solution once a week so that cleaning is optimal.
- Please note, all parts must still undergo WaterJet support removal before this cleaning.
- Fine sandpaper can still be used for a glossier finish.
- All handling of Sodium Hydroxide should be done according to local safety conditions

Any side effects?

- This soaking should not surpass 2 hours otherwise there is a risk of deformation
- For the large majority of models, there will be no effect on mechanical properties.
- For models with thin walls <1 mm in z direction (less so in x and y), there may be slight deformation so these models should be soaked for a shorter time.

Model Cleaning Procedure

This cleaning procedure is intended as a surface preparation procedure, especially desirable, before sand blasting or painting.

This procedure requires the use of eyes protective goggles and hand latex gloves. Sodium hydroxide solution is an alkaline (basic) solution that should not come in contact with eyes and skin.
In case of accidental eyes or skin direct contact with the sodium hydroxide solution, immediately thoroughly clean the contacted area with running tap water.

1. Remove the support material and clean the model as thoroughly as possible. The use of Objet's WaterJet is strongly recommended.
2. Immerse the model into a 2% Sodium Hydroxide for approximately 1-2 Hrs.
3. Immediately rinse the model using running tap water. A second water jet cleaning at this moment is most recommended.
4. Wipe the water from the model using wiping paper and wait till the MODEL is completely dry. Otherwise, for faster drying, it is recommended to immerse the model in Isopropyl alcohol for a few seconds and let it to dry at room temperature for approximately half an hour.

Surface preparation Solution

For a 1 liter solution:

1. Place 20gr Sodium hydroxide directly into a ~1.5 liter plastic (Polyethylene, Polypropylene, etc) or glass container.
2. Add water to complete 1000 gr (980 grams water +20 gr sodium hydroxide).
3. Gently stir till complete sodium hydroxide dissolution (about 5 minutes).
4. Let the solution cool down to room temperature (The dissolution process of sodium hydroxide produces heat).

The solution is ready and can be used to clean several models, depending on the models size.

Painting of PolyJet™ Parts

Supplies:

1. Primer
2. Paint
3. Sandpaper – 320 & 400-grid wet/dry
4. Body filler or sandable putty (optional)
5. NaOH solution
6. Tack cloth
7. Disposable gloves
8. Spray mask

Overview

For sales samples, photography or finished models, painted PolyJet™ parts produced using Objet 3-Dimensional Printing Systems will give your customers a compelling preview of your newest products. With a little patience and almost any type of paint, you can easily decorate your prototypes to look like production parts.

Painting PolyJet models takes half the time of other rapid prototypes. The smooth surfaces and crisp details minimize the tedious and time-consuming steps of sanding and filling. Since surface preparation is the key to the quality of painted models, PolyJet delivers better looking models in less time.

The supplies needed for your painting projects are inexpensive and are available at any hardware supply retailer.

Process

1. Remove support material

The key to a perfectly painted model is its preparation. This starts with the removal of all support material. To optimize paint adherence and cosmetic appeal, it is best to completely remove all support material with the WaterJet station. Well-prepared models will have a consistent feel on both supported and unsupported surfaces.

Figure 1. Removal of support material. Use WaterJet station to remove support material.

There are two possible methods for obtaining a clean model surface. The first option is to use a NaOH solution (2% diluted in water). To clean and degrease the model, simply dip the model in the NaOH solution for 30 to 40 minutes, rinse with water and let dry. The second option is to bead blast the model.

2. Sand surfaces

With 320-grit wet sandpaper, sand the model for a smooth, paint-ready surface. While sanding, keep the sandpaper and model wet by repeatedly dipping the sandpaper in water or placing the model under running water.

With the thin layers and fine detail of the PolyJet model, surfaces should need only a light sanding. Following sanding, wash the model in water and allow it to dry completely.

3. Apply primer

Primer serves two purposes. Firstly, it provides a good bond coat for paint. Secondly, it will highlight any areas on the model where additional finishing may be needed.

Spray the model with fast-drying primer. Lacquer-based primers and paints are a good choice since they sand well, dry quickly and are readily available. When priming or painting, use two light coats instead of one heavy coat, to prevent drips and puddles. If you do not have a paint sprayer, apply the primer from a spray can. Remember to spray the primer in a well-ventilated area and wear appropriate safety equipment.

After the primer has dried to the touch, inspect the model for any areas that need additional sanding or repair.

Painting Show-Quality Models

4. Sand and fill blemishes

Depending on the results of the primer coat, you can either proceed to the next step or do some additional

Figure 2. Wet-sanding. Wet-sand the model with 320-grid sandpaper.

Figure 3. Apply Body filler.

Figure 4. Dry sanding. Dry sand the model with 400-grit sandpaper.

Tip: *To preserve the accuracy of your model when sanding, apply a red or white primer as the base coat and follow with gray primer. The color difference gives you a visual reference that you are getting close to the model's surface.*

finishing work. Typically, if the primer is applied correctly, no additional finishing is needed prior to applying the finish paint. However, if there are blemishes in the primer coat you may want to do some additional finish work. Finishing may include wet-sanding and/or filling small pocks.

If sanding is all you need, wet-sand the surfaces with 400-grit sandpaper. Stop sanding if the PolyJet material begins to peek through the primer. Rinse and dry the model. If any of the model surface is exposed, repeat step three. Otherwise, proceed to step five.

Since the Eden systems build with such small layers, you will not have to fill in layer stair-stepping. However, if small blemishes show up in the primed model, you can easily fill them with a dab of auto body putty. Body putty comes in many forms, but you will want fast-curing, easily sanded putty such as Freeman TUF-Carv. Alternatively, you can use premixed glazing putty such as 3M™ Acryl-Blue.

After the putty has dried – usually in less than 30 minutes – sand the area smooth. Start with 220-grit sandpaper and finish with 400-grit wet-sanding. Rinse the model with water and dry. Repeat step three.


Figure 5. Sandblasting.


Figure 6. Apply Primer Paint.


Figure 7. Apply Final Paint.

5. Apply finish paint

Prior to painting the model, ensure it is clean and dry. Use a tack cloth or compressed air to remove dust. Apply several thin coats of finish paint. Allow the paint to dry between each coat. As with the primer, spray paint will do the job if you do not have a paint sprayer available.

6. Apply clear coat (optional)

A coat of clear lacquer can be applied to provide additional protection against scratches, chips, and other marks.

Clear coat paint can be purchased in a variety of finishes including matte, semi gloss, and gloss. Choose a lacquer-based clear coat with the desired finish.

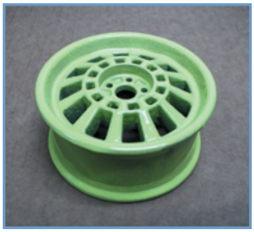


Figure 8. Painted Model With Desired Finish.

Suppliers

- Freeman TUF-Carv is available at:
  Freeman Manufacturing & Supply Company – www.freemansupply.com
- 3M Acryl-Blue is available at most automotive supply retailers.
- Sherwin Automotive – www.sherwin-automotive.com
- Midway Auto Supply – www.midwayautosupply.com

Creating Clear or Translucent Models

Overview

Not all plastic parts are opaque. For clear parts such as lenses, containers, covers, panels and a variety of other applications, Objet's PolyJet™ Technology offers the advantages of rapid prototyping while also enabling the translucency required for the application.

Although there are no shortcuts to achieving the transparency and brilliance of clear parts, the process is simple and inexpensive.

With most rapid prototyping technologies, clear models are either impossible or too time-consuming to make. However, PolyJet Technology makes it both possible and practical. The smooth surfaces of PolyJet models and the translucency of FullCure® 720 model material combine to make clear models a reality. Right out of the machine, you are ready to begin light sanding and polishing to produce a clear prototype.

Process

1. Build model

Orient the model so that the critical surface faces upwards and build in glossy mode (do not use support material). Wherever possible, avoid support material on clear surfaces since it will be difficult to remove (figure 1).

2. Prepare model

Using the WaterJet station, thoroughly pressure wash the model to remove the support material (figure 2). Pay special attention to corners, channels and pockets

Supplies:

1. Sandpaper:
   dry: 220 & 320-grid
   wet: 400 & 600-grid
   micro-mesh sandpaper (optional)
2. Polishing compound:
   3M™ Plastic Polish

Tools:

1. Buffing wheel / rotary tool with buffing drum

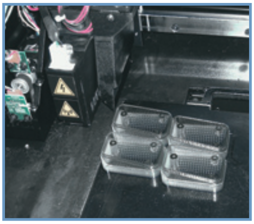


Figure 1. Build orientation. Orient the part to minimize support material on clear surface and build with glossy mode.

Figure 2. Wash model. Pressure wash the model to remove all support material.

to ensure that the support material is completely removed.

Note: Sand blasting is not recommended. The abrasiveness can create small pits that are difficult to polish. However, for a frosted surface, mask off the part and sandblast the unprotected area.

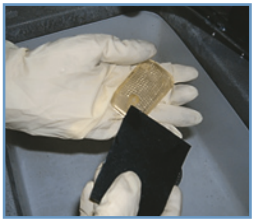


Figure 3. Dry-sanding the part. Sand all surfaces to smooth the model.

3. Dry-sand surfaces

Following support removal, thoroughly dry the model and sand all surfaces with 200-grit sandpaper. A light sanding will remove surface imperfections and layers (figure 3).

After the 220-grit sanding, repeat with 320-grit to begin the polishing process.

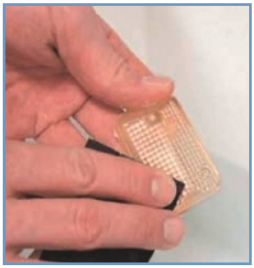


Figure 4. Wet-sanding. Wet-sand the model to begin polishing the clear surfaces.

4. Wet-sand surfaces

Lightly wet-sand the model, progressing through 400, 600 and 1000-grit sandpapers.

The wet-sanding is not intended to remove material. Rather, it reduces the scratches from previous sandings, so a light touch is all that is needed (figure 4).

Between each sanding, rinse the model with water to remove any grit and debris.

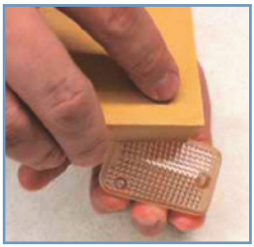


Figure 5. Micro-mesh sanding (optional). Using micro-mesh sandpaper, polish out all surface scratches prior to buffing.

5. Micro-mesh sanding (optional)

For an exceptional finish, polish the model with micro-mesh sandpaper (figure 5).

Sand all surfaces with 1500 micro-mesh sandpaper. Depending on the desired results, continue sanding with 1800, 2400, 3600 and 4000 micro-mesh sandpaper.

As with step 4, you can use soapy water, mineral oil or vegetable oil to lubricate the surface while sanding.

6. Polish model

The final step to achieving a clear PolyJet part is to buff and polish the surfaces. Using either a buffing wheel or a rotary tool with a buffing drum, apply a polishing compound to the buffing pad and work it onto all surfaces of the model. Reapply the polishing compound frequently.

An effective polishing compound is 3M Plastic Polish. Polishing compounds for plastics are also available from several other manufacturers. Some of these compounds do not require a buffing wheel.

After polishing all surfaces, buff off the compound with a soft cloth or a clean buffing pad. Your PolyJet model is now ready to be used as a lens, container, or cover (figure 6).

Figure 6. Finished model. The polished PolyJet model has the clarity needed for product demonstration.

Tip: *When wet-sanding, you can add a few drops of dishwashing soap or vegetable or mineral oil to the water to lubricate the surface.*

Penetrating Dye for Translucent Color

Overview

Color brings life to your models, and there is no simpler way to add color and preserve translucency than using aniline dye with PolyJet™ models. Just apply the penetrating aniline dye to your PolyJet models. In fifteen minutes, and for less then a few dollars, you can finish your models with vibrant, translucent color.

Smooth surfaces and fine resolution eliminate the time and effort of sanding the model. These factors, combined with the speed of the PolyJet process, mean that showpieces are ready the same day that the design is completed – a unique solution made possible by the translucency of the FullCure® material.

Applying dye is much easier and faster than painting models. No skill is needed for this one-step process. Additionally, the aniline dye does not add any material to the surface of the parts, so the model's dimensional accuracy is not changed.

Aniline dyes come in a wide range of colors and cost less than US$5.00 for a 4oz bottle. Sold as a stain for leather or wood, the dyes are readily available from most leatherworking and woodworking supply stores.

Supplies:

1. Alcohol-based aniline dye
2. Isopropyl/ denatured alcohol
3. NaOH solution
4. Stiff-bristled brush
5. Spray bottle
6. Paper Towels
7. Gloves

Process

1. Prepare Model

Remove all support material with the Water Jet. If not completely removed, the support residue may cause the model to have a blotchy appearance. An additional

Figure 1. Red leather dye bottle.

finishing option is to dip the model in NaOH solution. Rinse the model with water and dry.

If desired, complete model preparation by sanding surfaces using either wet or dry sandpaper.

2. Prepare Aniline Dye (Optional)

For optimal results, purchase alcohol-based aniline dye. Although available in water-based formulations, the aqueous solution will not penetrate the model surface.

If necessary or desired, you can customize your color with either premixed or powdered aniline dyes. Simply combine two or more dyes to create a new color. You can also lighten colors by diluting the dye with alcohol. When diluting, do not exceed a ratio of one part alcohol to three parts dye.

Before dyeing the model, protect the work area, clothing, skin, and eyes. Although alcohol will remove the dye, its penetrating nature makes it difficult to remove stains completely.

Figure 2. Apply aniline dye Aniline dye is applied to the model by brushing (shown), or dipping.

3. Apply Aniline Dye

Spray or brush the dye onto the model. Apply a light coat of dye to all surfaces (Figure 2). The dye will penetrate the model in a few seconds and will dry to the touch within 5 to 15 minutes.

Working quickly, brush the surface of the model, or wipe with a paper towel, to distribute the dye evenly and remove any excess. Puddles of dye will deepen the tint, so even dye distribution is important.

Figure 3. Aniline dye comes in a wide range of colors and is sold as a stain for leather or wood.

To darken the color or to correct uneven tinting, apply a second coat of aniline dye. If the color is too dark, or is blotchy, wipe the surface with alcohol to remove the dye from the model and repeat the dyeing process.

Allow the dye to dry for 15 minutes. Rinse the model in water and dry.

4. Clear Coat (Optional)

Clear coating will give luster to the model and protect the finish.

Spray on a lacquer or polyurethane clear coat. To protect the model finish and/or give additional luster, clear coat paint can be applied.

Clear coats come in a variety of finishes including: matte, semi-gloss and glossy.

For best results, use of a lacquer based glossy clear coat is recommended.

Simply spray on a light coat of the clear coat and let dry. Your models will be brilliant, vibrant, and ready for use. Note: Figure 4 is the finished model.

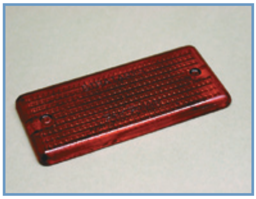


Figure 4. Finished model with clear coat (optional) The translucent red color of the finished model is perfect for this tail-light lens. Clear coat spray protects the finish and adds luster to your showpiece

Aniline Dye Suppliers

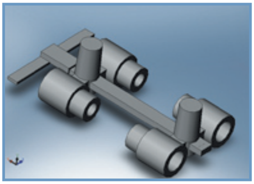
- Leather dyes – available in a wide range of colors. Fiebing dyes are available at tack, saddlery and leatherworking retailers.
- The Fiebing Company – www.fiebing.com
- A Leather Source – www.aleathersource.com
- Tandy Leather – www.tandyleather.com
- Woodworking dyes – available in wood tone colors. J.E. Moser dyes are available at woodworking supply retailers.
- Woodworkers Supply Inc. – www.woodworker.com

Sand Casting Applications

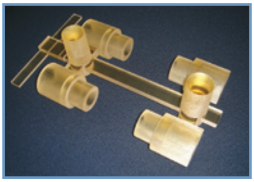
Overview

Sand casting is an economical process for creating rough metal parts. Raw castings are then machined to produce finished products or components. Sand casting is the least expensive of all casting processes, including die and investment casting. Sand casting may require a longer lead time for production at high output rates
(1–20 pieces/hour/mold), but is unsurpassed for large-part production. Sand has almost no upper limit on part weight and minimum part weight ranges from 0.075–0.1 kg. The sand is bonded together using clays or chemical binders. In most operations, the sand can be recycled many times, requiring the addition of only small amounts of sand each time.

Preparation of the sand mold is fast but requires a pattern that can "stamp" out the casting template. Typically, sand casting is used for processing low-temperature metals, such as iron, copper, aluminum, magnesium, and nickel alloys. It can also be used for high-temperature metals where other means would be impractical. Sand casting is by far the oldest and best understood of all techniques. As such, automation can easily be adapted to the production process, although somewhat less easily to the design and preparation of forms.



Picture 1. CAD design for a pattern.



Picture 2. Printing the pattern.

The Sand Casting Process

In the sand casting process, a pattern is made in the shape of the desired part. The pattern can easily be made using PolyJet™ models.

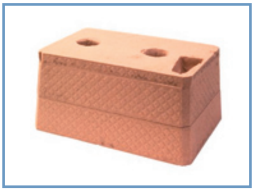
A single piece or solid pattern is used for simple designs. Patterns that are more complex are made in two parts, and are called split patterns. This can also be designed in the CAD level, and printed by Objet systems. The upper part of a split pattern is called a cope, while the bottom section is called a drag. Where the cope and drag separate is known as the parting line. Both solid and split patterns can have cores inserted to complete the final part shape. When making a pattern, it is necessary to taper the edges so the pattern can be removed without breaking the mold.

Application Tip: Sand castings generally have a rough surface, sometimes with surface impurities and surface variations. A machining finish allowance is made for correcting these kinds of imperfections.

Forming the Cavity

The pattern is housed in a box called the flask, and then packed with sand. A binder helps harden the sand into a semi-permanent shape. Once the sand mold is cured, the pattern is removed. This leaves a hollow space in the sand in the shape of the desired part. The pattern is made larger than the cast to allow for shrinkage during cooling. Sand cores can then be inserted in the mold to create holes and improve the casting's overall shape. Simple patterns are usually open on top, allowing molten metal to be poured into them. Two-piece molds are clamped together. Molten metal is poured into a pouring cup from where it travels down a sprue and into the gating system. Vent holes are created to allow hot gases to escape during the pour. Ideally, the pouring temperature of the molten metal should be a few hundred degrees higher than the melting point, assuring good fluidity. The temperature difference also prevents premature cooling and the resulting voids and porosity. After the metal cools, the sand mold is removed and the metal part is ready for additional operations, such as cutoff and grinding.

Picture 3. The sand casting mold – forming the cavity.

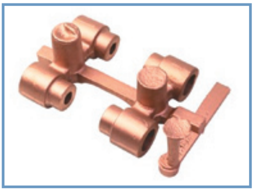


Picture 4. The pattern is removed from the flask.

Sprues and Runners

The molten material is poured into the pouring cup, which is part of the gating system that supplies the molten material to the mold cavity. The vertical part of the gating system that is connected connected to the pouring cup is the sprue, and the horizontal portions are called the runners. The multiple points where the material is introduced to the mold cavity are called the gates. Additionally there are extensions to the gating system, called vents, that provide the path for the built-up gases and the displaced air to vent to the atmosphere.

The cavity is usually made oversized to allow for metal contraction as it cools down to room temperature. This is achieved by making the pattern oversized. To allow for shrinking, the pattern must be oversized according to certain averaged factors. There are linear factors that apply in each direction. These shrinkage allowances are only approximate because the exact allowance is determined by the shape and size of the casting. In addition, different parts of the casting might require a different shrinkage allowance.



Picture 5. The desired bronze cast model.

Metal Spin Casting Applications

Spin Casting Applications

One of the most exciting modern applications of spin casting technology is its use in rapid prototyping and product development. It is ideal for quickly and economically producing numerous fully functional, fragile parts in high-strength metal or plastic from computer-generated RP models. Product designers can then subject multiple parts to thorough testing and evaluation in their intended applications. With the new rubber mold materials now available, molds can be made and prototypes or development parts cast in as little as three hours. Even complex parts usually take less than one day. Thus, design changes in size, function, fit or appearance can be quickly reproduced without requiring a large investment in tooling or machine time.

Figure 1. Casting of fashion accessories.

Figure 2. Casting of functional parts.

Figure 3. Examples of thin-walled parts.

Spin Cast Advantages

- Achieve a competitive edge with faster “time to market” capabilities
- No costly metal tooling required
- Same-day results with in-house control
- Simple to use technology
- Increase productivity – provides 30-50% more casting cycles per hour, per operator
- No heavy mold cover plate – to handle each cycle
- No lift-over of molds
- Automatically adjusts for mold height – no manual adjustments needed
- All mold handling done at waist level

Maximum Part Size

The maximum part size that can be cast using spin cast technology is

100 x 50 x 35mm (L x W x H) with nominal wall thickness
of 2.5mm (min.) to 6.5mm (max.).

Metals That Can Be Cast

Figure 4. Casting Objet models.

Figure 5. The rubber master mold.

Figure 6. The cast models.

Zinc

Commercial grade zinc-based alloys, derived and modified from standard zinc pressure die cast alloys. Zinc alloys are often used as direct replacements for aluminum, iron, copper and low grade steel-based alloys to provide similar strength and/or reduced cost on the same application.

Zinc alloys readily accept a wide variety of decorative and corrosion-resistant surface finishes. They can be painted to match adjacent parts, externally dyed in a variety of colors or chrome plated for a hard, durable finish. They can also be fully electroplated to take on the appearance of brass, bronze, stainless steel, silver, chrome or gold, etc.

High tin, white metal & lead alloys

Containing no lead or cadmium. Lightest tin-based alloy for jewelry casting. Highest degree of strength, whiteness and brightness. Castings do not need to be plated. Suitable for intricate shapes, filigree, textured surfaces and for pronging and model making. Normal casting temperatures range from 274 – 330°C.

Special grade, ready to use zinc-aluminum-copper alloy.

This is the most popular spin-casting zinc alloy, ideal for medium-sized parts up to 1kg each, with wall thickness of 16mm or under. Produces a very finegrain, smooth-surfaced finish with excellent detail and very low porosity. Has high strength and hardness and is fully electroplatable. Normal casting temperatures range from 400 – 420°C. Provides a very long mold life, usually 30% longer than other commercial grade zinc alloys.

Six Easy Steps

STEP 1 . Preparing The Mold

Parts or models are laid out on a disc of uncured silicone rubber. Depending upon model/pattern thickness and shape, cavities may be cut or molded by hand to accommodate the part. The uncured silicone material is soft and pliable like clay. The mold parting line is formed at this stage and can be built up or lowered around any section of the model/pattern. Parts of any complexity can be handled. Cores and pull-out sections can also be easily incorporated, if required. Mold parting compound is sprayed on the mold and "acorn" nuts are arranged around the edge where (like pins of a die) they precisely position the mold halves in line with each other.

Figure 7. Preparing the mold.

STEP 2. Vulcanizing the mold

After preparation, the mold is placed in a vulcanizing frame. This frame is placed in the heated vulcanizing press for curing. The combination of heat and pressure forces the silicone into all crevices and around all details of the model/patterns.

The heat cross-links and cures the silicone. The resulting mold is tough, resilient, dimensionally accurate, and heat and chemically resistant.

After vulcanization the mold is easily flexed to release the patterns (and later, parts) from the cavities. This is true even for patterns with many undercuts.

Figure 8. Vulcanizing the mold.

STEP 3. Gating & venting

The gates, runner system and air vents are easily cut into the cured rubber mold with a sharp knife or scalpel. Air vents may also be drilled into the cavity to aid in venting of trapped air or gases.

Similar gating and venting systems are used for metals and for plastics, so both materials can be cast in the exact same mold for evaluation, if desired.

Figure 9. Gating & venting.

STEP 4. Placing the mold in the spin-caster

The mold is placed into the casting unit – the front-loading unit shown. The mold is automatically centered and closing the door activates a pneumatic mold clamp. Spin speed, clamping pressure and cycle time are fully adjustable with the solid state digital controls.

Figure 10. Placing the mold in the spin-caster.

STEP 5. Pouring & spin-casting

After the spin cycle starts, the liquid metal, plastic or wax is poured into the casting unit.

Pressure caused by centrifugal force pushes the liquid through the mold's runner system, completely filling every section, corner, detail and surface finish in each mold cavity.

Figure 11. Pouring & spin-casting.

STEP 6. Removal of spin-cast parts

After metals solidify and plastics set, the parts are quickly removed from the mold. With metal, 50 to 60 cycles per hour are usually required; with plastic or wax, 8 to 12 cycles per hour are typical. The gates, runners and vents are easily broken away by hand. Castings are ready for assembly, for painting, planting or coating, with no additional clean-up needed. Spin casting is a precision casting process producing high-integrity, close-tolerance parts comparable to die casting or plastic injection techniques.

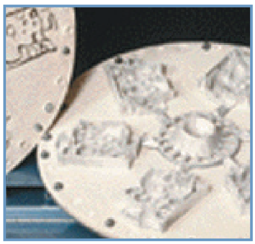


Figure 12. Removal of spin-cast parts.

Compare Spin Casting To Other Processes

PROCESS	SPIN CASTING	DIE CASTING	PLASTER MOLD CASTING	SAND CASTING	LOST-WAX INVESTMENT CASTING	PERMANENT MOLD CASTING	GRAPHITE MOLD CASTING	PLASTIC INJECTION MOLDING
Type of Molds Used	Vulcanized "TEKSIL" Rubber	Machine Tooled Steel	Plaster	Sand	Ceramic	Machined Iron, Steel	Machined Graphite	Machined Aluminum, Brass or Tool Steel
Type of Casting Materials	Zinc, Tin/Lead, Polyurethane, Polyester, Epoxy, Pattern Wax	Zinc, Aluminum, Magnesium	Most Nonferrous Metals	Most Foundry Castable Metals	Most Foundry Castable Metals	Zinc, Aluminum, Magnesium	Zinc	Most Thermo-Plastics
Average Cost of Mold Tooling (U.S.Dollars)	$35 to $250	$10,000 to $250,000+	$1,000 to $25,000 (Wood or Metal Pattern)	$500 to $10,000 (Wood or Metal Pattern)	$1,000 to $25,000 (Machined Aluminum)	$5,000 to $150,000+	$2,000 to $30,000	$5,000 to $150,000+
Ordering Quantities	1 & Up	25,000* & Up	100 & Up	100 & Up	1,000 & Up	10,000* & Up	5,000 & Up	15,000* & Up
Part Size (Length or Width)	‹ 1/2" - 12" ‹ 1.25 -30 cm	‹ 1/2" - 24" ‹ 1.25 -60 cm	‹ 4" - 36" ‹ 10 -90 cm	‹ 3" - 36" ‹ 7.5 -90 cm	‹ 1" - 24" ‹ 2.5 -60 cm	‹ 4" - 24" ‹ 10 -60 cm	‹ 4" - 24" ‹ 10 -60 cm	‹ 1/2" - 24" ‹ 1.25 -60 cm
Wall Thickness	‹ 1/8" - 1/2" 0.3 -1.25 cm	‹ 1/8" -3/4" 0.3 - 2 cm	‹ 1/8" - 1" 0.3 -2.5 cm	‹ 1/4" - 1" 0.6 -2.5 cm	‹ 1/8" - 1" 0.3 -2.5 cm	‹ 1/4" - 1" 0.6 -2.5 cm	‹ 1/4" - 1" 0.6 -2.5 cm	‹ 1/8" - 1/2" 0.3 -1.25 cm
Casting Tolerances	Very Close	Closest	Close	Lowest	Very Close	Loose	Loose	Closest
Ability to Make Design Changes	Easiest	Very Difficult	Difficult	Easy	Very Difficult	Difficult	Difficult	Very Difficult
Per Part Cost	Very Low	Lowest	Very High	Very Low	Highest	Low	High	Lowest
Usual Secondary Machining Required	Very Little or None	Lowest or None	Low	Highest	Very Little or None	Low	Low	Lowest or None
Usual Initial Parts Lead Time Required	4 hrs - 2 days	12 - 24 weeks	6 - 12 weeks	4 - 12 weeks	8 - 16 weeks	12 - 24 weeks	8 - 16 weeks	12-24 weeks

*Depends largely on cost of mold tooling

‹ Less than

VLT Rubber-based process for Jewelry

Background

The recent introduction of Castaldo® VLT™ [Very Low Temperature] molding rubber opens the way to a new time-saving process for jewelry molding using Objet Eden™ 3-Dimensional Printing Systems. The new rubber allows Objet users to utilize their PolyJet™ patterns as master models and mold them in as little as one hour. This eliminates the need to go through the time-consuming process of creating a metal master model.

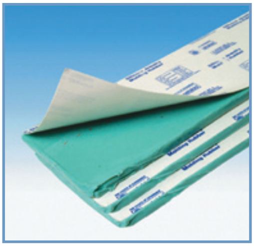


Figure 1. The VLT™ Silicone Molding Rubber.

Direct casting of resin models made by most rapid prototyping systems do not burn out cleanly. However, using cold-mold compounds that do not damage the pattern and an RP system that supports the specialized material offers the perfect alternative.

Another recently developed alternative method involves making a liquid rubber mold of the model, curing it overnight, injecting the wax, and then casting the wax (another overnight process) to get the master model. Finally, they make a traditional rubber mold, shoot waxes, and start production casting. All together, the process takes more than two days.

Many casters, while still preferring to make a mold of the resin model and shoot waxes, are unhappy with the long curing times: quite simply, they want to make their models as fast as possible.

New Methodology

Now this entire process can be done rapidly – in less than half the time.

VLT rubber can be cured at temperatures ranging from 160°F (71°C) to 180°F (83°C), well below the softening point of most resin materials. At a temperature of 160°F, a standard 3/4-inch mold will be cured and ready for injection in 90 to 120 minutes. At 180°F, that time is further reduced to just 30 to 45 minutes. However, as with traditional casting rubbers, longer curing times mean better molds – the longer the cure, the more likely it is that the rubber will flow into every nook and cranny to provide detail. In addition, when VLT rubber cures, it shrinks just 1.4 percent.

Figure 2. Placing the Objet model inside the mold.

Perhaps one of the greatest benefits of VLT rubber is that it makes rapid prototyping more useful for mass production. Enabling PolyJet models to be used directly as master models is an important development for the jewelry industry. This is because PolyJet models offer significant time savings in a market where time can be a vital competitive edge.

Figure3. Finished mold can be complex, and even include spiral plugs.

On a practical level, it is too expensive and time consuming to run a rapid prototyping machine a thousand times in order to create the high number of castings needed. Now, with VLT rubber and PolyJet, a prototype piece can be directly molded, and the subsequent wax models can be used to make thousands of castings.

VLT rubber also works well with traditional hand-carved waxes. And, VLT rubber is designed specifically for molding – i.e. it acts like any other molding rubber, only at much lower temperatures.

Essentially, the VLT and PolyJet methodology leverages traditional technology, tools, and techniques. This means there is no need to learn anything new, buy new equipment, or train people in new techniques. If you are already doing lost-wax casting, the VLT and PolyJet methodology fits right in.

How Does it Work?

Castaldo VLT Silicone Molding Rubber can be vulcanized at any of a wide range of time and temperature combinations, depending on the characteristics and requirements of the model material. Below are some suggested combinations for a typical mold that is 0.75” / 19 mm thick:

88° C / 190° F for 30 minutes
82° C / 180° F for 45 minutes
76° C / 170° F for 60 minutes
71° C / 160° F for 90 minutes

The only change from established mold making techniques required by Castaldo VLT Silicone Molding Rubber may be the need to coat the plastic model with a release spray before vulcanizing to ensure easy release of the model after vulcanization. Teflon® (PTFE) sprays work very well, as do common household cooking oil sprays made with olive oil or canola oil, such as PAM®. Wax models do not need to be sprayed.

Figure4. The resin release spray.

Key Advantages

Existing tools and technology. The VLT and PolyJet methodology utilizes the simple tools and easy technologies you already have and know how to use.

Easy to work with. VLT Silicone Molding Rubber has the consistency of modeling clay or putty, reducing mold packing time to a few minutes. There is no need to cut and shape the pieces to fit the mold frame. Merely pull off a piece with your fingers and push it into the mold frame as desired.

Easy to cut. Molds made of VLT rubber are firm, yet they “cut like butter”.

Minimal shrinkage. Rubber shrinkage is only 1.4%.

Easy, spray-less release of wax injections. Finished molds require no mold release spray. Wax patterns release easily because the rubber already contains anti-stick compounds.

High-shine finish. Molds made of VLT rubber provides waxes with an extremely shiny finish, reducing the polishing work required on your casting.

High tear strength. For a silicone rubber compound, VLT rubber is exceptionally high in tear strength, meaning that molds made from it last for years.

Cheaper and easier than RTVs. Room temperature vulcanizing (RTV) compounds require exact measuring and exact mixing. They have limited working times and require vacuum de-bubbling to provide usable molds.

Figure5. Objet jewelry models.

VLT Rubber Specifications

Sizes:

- Regular strips: 18” x 27/8 “ x ~3/8” (45.7cm x 7.3cm x ~6mm). Packaged in 5lb (2.27kg) cartons.
- Double-wide strips: 18” x 53/4” x ~3/8” (45.7cm x 14.5cm x ~6 mm). Package in 10lb (4.5kg) boxes.

Storage:

As with any unvulcanized rubber compound, store away from any source of heat and light. Unvulcanized shelf life is at least one year if properly stored.

Processes

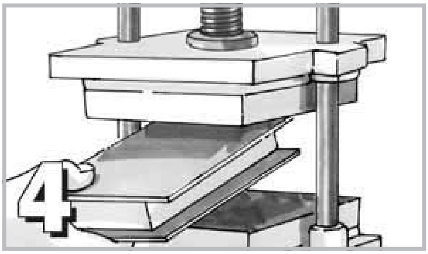
Castaldo VLT Silicone Molding Rubber is compatible with all mold making techniques, including mold cutting and powder and cream separation molds. It is particularly adaptable to the powder and cream separation processes since the parting line is so easily controlled. For patterns strong enough to resist some pressure, merely push the model into rubber to the desired point. If not satisfied with the results, remove the model, smooth the rubber over with your finger or tool and re-insert the model.

The VLT Molding Rubber Process

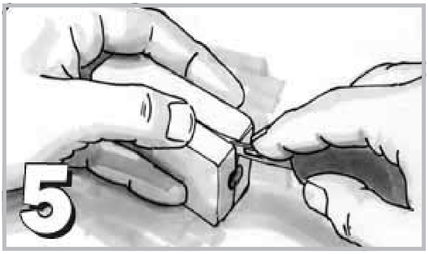
Silicone Molding Rubber is soft and pliable, with a consistency like putty or molding clay.

Place the Objet model inside the Silicone Mold.

Placing and embedding the rubber onto model.



Curing Silicone Jewelry Molding Rubber Molds involves no mixing, and at low temperature.



The Silicone Jewelry Molding Rubber Molds are then to be cut and open by hand.

Parting lines are easily controlled and corrected by hand when used with the powder separation.

Finished molds can be complex with cores, straight plugs or even spiral plugs.

USG-00010 updated:Q3/07

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