

Guide to Basic Post Process Applications - Objet line of 3D Printers

**Learn how to save time and
cost to ensure successful
product development**





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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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Introduction

About this Guide

Objet 3D Printers can print high-quality, accurate models in a wide variety of materials. Often, printed models are ready immediately after printing and cleaning. However, you may wish to further enhance the appearance and functionality of your printed models.

This guide describes a number of post-process applications that enable you to create attractive 3D models and product prototypes.

Who Should Use this Guide?

This guide is intended for users of Objet 3D Printers. Experience with printing and handling 3D models is advantageous.

For More Information

Visit <http://www.stratasys.com> for more details about Stratasys, its technologies, products and applications.

Post Process Applications

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Safety Information

Sodium Hydroxide

1. Do not let sodium hydroxide come in contact with your eyes or skin. It may cause chemical burns, scarring and blindness.
2. Use protective goggles and nitrile gloves when handling sodium hydroxide and models soaked in it.
3. In case of direct contact with sodium hydroxide, clean the affected area immediately with running water and then seek medical attention.
4. Mixing sodium hydroxide with water generates heat that could ignite other materials.

Paints and Primers

1. Paints, primers and similar substances can cause skin irritation. Use protective gloves when handling these substances.
2. Inhaling paint or primer can be dangerous to your health. When spraying paint or primer, always wear a spray mask.
3. Always spray paints and primer in a well-ventilated area.

Aniline Dyes

Aniline dyes are toxic and the stains they leave on material are extremely difficult to remove. Before working with aniline dyes, protect your skin, eyes, clothing and your work area.

Handling Hot Parts

Always wear oven gloves when handling hot parts.

Cleaning Models with Sodium Hydroxide

Introduction

Sodium hydroxide can be used as a surface preparation for models that require a smoother, more refined feel, or for models to be painted or used as silicone molds.

Benefits

Cleaning models with sodium hydroxide

- eliminates support material residue not removed by the WaterJet.
- improves transparency of models printed in VeroClear.

Required Tools and Materials

- Sodium hydroxide (also known as NaOH, lye, or caustic soda)
- Protective goggles
- Nitrile gloves
- 1.5 liter plastic or glass container
- Running tap water
- A stirring tool
- Disposable paper towels
- Isopropanol (also known as IPA or isopropyl alcohol)
- Fine sandpaper

Safety

See Safety Information on page 6.

Caution

Models with walls less than 1 mm thick may deform slightly if soaked for more than one hour. Soak the model in sodium hydroxide for between half-an-hour and several hours, depending on how delicate the model is and how much support material needs to be removed.

NOTE: Soaking most models in sodium hydroxide will not affect their mechanical properties.

Preparing a Sodium Hydroxide Solution

1. Pour 20 grams of sodium hydroxide into a 1.5 liter plastic or glass container.
2. Slowly pour about 980 ml of water into the container.
3. Gently stir until the sodium hydroxide is completely dissolved. This process produces heat.
4. Allow the solution cool to room temperature.

Cleaning the Model

1. Using the WaterJet, remove the support material from the model as thoroughly as possible.
2. Immerse the model in the sodium hydroxide solution for up to two hours, depending on the model size and type (see Caution above).
3. Remove the model from the solution and immediately rinse the model under running tap water.
4. Using the WaterJet, remove any remaining support material from the model.
5. Wipe down the model with a disposable paper towel and wait until the model is completely dry. (For faster drying, immerse the model in isopropyl for a few seconds and let the model dry for at least half an hour).
6. For a glossy finish, see Polishing and Buffing on page 17.

Painting 3D Printed Models

Introduction

You can paint printed models to look like the finished product. Models printed on Objet 3D Printers have smooth surfaces and crisp details. This minimizes the need for sanding and filling, which can be time-consuming.

Benefits

Painting printed models produces a compellingly realistic preview of your product, which can be used as sales samples and photographic models.

Required Tools and Materials

- Primer (spray can or paint sprayer)
- Paint (spray can or paint sprayer)
- Sandpaper (220 and 400-grit wet/dry)
- Body-filler (optional)
- Sodium hydroxide solution
- Tack cloth
- Nitrile gloves
- Spray mask

Safety

See Safety Information on page 6.

Preparation

Cleaning the Model

Removing support material from the model enhances paint adherence and appearance and ensures a uniform feel.

For details, see **Cleaning Models with Sodium Hydroxide** on page 7.

Sandblasting the model will achieve a similar effect, although it is not recommended because it can create small pits that are difficult to polish.

Priming the Model

Applying primer to printed models provides a bond for paint. It also highlights areas on the model where additional finishing may be needed.

1. Spray fast-drying primer. Lacquer-based primers dry quickly and can be sanded easily.
2. To prevent drips and puddles, spray two light coats of primer, instead of one thick coat.



Cleaning a model with the WaterJet



Applying primer

TIP Before sanding, apply a red or white primer as the first coat and then apply a grey primer. When sanding, the color difference indicates when you are getting close to the model's surface.

Sanding and Filling Blemishes

Depending on the results of the primer coat, you may wish to do some additional finishing work before painting.

1. Sanding is best done with 400-grit sand paper. Stop sanding if the Inkjetmaterial begins to show through the primer. Rinse and dry the model.
2. If small blemishes show on the primed model, you can easily fill them with a dab of auto-body putty. Use fast-curing putty, which is easily sanded, such as Freeman TUF-Carv or premixed glazing putty, such as 3MTM Acryl-Blue.
3. After the putty has dried, begin sanding the area with 220-grit sandpaper, finishing with 400-grit wet-sandpaper.
4. Rinse the model with water and then dry it thoroughly.
5. Apply another coat of primer, if necessary.

Painting the Model

1. Make sure that the model is clean and dry. Use a tack cloth or compressed air to remove dust.
2. Apply several thin coats of paint, allowing the paint to dry between each coat.

Applying a Clear Finish

Clear lacquer can provide additional protection against scratches, chipping and marks.

Apply at least two thin coats of clear lacquer. Allow the lacquer to dry between coats.



Dry sanding



Cleaning a model with the WaterJet



Applying filler



Applying paint



Painted model

Creating Clear or Translucent Models

Introduction

Objet technology and VeroClear (RGD810) model material make it possible and practical to print both clear and translucent models. With a little post-processing, you can manipulate the transparency of your model.

The clarity of VeroClear parts improves considerably over time. To improve the clarity of parts more quickly, consider photobleaching (see page 21).

Printing Models

To ensure maximum clarity of your clear or translucent model, make sure your Objet 3D Printer is clean and that Objet Studio is properly configured.

Cleaning the Objet 3D Printer

Traces of previous materials affect the clarity of VeroClear parts. Before printing with VeroClear:

1. Replace one or both of the currently installed cartridges with Objet VeroClear.
2. Run the Material Replacement Wizard and select the flushing option appropriate for your printer. See the VeroClear Application Note for details.
3. Clean the print heads, wiper, and roller waste collector thoroughly.

Objet Studio

Properly adjusting Objet Studio settings helps to increase model clarity and reduce post-processing.

1. In Objet Studio, orient the model so that the critical surface faces upwards.
2. For maximum clarity, choose a matte surface finish.

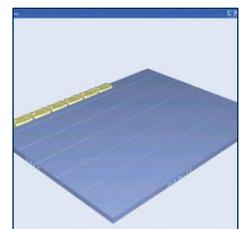


Properly oriented models

UV Radiation

Exposure of VeroClear parts to UV radiation results in a yellowish tint. To reduce the number of print-head and UV-lamp passes:

1. Set Objet Studio to High Speed printing mode (on supported printers).
2. Arrange glossy parts so they have similar heights.



Parts with similar heights

Treating Transparent Models

You can enhance the transparency of printed models using the following procedures.

1. WaterJet

For most models, the most efficient way to remove support material is to use a high-pressure water jet.



Removing support material

2. Sandblasting

Sandblasting is not generally recommended because it can create small pits in the model surface. However, for a frosted surface finish, mask off the parts of the model you do not want to look frosted and then sandblast the unprotected area.



Removing support material

3. Dry-Sanding

Make sure that the model is completely dry and sand all surfaces with 200-grit sandpaper. Light sanding is all that is required to remove surface imperfections and unwanted layering.

To improve the clarity even further, sand it again with 320-grit sandpaper.

4. Wet-Sanding

Dry sanding may leave scratches on the model. To remove them, lightly wet-sand the model with 400-grit, then 600-grit and finally 1000-grit sandpaper.

Rinse the model between each sanding to remove any dust or debris.



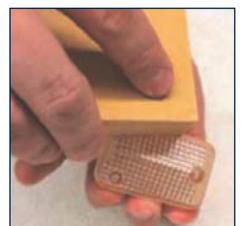
Wet-sanding

TIP To lubricate the model's surface while wet-sanding, use soapy water, mineral oil or vegetable oil.

5. Micro-Mesh-Sanding (Optional)

For an exceptional finish, sand the model with 1500-grit micro-mesh sandpaper. You can continue sanding with 1800-grit, 2400-grit, 3600-grit and 4000-grit micro-mesh sandpaper.

Rinse the model between each sanding to remove dust and debris.



Sanding with micro-mesh sandpaper

6. Polishing and Buffing

Apply a polishing compound, such as 3M Plastic Polish, to a buffing wheel or a polishing tool. Work the polishing compound onto all surfaces of the model then buff off the compound with a soft cloth or clean buffing pad.



Finished transparent model

Dyeing Translucent Models

Introduction

Painting models can greatly enhance their impact, but it also makes them opaque. Dying adds color and life to your printed models while retaining translucency.

Benefits

- Dying your models is faster and easier than painting.
- Translucency of models printed in Objet FullCure is preserved because the dye is absorbed into the model material.
- Dyed models retain their original dimensions.

Required Tools and Materials

- alcohol-based aniline dye

Note: *Water-based aniline dye does not penetrate the model surface. Use only alcohol-based aniline dye.*

- isopropyl alcohol
- sodium hydroxide solution
- stiff-bristled brush
- spray bottle
- paper towels
- protective gloves



Aniline dye

Safety

See **Safety Information** on page 6.

Preparation

IMPORTANT: *Aniline dyes are toxic and the stains they leave on material are extremely difficult to remove. Before working with aniline dyes, protect your skin, eyes, clothing and your work area.*

Preparing the Model

1. Thoroughly remove the support material from the model and immerse the model in a sodium hydroxide solution (see **Cleaning Models with Sodium Hydroxide** on page 7).
2. If necessary, sand the model (see **Dry-Sanding** on page 16).

Customizing Aniline Dye (Optional)

Aniline dye comes in a variety of colors. You can also combine aniline dyes to create custom colors. To lighten the color, add alcohol to the dye, but do not exceed a ratio of one part alcohol to three parts dye.

Applying the Aniline Dye

Aniline dye penetrates the model in a few seconds, so you need to work quickly.

Brush or spray a light coat of the aniline dye onto the model. You can spread the dye evenly over the model by wiping it with a paper towel.

IMPORTANT: *Distribute the dye evenly.*

To darken the color or correct uneven tinting, apply a second coat. If the color is too dark or is blotchy, wipe the surface with alcohol.

Allow the dye to dry for at least 15 minutes. Rinse the model and then dry it.

Applying a Protective Coat (Optional)

Spray on a clear lacquer or polyurethane coat to give luster to the model and protect the finish.



Models dyed with a variety of colors



Applying aniline dye



Model treated with aniline dye

Photobleaching Transparent Models Printed with Objet VeroClear

Introduction

Photobleaching is the process of exposing printed models to intense florescent lighting to improve the transparency of the model.

Models printed in Objet VeroClear (FullCure®810) have a slightly yellow tint. The yellow tint fades naturally over time, but you can greatly accelerate the process by photobleaching.

Photobleaching can reduce the yellow tint by 70% in only six hours, and by over 90% in 24 hours. Final clarity depends on the model geometry.

Photobleaching Methods

There are two methods of photobleaching, both of which are suitable for all model geometries

- **Illumination chamber**
 - Enables controlling temperature and light intensity.
 - Assures predictable results.
 - Costs approximately US\$1,300.
- **Table lamps**
 - Results vary due to lack of precise control over temperature and light intensity.
 - Self-assembled from readily available parts.
 - Low cost solution



Illumination chamber



Applying aniline dye



Before photobleaching



After photobleaching in an illumination chamber



After photobleaching with table lamps

CAUTION: With both methods, ensure that the model temperature is 40 °C (104 °F). Higher temperatures may cause model distortion; lower temperatures may not produce satisfactory results.

Illumination Chamber

Use a 150 liter illumination chamber.

Make sure that the fluorescent lamps are 45 W, 6500K.

1. Arrange the printed models inside the illumination chamber with enough distance between them to allow light to reach all sides of the model.
2. After photobleaching the model for six hours, inspect them. If necessary, continue for up to 18 hours more.

Table Lamps

Required Materials

- large container
- aluminum foil
- at least two 45 W, 6500K table lamps

Using the Table Lamps

1. Cover the inside of a container with aluminum foil.
2. Arrange the printed models inside the container with enough distance between them to allow light to reach all sides of the model.
3. Position the lamps approximately 10 cm (4 in) above the models and turn them on.
4. After photobleaching the model for six hours, inspect them. If necessary, continue for up to 18 hours more.

Gluing Printed Parts

Introduction

Although large models can be printed, it may be more practical to print individual parts that can be glued together.

Required Tools and Materials

- Protective gloves
- Protective goggles
- Sodium hydroxide solution
- Glue for rigid parts, such as:
 - Super-glue (ciano acrylate)
 - Alteco-ACE-D and an activator spray
 - LOCTITE 401 (medium viscosity)
 - Al-fix and an activator
 - Kleiberit 851.0
- Glue for flexible parts, such as:
 - Sico Met 8300 and Accelerator Spray (for elastomers)
 - Permabond Black Magic 737 (for flexible parts)

Preparing the CAD or STL File

Carefully consider where to separate the model's parts so that you can easily connect them after printing. You can do this with your CAD software or STL-file manipulation software.

To maintain dimensional integrity, add clearance between parts to account for the space required for the glue. This varies depending on the type of glue used, but the typical space required is 0.1 mm.

Safety

See Safety Information on page 6.

Preparing Parts for Gluing

Before gluing, it is important to thoroughly clean the model. For details, see **Cleaning Models with Sodium Hydroxide** on page 7.

Gluing the Parts

Apply the glue on the desired surface and spray it with an accelerator or activator, if necessary.

Thermal Treatment

Introduction

Models printed with Objet High-Temperature (RGD525) and ABS-like materials (RGD5160-DM) can be treated to increase their resistance to heat.



Despatch LBB programmable oven

Benefits

Thermal treatment is useful

- for models used with hot air or water.
- for models exposed to strong lighting conditions, such as at an exhibition or trade show.

Required Tools and Materials

A programmable oven with the following recommended specifications:

Maximum operating temperature		250-300 °C (480-570 °F)
Temperature stability (PID controller On/Off)		±0.1/±0.2 degrees
Temperature uniformity		At 300 °C ± 5° (at 570 °F ± 10°)
Heat-up time to maximum temperature		25 minutes
Recovery time to maximum temperature		4 minutes
Dimensions		as required
Volume (liters)		as required
Air changes per hour		10-50 (depends on oven size)
Maximum power		750 W for a 28-liter oven
Holding power		300 W for a 28-liter oven
Controller features		stores 4 programs and up to 16 segments

Safety

See **Safety Information** on page 6.

Thermal Treatment for Models Made of Objet High Temperature material - RGD525

Thermal treatment can increase the heat-deflection temperature (HDT) of Objet RGD525 (High-Temperature Material) from 65 °C (149 °F) to 80 °C (176 °F).



Model printed with Objet RGD525

Procedure

1. After cleaning the models place them in a programmable oven, using the following guidelines:
 - Place models on a flat surface and not on an oven rack.
 - Make sure models are not too close together.
 - Support parts with thin walls or overhangs.
2. Set the ramp-up rate to 1 °C (1.8 °F) per minute.
3. Set the temperature to 50 °C (122 °F).
4. Turn on the oven.
The oven temperature reaches 50 °C (122 °F) after approximately 35 minutes.
5. Maintain the temperature at 50 °C (122 °F) for two hours.
6. Increase the temperature to 60 °C (140 °F).
The oven temperature reaches 60 °C (140 °F) after approximately 10 minutes.
7. Maintain the temperature at 60 °C (140 °F) for two hours.
8. Increase the temperature to 70 °C (158 °F).
The oven temperature reaches 70 °C (158 °F) after approximately 10 minutes.
9. Maintain the temperature at 70 °C (158 °F) for one hour.
10. Cool the model in the oven.
11. When the oven temperature is lower than 35°C (95 °F) remove the part.

WARNING: Always wear oven gloves when handling hot parts.

Thermal Treatment for Models Made of Objet ABS - like materials - Objet RGD5160-DM

The heat-deflection temperature (HDT) of models made of Objet RGD5160-DM (ABS-like Material) is 58-68 °C (136-154 °F). The HDT can be increased.

- Method A increases the HDT to 90 °C (194 °F).
- Method B increases the HDT to 100 °C (212 °F).



Model printed with Objet RGD5160-DM

Method A

1. Clean the part and remove the support material.
2. Place the part in a programmable oven.
3. Set the ramp-up rate to 1 °C (1.8 °F) per min.
4. Set the temperature to 60 °C (140 °F).
5. Turn on the oven. The oven temperature reaches 60 °C (140 °F) after 35 minutes.
6. Maintain the temperature at 60 °C (140 °F) for two hours.
7. Increase the temperature to 70 °C (158 °F).
The oven temperature reaches 70 °C (158 °F) after approximately 10 minutes.
8. Maintain the temperature at 70 °C (158 °F) for two hours.
9. Increase the temperature to 80 °C (176 °F) and maintain for one hour.
10. Cool the model in the oven.
11. When the oven temperature is lower than 35 °C (95 °F), remove the model.

CAUTION: Always wear oven gloves when handling hot parts.

Method B

This procedure may cause greater distortion to unsupported thin walls and overhangs. If this is a concern, use Method A.

1. Clean the part and remove the support material.
2. Place the part in a programmable oven.
3. Set the ramp-up rate to 1 °C (1.8 °F) per min.
4. Set the temperature to 60 °C (140 °F).
5. Turn on the oven. The oven temperature reaches 60 °C (140 °F) after 35 minutes.
6. Maintain the temperature at 60 °C (140 °F) for two hours.
7. Increase the temperature to 70 °C (158 °F).
The oven temperature reaches 70 °C (158 °F) after approximately 10 minutes.
8. Maintain the temperature at 70 °C (158 °F) for two hours.
9. Increase the temperature to 80 °C (176 °F) and maintain for one hour.
10. Increase the temperature to 100 °C (212 °F) and maintain for one hour.
11. Cool the model in the oven.
12. When the oven temperature is lower than 35 °C (95 °F) remove the part.

CAUTION: Always wear oven gloves when handling hot parts.

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