Guide to Basic Post-Printing Processes for PolyJet 3D Models

How to save time and expense during product development

stratasys®

USG-00010
Rev. F

Copyright

Trademarks

The following are registered trademarks of Stratasys Ltd.: Stratasys®, Objet®, FullCure®.

Microsoft and Windows are trademarks of Microsoft Corporation.

All names of products and services cited in this document are trademarks or registered trademarks of their respective companies.

Warnings

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

Stratasys Ltd.

www.stratasys.com

Introduction

About this Guide

Stratasys PolyJet 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-printing processes that enable you to create attractive 3D models and product prototypes.

Who Should Use this Guide?

This guide is intended for users of Stratasys PolyJet printers. Experience with printing and handling 3D models is advantageous.

For More Information

Visit www.stratasys.com for more details about Stratasys, its technologies, products and applications.

Contents

Safety Information

Handling Printed Models

Wear protective gloves when handling printed models before they are washed.

Sodium Hydroxide

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

Paints and Primers

- Paints, primers and similar substances can cause skin irritation. Use protective gloves when handling these substances.
- Inhaling paint or primer can be dangerous to your health. When spraying paint or primer, always wear a spray mask.
- 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.

Hot Parts

Always wear oven gloves when handling hot parts.

Cleaning Printed Models

Removing Models from the Printer

After printing models, allow them to cool in the printer, with the cover closed. If they must be removed quickly, wait at least 10 minutes and use a scraper or spatula, taking care not to pry or bend the model, and allow to cool for several hours.

Removing the Support Material

Support material can be removed using different methods, depending on the type of Support material, the size of the model, how delicate it is, the amount and location of the Support material, and other factors.

- SUP705, a gel-like Support material, suitable for all Stratasys PolyJet printers, removed manually and with jets of pressurized water.
- SUP706, a Support material suitable for some Stratasys printers, which dissolves in a solution of sodium hydroxide (caustic soda). SUP706 can also be removed manually, like SUP705.
- SUP707, a specialized Support material for designated systems that dissolves in water. (Removing SUP707 is described in a separate document.)

Removing SUP705:

1. Break away excess Support material surrounding the model. For delicate models, use a toothpick, pin or small brush after dipping the model in water.
2. Use a high-pressure water jet, taking care when cleaning delicate models.
3. Optional: Soak models in a 1% solution of sodium hydroxide (see below). This eliminates residue not removed by the water jetting and gives models a smooth, clean finish. It is also recommended for models printed in VeroClear, to improve transparency.

   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 half-an-hour to several hours, depending on how delicate the model is and how much Support material needs to be removed.

   Rinse models thoroughly under running water or in a cleaning unit.

For a glossy finish, see Polishing and Buffing on page 11.

Removing SUP706:

Although SUP706 can be removed with a high-pressure water jet, its advantage over SUP705 is that it can be dissolved in a sodium hydroxide solution (see below). This is especially useful when printing delicate parts.

1. When feasible, carefully break away outer Support material by hand.
2. Place models in a suitable cleaning tank containing a solution of 2% sodium hydroxide and 1% sodium metasilicate (Na_2SiO_3).
   The cleaning tank should employ a pump (or other device) that circulates the solution continuously.

   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 half-an-hour to several hours, depending on how delicate the model is and how much Support material needs to be removed.
3. Rinse models thoroughly under running water.
4. Optional: To strengthen models, dip them in a 15% glycerol solution for 30 seconds, then place them on a mat to dry.

For a glossy finish, see Polishing and Buffing on page 11.

Note:
Over time, SUP706 dissolves into the solution, reducing its effectiveness. Replace the solution when the Support material reaches 15%–20% of the solution (after approximately one month of average use).

Preparing a Sodium Hydroxide Solution

For SUP705:

1. Pour 990 ml of water into a 1.5 liter plastic or glass container.
2. Slowly pour 10 grams of sodium hydroxide (NaOH—CAS 1310-73-2) into the container.

   This results in a 1% solution of sodium hydroxide.

> **Warning:**
> Always add sodium hydroxide (caustic soda) to water. Never pour water into a sodium hydroxide solution or onto sodium hydroxide pellets. This could generate heat and ignite other materials. Always take adequate safety precautions; use nitrile gloves when handling sodium hydroxide and models soaked in it.

3. Gently stir until the sodium hydroxide is completely dissolved (about 15 minutes).
4. Allow the solution cool to room temperature. (Preparing the solution may produce heat.)

For SUP706:

Use a tank that circulates the cleaning solution continuously.

1. Make sure that the tank is clean.
2. Fill the tank with 20 liters of water.
3. Operate the circulation device.
4. Slowly pour 400 grams of sodium hydroxide (NaOH—CAS 1310-73-2) into the tank.

> **Warning:**
> Always add sodium hydroxide (caustic soda) to water. Never pour water into a sodium hydroxide solution or onto sodium hydroxide pellets. This could generate heat and ignite other materials. Always take adequate safety precautions; use nitrile gloves when handling sodium hydroxide and models soaked in it.

5. Continue mixing the solution until the sodium hydroxide is completely dissolved (about 15 minutes).
6. Add 200 grams of sodium metasilicate (Na_2SiO_3—CAS 6834-92-0) to the solution and continue mixing for about 15 minutes.

   You now have a solution with approximately 2% sodium hydroxide and 1% sodium metasilicate.

   Note: If you need to fill a larger tank, maintain these proportions in the solution.
7. Allow the solution cool to room temperature.

> **Important:**
> **Read Safety Information on page 5 before handling sodium hydroxide.**

Painting Printed Models

Introduction

You can paint printed models to look like the finished product. Models printed on Stratasys PolyJet 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, for use 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 5.

Preparation

Cleaning the Model

Completely removing Support material from the model enhances paint adherence and appearance, and ensures a uniform feel.

For details, see Cleaning Printed Models on page 6.

Sandblasting the model achieves a similar effect. However, this is not recommended because it can create small pits that are difficult to polish.

Cleaning with a water jet

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. Use a fast-drying spray 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.

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 model 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 3M™ 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.

Dry sanding

Cleaning with running water

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 filler

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 each coat to dry before applying another coat.

Applying paint

Painted model

Creating Clear or Translucent Models

Introduction

Printing with VeroClear (RGD810) Model material on Stratasys printers makes clear and translucent models both possible and practical. With a little post-printing processing, you can control the degree of model transparency.

The clarity of VeroClear parts improves considerably over time. To improve the clarity of parts more quickly, consider photobleaching (see page 14).

Printing Models

To ensure maximum clarity in a clear or translucent model, make sure the printer is clean and that Objet Studio is properly configured.

Cleaning the 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 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-printing processing.

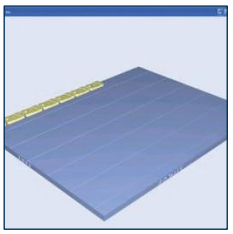
1. In Objet Studio, orient the model so that the critical surface faces upwards.
2. For maximum clarity, choose the “matte” surface finish.

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 the High Speed printing mode (if available).
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. **Water-jetting**
   For most models, the most efficient way to remove Support material is to use a cleaning unit that employs high-pressure water-jetting.


Water-jet Support removal

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

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.


Dry-sanding

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 residue.

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

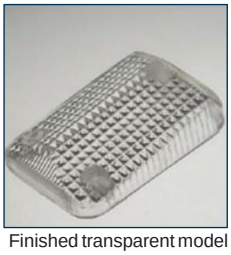

Wet-sanding

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 residue.


Micro-mesh sanding

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. Dyeing adds color and life to your printed models while retaining translucency.

Benefits

- Dyeing your models is faster and easier than painting.
- Translucency of models 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
- a stiff-bristled brush
- a spray bottle
- paper towels
- protective gloves

Aniline dye

Safety

See Safety Information on page 5.

Instructions

> **Caution:**
> 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 Printed Models on page 6).
2. If necessary, sand the model (see Dry-Sanding on page 11).

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.

Models dyed with a variety of colors

Applying Aniline Dye

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

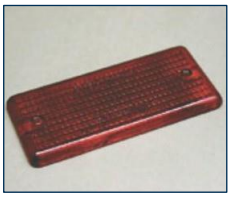
Brush or spray a light coat of the aniline dye onto the model. You can spread the dye evenly over the model by wiping it with a paper towel.

Important:
Distribute the dye evenly.

Applying aniline dye

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.



Model treated with aniline dye

Applying a Protective Coat (Optional)

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

Photobleaching Transparent Models Printed with VeroClear

Introduction

Photobleaching is the process of exposing models printed in VeroClear (RGD810) to intense florescent lighting to improve their transparency of the model. Initially, these models 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 results depend on the model geometry.

Photobleaching Methods

There are two methods of photobleaching, both of which are suitable for all types of models.

- **Illumination chamber**
  - Enables controlling temperature and light intensity.
  - Assures predictable results.
  - Costs approximately US$1,300.

Illumination chamber

- **Table lamps**
  - Results vary due to lack of precise control over temperature and light intensity.
  - Assembled from readily available parts.
  - Low cost.

Photobleaching with table lamps

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.
- Use 45 W, 6500K fluorescent lamps.

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 for six hours, inspect the models. 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 for six hours, inspect the models. 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 (cyanoacrylate)
  - 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:
  - Sicomet 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 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 5.

Preparing Parts for Gluing

Before gluing, it is important to thoroughly clean the model. For details, see Cleaning Printed Models on page 6.

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 High-Temperature Model material (RGD525) and Digital ABS Model materials 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 is required, with the following recommended specifications:

Maximum operating temperature	250°C–300°C (480°F–570°F)
Temperature stability (PID controller On/Off)	±0.1/±0.2 degrees
Temperature uniformity	At 300°C ± 5°C (at 570°F ± 10°F)
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 9000 W for a 900-liter oven
Holding power	300 W for a 28-liter oven 3500 W for a 900-liter oven
Controller features	stores 4 programs and up to 16 segments (Eurotherm programmer, or similar)

Safety

See Safety Information on page 5.

Thermal Treatment for Models Made of High Temperature material—RGD525

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

Model printed with 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. Remove the model when the oven temperature is below 35°C (95°F).

Warning:
Always wear oven gloves when handling hot parts.

Thermal Treatment for Models Made of Digital ABS

The heat-deflection temperature (HDT) of models made of Digital ABS materials is 58°C to 68°C (136°F to 154°F). The HDT can be increased, as follows.

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

Model printed with 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. Remove the model when the oven temperature is below 35°C (95°F).

Warning:
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. Remove the model when the oven temperature is below 35°C (95°F).

Warning:
Always wear oven gloves when handling hot parts.

c-support@stratasys.com
STRATASYS.COM