igus® design guide

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# Tips for successful printing with resin

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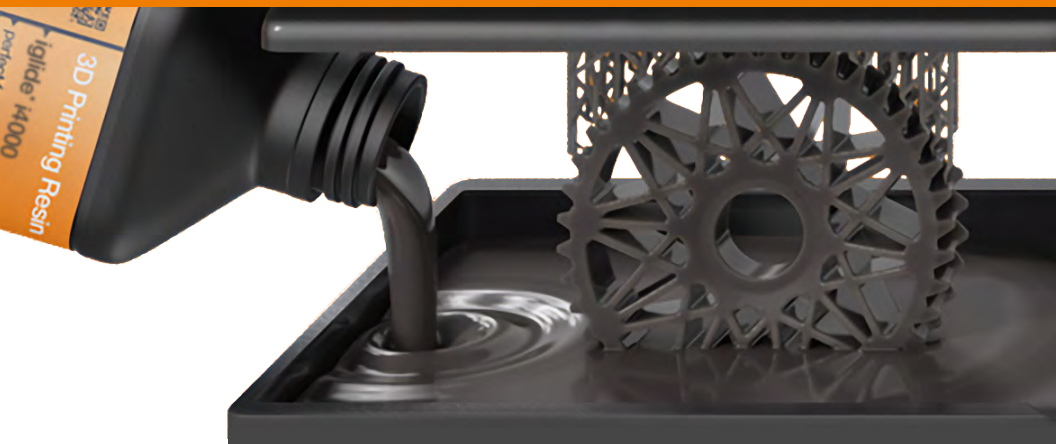



## Introduction

In resin 3D printing, a modern manufacturing process, liquid photopolymer resin is cured in layers by a UV light source. The best-known technologies include stereolithography (SLA), digital light processing (DLP) and LCD 3D printing. These processes are characterized by an exceptionally high level of detail, smooth surfaces and the ability to produce even the most complex shapes with precision.

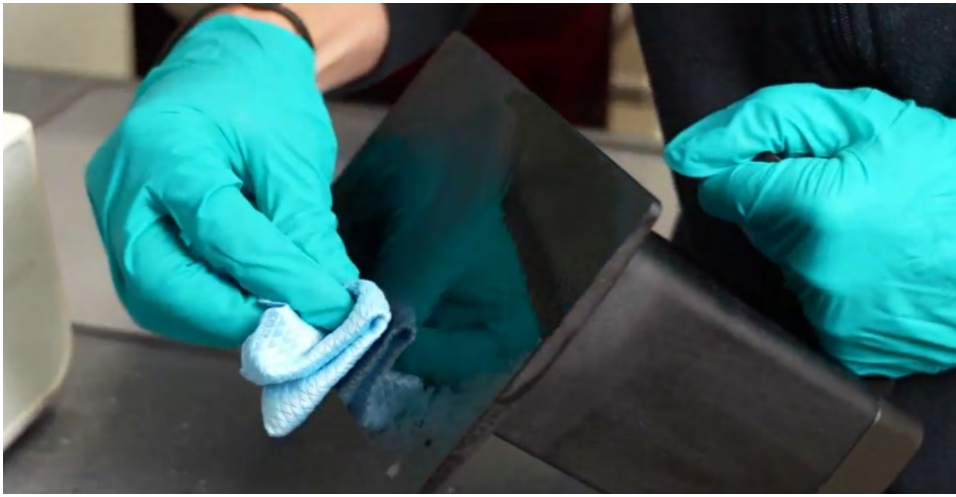
Especially in comparison to other 3D printing processes such as fused deposition modeling (FDM) or selective laser sintering (SLS), resin 3D printing offers significantly better surface quality, finer wall thicknesses and a wide choice of materials. This makes it ideal for a wide range of applications, for example in jewelery design, dental technology or prototype construction.

Resin 3D printing also has clear advantages over conventional manufacturing processes. It enables the production of parts without cost-intensive mold construction and reduces material waste to a minimum thanks to its additive working method. In addition, design changes can be implemented quickly, which enables particularly efficient iteration and customization of prototypes. The independence from geometric restrictions and the cost efficiency for small production quantities make resin 3D printing an attractive choice for applications where precision and flexibility are crucial.

# 1. Tips & tricks for resin 3D printing

## 1.1 Cleaning the print bed

Clean the print bed thoroughly before each print to remove dust, oil or resin residues that could impair adhesion. Use isopropanol (IPA) and a lint-free cloth for cleaning. To further improve adhesion, you can lightly wet the surface of the print bed (e.g. with fine sandpaper, grit 400-600). This ensures better mechanical adhesion of the first layers.

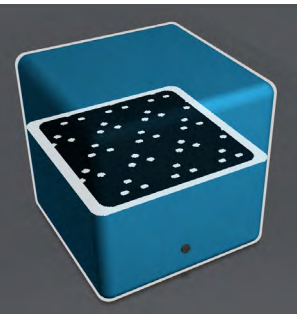


## 1.2 Filtering the resin

After each print, there may be small, hardened particles in the resin that could cause problems during the next print. To be on the safe side, filter the resin through a fine metal sieve or special resin filters before reusing it. This prevents particles from scratching the FEP film or settling in the model.

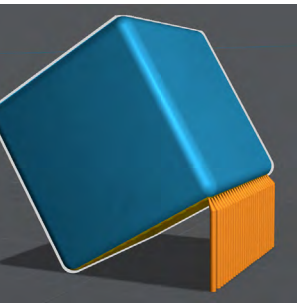

## 1.3 Optimizing the exposure time

The optimum exposure time depends on the resin, the printer model and the layer thickness. Carry out test prints with different exposure times to find the best settings for your resin. Many slicer programs offer special test templates with which you can efficiently determine the exposure time. Exposure times that are too short lead to weak layers, while times that are too long can lead to distorted details or resin residue on the FEP film.



## 1.4 Hollowing out models

Cavities in larger models not only save material, but also reduce weight. Use the hollowing function in your slicer software and add drainage holes to allow excess resin to drain away. Place these holes in inconspicuous places and make sure they are large enough to effectively drain off air and liquid.



## 1.5 Clever placement of support structures

Customized support is crucial to the success of your printing. Position support structures in such a way that they provide optimum support for the model but are also easy to remove. Avoid supports in visible or hard-to-reach places. Use thinner supports for fine details and thicker supports for heavier sections. Adjust the spacing of the support structures individually so that they are stable on the one hand and require less reworking on the other. You can use the automatic support generation as a starting point and adjust the position manually if necessary to achieve the optimal result.

## 1.6 Improving UV curing

After washing the model, it should be fully cured under UV light. A special UV chamber is best suited for this. The models are often rotated constantly in this chamber during the curing process to ensure that all sides are exposed evenly. However, avoid excessive curing as this can cause the model to become brittle. Keep to the times recommended by the resin manufacturer, which are typically between two and ten minutes. Make sure to cure evenly to avoid stresses in the material.

## 1.7 Observing room temperature

The ambient temperature has a major influence on the print quality. Ideally, you should work in an area with a constant temperature of 25–30°C (77–86°F). Lower temperatures can affect the flowability of the resin, while higher temperatures can affect adhesion and curing.


## 1.8 Shaking resin before use

Mix the resin thoroughly before use to distribute pigments and other ingredients evenly. Shake the bottle for at least one minute and then allow the resin to rest briefly so that trapped air bubbles can escape.

## 1.9 Leveling the print bed

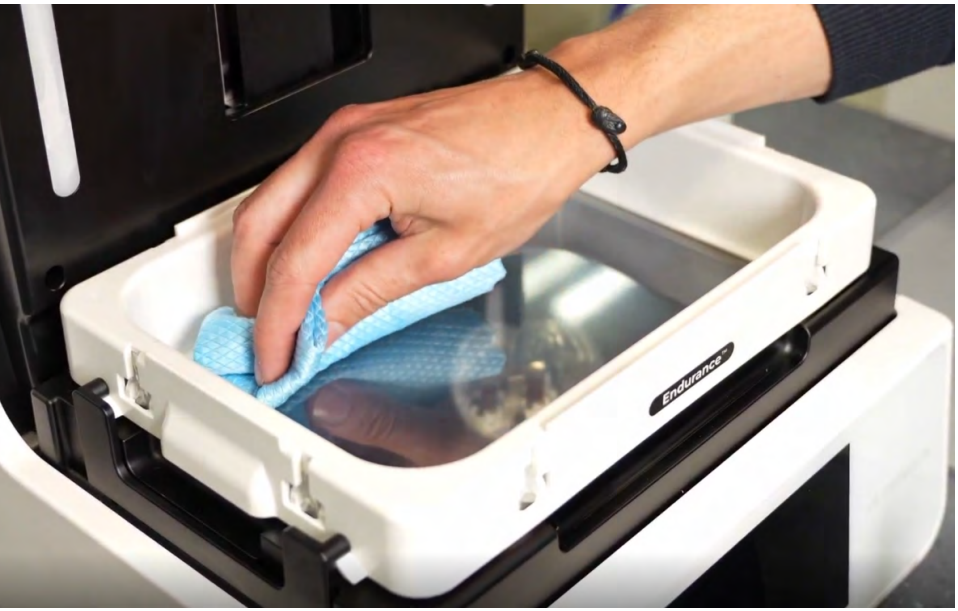
Precise leveling of the print bed is essential to avoid adhesion problems. Calibrate the print bed regularly, especially after transporting or cleaning the printer. Follow the manufacturer's instructions to ensure an even distance between the print bed and the FEP film.

## 1.10 Post-processing

After printing, you should remove the supports carefully so as not to damage the model. Use pliers or cutting tools and sand off any residue with fine sandpaper (600 grit or higher) to achieve a smooth surface. This is particularly important for visible or sensitive areas of the model.

## 1.11 Printer maintenance

Clean and maintain your printer regularly. Remove resin residue from the FEP film, clean the print bed and check moving parts such as the Z-axis for wear. A well-maintained printer guarantees consistent printing results and a longer service life.




## 1.12 Ensuring ventilation

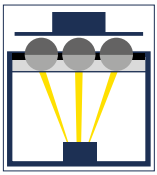
Work in a well-ventilated area, as resin vapors can be harmful to health. Use fans or extraction systems to dissipate the vapors effectively.

# 2. Frequently asked questions

## 2.1 What is the difference between DLP, LCD and SLA?

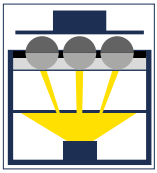
| Technology | Light source/exposure | Speed | Daily accuracy | Cost |
|---|---|---|---|---|
| **DLP** | Projector (exposes entire layer simultaneously) | Fast | High | Medium |
| **LCD** | LCD mask (exposes entire layer simultaneously) | Fast | Medium to high | Low |
| **SLA** | Laser (selective exposure) | Slow | Very high | High |

**DLP**
Digital Light Processing



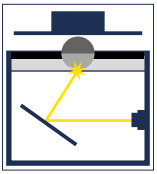
A projector casts light onto the entire layer to cure it all at once.

**LCD**
Liquid Crystal Display



An LC display shows the areas to be exposed so that an entire layer is cured simultaneously.

**SLA**
Stereolithography (laser)



A laser beam selectively hardens the liquid resin point by point.

**DLP (Digital Light Processing):**

This technology uses a digital projector that projects UV light and exposes entire layers of the resin at once. As a result, DLP printers are faster than SLA printers while maintaining a high level of detail. They are particularly suitable for larger models, as the layer exposure remains independent of the number of details in a layer.

**LCD (Liquid Crystal Display):**

Similar to DLP, this method also exposes entire layers, but uses an LCD panel that lets UV light pass through. The devices are cheaper and ideal for beginners. However, the service life of the LCD panel is limited and the detail accuracy can vary depending on the printer and material.

**SLA (stereolithography):**

This method uses a UV laser that hardens the resin at selected points. SLA offers the highest precision and is particularly suitable for delicate and detailed models, for example in the fields of jewelery or dental technology. However, the process is slower and more expensive.

## 2.2 How are resin models cleaned?

- **Cleaning agent:** Use isopropanol (IPA) or special resin cleaner to remove excess liquid resin from the model surface.

- **Steps for cleaning:**
  - ▶ Rinse the model thoroughly in a bath of IPA or resin cleaner after printing.
  - ▶ Swivel or stir the model carefully to clean even fine details.
  - ▶ Allow the model to dry completely before curing it under UV light.


## 2.3 How do I store resin?

- **Storage conditions:** Store resin in a dark, cool and well-sealed container. Direct sunlight or heat sources should be avoided as UV light can harden the resin prematurely. Keep resin and cleaning agents away from children and pets.

- **Additional tip:** Keep the original label of the resin on-hand so that you can look up the specifications or instructions later.

## 2.4 How harmful are vapors and resin?

- **Health risks:** Resin can be irritating to the skin, toxic and potentially harmful to the respiratory tract.

- **Safety measures:**
  - ▶ Wear nitrile gloves to avoid skin contact.
  - ▶ Use safety goggles to protect your eyes.
  - ▶ Work in a well-ventilated area, preferably with an air purifier or extraction system.
  - ▶ Avoid contact with open food or drinks.


## 2.5 How can I reduce odors or vapors?

- **Air purification:** Install an air purifier with activated carbon filters or use an extraction system.
- **Ventilation:** Ensure continuous air circulation in the room, e.g. by means of open windows or fans.

## 2.6 How do I dispose of excess or out-of-date resin?

- **Curing:** Allow excess resin to cure completely under UV light before disposing of it.
- **Waste separation:** Dispose of the hardened resin in accordance with local regulations for plastic waste. The bottles should be disposed of empty and well-sealed in hazardous waste.

## 2.7 How can I extend the service life of the FEP film?

- **Cleaning:** Clean the FEP film carefully after each print with isopropanol and a soft cloth.
- **Care:** Take care not to use sharp tools or exert excessive pressure on the film.
- **Regular checks:** Check the film regularly for cracks or scratches and replace it in good time if necessary.

## 2.8 Which software is suitable for slicing resin 3D models?

- **ChiTuBox:** A widely used and easy-to-use software that is compatible with most resin printers.
- **Lychee Slicer:** Offers advanced features such as automatic optimization of support structures and user-friendly tools.
- **PrusaSlicer:** Supports some resin printers and offers regular updates, ideal for users with mixed printing needs (FDM and resin).
- More expensive devices are often supplied with a suitable slicer that is perfectly matched to the printer and the materials being processed.

## 2.9 How can I remove models from the build plate more easily?

- **Use a spatula:** A thin, flexible spatula is ideal for gently removing the models from the printing plate.
- **Heat:** If your printer supports this, heat the printing plate slightly to reduce adhesion.
- **Flexible print bed:** Another option is to use a flexible print bed, which you can bend to make it easier to remove the models. It should be noted that these usually build up a little, which means that the position of the end stop may need to be adjusted.

## 2.10 How can I improve the detail accuracy?

- **Layer height:** Reduce the layer height to 0.025mm or less to obtain particularly fine details.
- **Exposure time:** Optimize the exposure time to avoid overexposure or underexposure.

## 2.11 How do I avoid bubbles from forming in the resin?

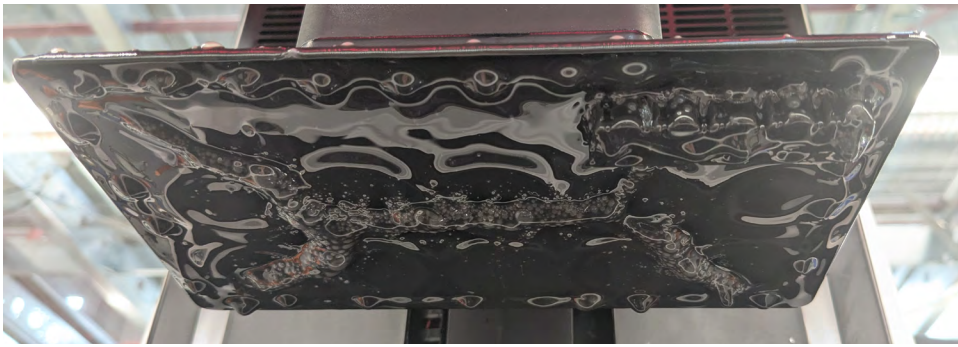
- **Stir slowly:** Avoid hectic stirring to minimize air pockets.
- **Resting time:** Leave the resin to rest for a few minutes after decanting so that bubbles can rise to the surface.
- **Temperature control:** Work at optimal room temperature 25–30°C (77–86°F) to improve the flowability of the resin.

## 2.12 Can I mix different resins?

- **Check compatibility:** Only mix resins from the same manufacturer and with a similar chemical composition.
- **Testing:** Try out mixtures in small quantities first to ensure that no unexpected chemical reactions occur.
- **Attention:** Do not mix igus® triboresins with other resins, as this can have a negative effect on wear resistance, among other things.

# 3. Troubleshooting guide

**The following list contains common problems with resin 3D printing, as well as the cause and the measures that can be taken to solve the problems. It can also be used generally as a checklist for successfully working with resin 3D printers.**



## 3.1 Model does not adhere to the print bed

**Cause:**

- The model will not adhere if the print bed is poorly leveled and therefore even contact can't be made with the first layer. Insufficient exposure time of the first layers or resin that is too viscous will also result in the resin not curing sufficiently.

**Solution:**

- Calibrate the print bed carefully according to the manufacturer's instructions. Make sure that this is absolutely flat.
- Increase the exposure time of the base layers so that they cure stronger and adhere better.
- Ensure a constant temperature in the print range 25–30°C (77–86°F) to improve the flowability of the resin.

## 3.2 Warped or distorted layers

**Cause:**

- A wobbly Z-axis can lead to irregular layers, as the movements are not sufficiently precise. A damaged or contaminated FEP film also prevents the clean removal of the layers.

**Solution:**

- Stabilize the Z-axis by tightening the screws and guides. Check that the axis is aligned straight and runs without clearance.
- Inspect the FEP film for cracks, scratches or impurities. Clean the film with a soft, lint-free cloth and isopropanol. Replace damaged films.

### 3.3 Resin adheres to the FEP film

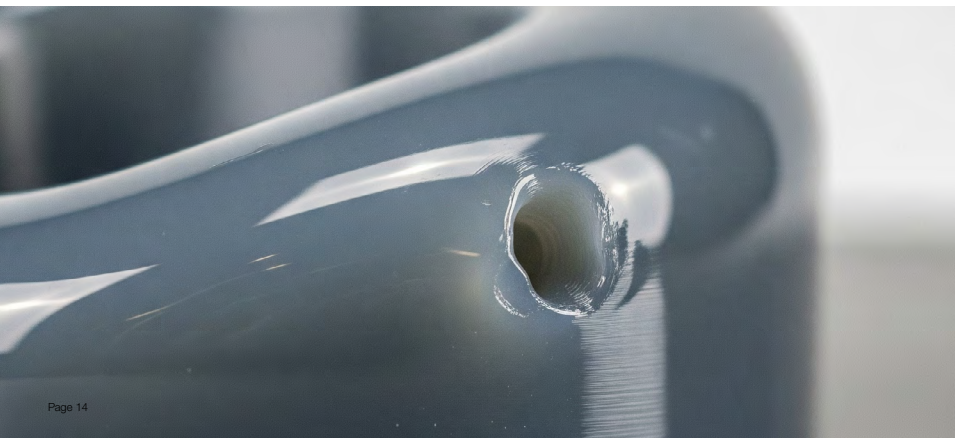
**Cause:**
- If the exposure time is too long, the resin will adhere more strongly to the FEP film than to the model. A dirty or damaged FEP film can also result in the layers not being separated cleanly.

**Solution:**
- Gradually reduce the exposure time for the normal layers until the model adheres securely and the layers come off easily.
- Clean the FEP film thoroughly to remove any resin residue or other impurities.

### 3.4 Cracks or holes in the model

**Cause:**
- Insufficient curing or air bubbles in the resin can cause the model to have blowholes, which can develop into cracks or holes.

**Solution:**
- Cure the finished model more thoroughly under UV light to ensure that all areas are stable and fully cured.
- Stir the resin thoroughly before printing to remove air bubbles. If available, you can use a vacuum chamber.



### 3.5 Support structures break during printing

**Cause:**
- Support structures that are too thin or weak may not provide sufficient support for the model during printing.

**Solution:**
- Increase the thickness and density of the support structures in the slicer software.
- Ensure that the support structures are optimally positioned, especially on overhangs and areas that are difficult to support.

### 3.6 Resin smells too strong

**Cause:**
- Poor ventilation of the work area or the use of low-quality resin can lead to strong, unpleasant odors.

**Solution:**
- Ensure good ventilation by using fans or an extraction device.

### 3.7 Print breaks off during printing

**Cause:**
- Weak support structures or insufficient adhesion to the print bed can cause prints to break off prematurely.

**Solution:**
- Increase the thickness and density of the support structures to ensure better stability.
- Ensure that the base adheres well to the print bed by extending the exposure time of the first layers.

### 3.8 Hard or sticky residue on the surface

**Cause:**
- Incomplete cleaning or curing of the model leaves sticky or hard residues on the surface.

**Solution:**
- Rinse the model thoroughly with isopropanol to remove any uncured resin.
- Cure the model sufficiently under UV light to ensure complete polymerization.

### 3.9 Resin inclusions in the model

**Cause:**
- The lack of drainage holes in hollow models means that air and excess resin cannot escape.

**Solution:**
- Add drainage holes at suitable points on the model to allow air and resin to flow off.

## 3.10 Distorted details

**Cause:**
- Overexposure or an incorrect layer thickness can cause fine details to become blurred or out of focus.

**Solution:**
- Reduce the exposure time of the normal layers to achieve more precise curing.
- Use a thinner layer thickness to reproduce finer details.

## 3.11 FEP film damaged

**Cause:**
- Excessive pressure or improper handling when removing resin residues can damage the FEP film.

**Solution:**
- Clean the FEP film carefully with a soft cloth and isopropanol to avoid scratches.
- Replace damaged FEP films regularly to ensure optimal printing results.

# Glossary

**Anti-aliasing:**

Technique for smoothing step effects on edges to achieve a higher surface quality.

**Base layer:**

The first layers of a printed component, which are exposed for longer to ensure better adhesion to the print bed.

**Bleeding:**

Effect in which the resin spreads into neighboring areas, which can reduce the sharpness of detail.

**Build plate:**

Printing platform on which the object is set up during printing.

**Calibration test:**

Test print to check parameters such as exposure time, Z-axis precision and support strength.

**Curing:**

Post-curing of the printed object using UV light for complete curing and stabilization.

**DLP (Digital Light Processing):**

A method of resin 3D printing in which a projector focuses UV light on the resin to harden an entire layer at the same time. Particularly precise and fast.

**Exposure time:**

Time that the UV light acts on the resin to cure it.

**FEP film:**

Transparent film at the bottom of the resin tank through which the UV light shines.

**Hollowing:**

The creation of cavities in the model to save material and shorten printing times (for SLA).

**Layer height:**

Thickness of a single layer in 3D printing. Influences the printing time and detail accuracy.

**LCD (Liquid Crystal Display):**

Utilizes a UV light source behind an LCD screen that displays translucent pixels to cure the resin. More cost-effective, but less durable.

**Overhang:**

Area of a model that extends beyond the previous layer and may require support structures.

**Peeling:**

Process of separating each printed layer from the FEP film before the next layer is printed.

**Raft:**

Flat, additional structure under a model that improves adhesion to the print bed.

**Resin settings:**

Information on exposure time, post-curing time and optimal temperature for the respective resin.

**Resin:**

Liquid, light-sensitive plastic that hardens under UV light.

**SLA (stereolithography):**

Works with a UV laser that cures the resin point by point. Very high precision, but comparatively slow.

**Slicing:**

Process in which a 3D model is broken down into individual layers and converted into printable instructions (G-code).

**Supports:**

Support structures that stabilize overhangs during printing.

**Vat:**

Container that holds the liquid resin during the printing process.

**Warpage:**

Deformations caused by uneven curing or shrinkage of the resin.

**Z-axis calibration:**

Adjustment of the vertical axis to ensure precise layer heights and adhesion to the print bed.

**Z-axis:**

Vertical axis of the printer that moves the printing from one layer to the next.