Best Tips for *3D Printing Consumer Electronic Housings*

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INTRO

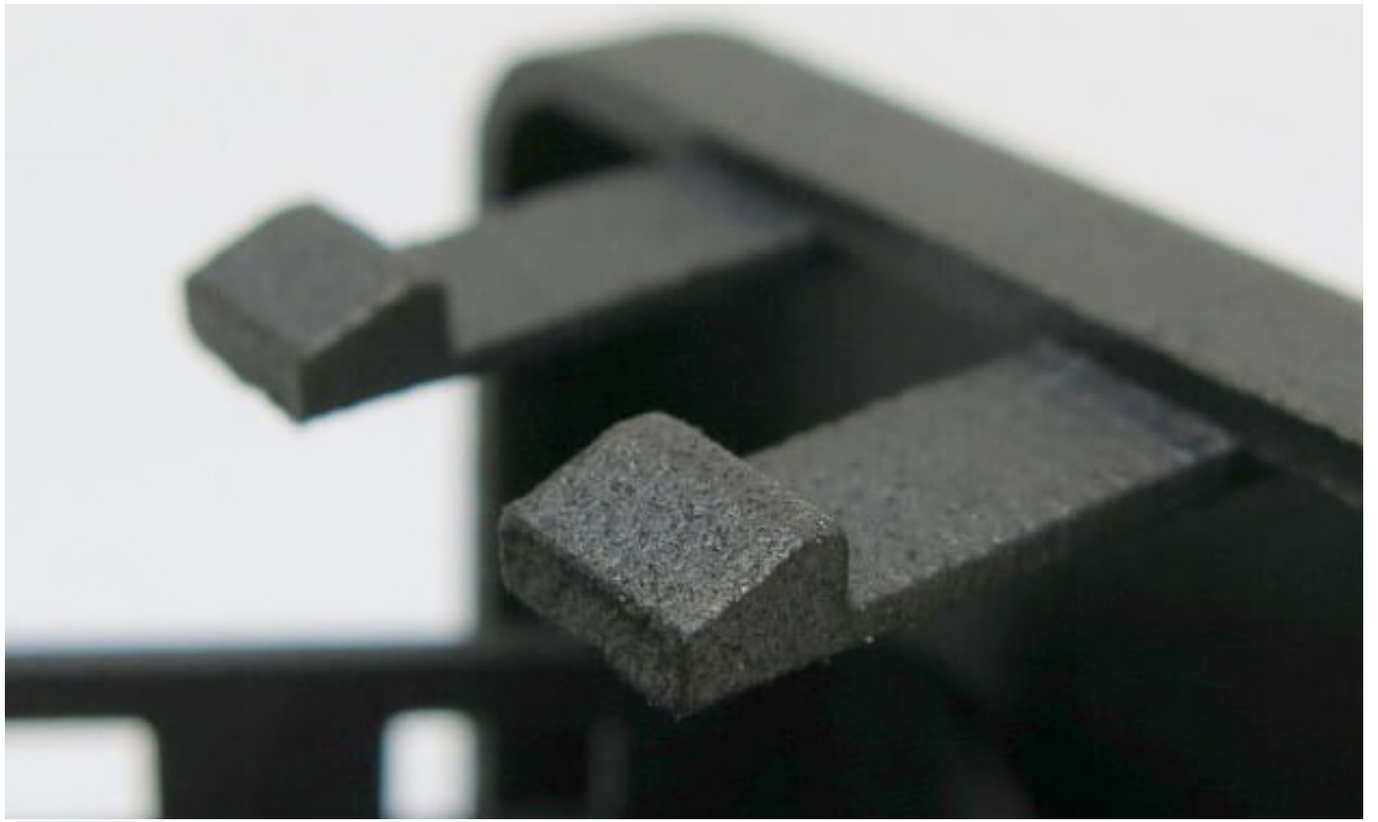
Make the most of 3D printing technologies

This ebook is aimed for designers of consumer electronics. It will provide the most important information and considerations of 3D printing consumer electronic housings. Starting with the benefits of Additive Manufacturing and the main factors of why you should 3D print your designs, we will then move on to how to design for 3D technologies and which material will suit your project best. After that, we will guide you through the special qualities of the materials. Lastly, we will introduce you to post-processing modifications.
With our ebook you will learn how Additive Manufacturing can be applied in the consumer electronics industry. We will focus on new, innovative solutions 3D printing gives you, we will also guide you through 3D printing materials.

THE BENEFITS OF 3D PRINTING

3D Printing allows for new design solutions

- Improve the ergonomy of the enclosures
- Produce complex assemblies in a single step, reducing assembly time and cost
- Capable of a great level of detail
- Mass customization, cost-inhibitive with traditional manufacturing methods
- Reduce weight while maintaining strength with lattice structures
- Safe design for wire channels
- Heat dispersion for PCB components



Save time and reduce cost with Additive Manufacturing

There are plenty of examples of why Additive Manufacturing is more cost and time-effective than traditional manufacturing techniques. First of all, the process itself is much faster. Starting with the prototyping stage, which 3D printing is great for as well, you can **quickly produce test parts,** edit 3D files accordingly and print them again.

When it comes to **production**, you don't need molds, welding fixtures ect. Additive Manufacturing **eliminates expensive and time-consuming tooling** as all the solutions can be already created in the design and there are **no assembly tools needed**. You can also quickly adjust the 3D model if you upgrade your product or create different versions.

3D printing is a **perfect solution for small series, low-volume production** or mass production on complex assemblies. With **no minimum order quantities and shorter lead times**, parts can be made on-demand when and where they are needed. With more than 75 material and finishing combinations, your 3D printed housings will have the **look and feel of injection molding** without the time and expense.

DESIGN CONSIDERATIONS

What is Design for AM (DfAM)?

DfAM is a way of designing components specifically for Additive Manufacturing. Without the limitations of traditional manufacturing methods, industrial designers are able to simplify component design and reduce final assembly for consumer electronics.

While additive manufacturing continues to advance, it's important to consult specialist industrial designers to discover new design possibilities which can save time and reduce costs and waste.

What are interlocking parts?

With powder-based 3D printing you are able to manufacture complex enclosures in a single production process which reduces assembly time and saves costs. For SLS and Jet Fusion printing processes, unsintered (loose) powder surrounds the fused powder which comprises the design. This loose powder allows internal components, hinges, or other fasteners to be built right into the design. While injection molding can limit the design process, 3D printing allows for complex components to be made at scale.

How can circuit boards, inserts, and port openings be integrated into the design?

Due to the flexibility of 3D printing, enclosures can take on any form without being cost-prohibitive for smaller quantities. Your housing can be made to match the ergonomy, function, and PCB components of the project. 3D printing allows you to exactly match the design specifications to components and reduce manual assembly time and cost. We recommend following the steps below for design and provide some tips for implementing Design for AM:

1. Consider the ergonomy and function of the finished product. Will it need to fit a specified shape? Be handheld? Fit certain industry standards?

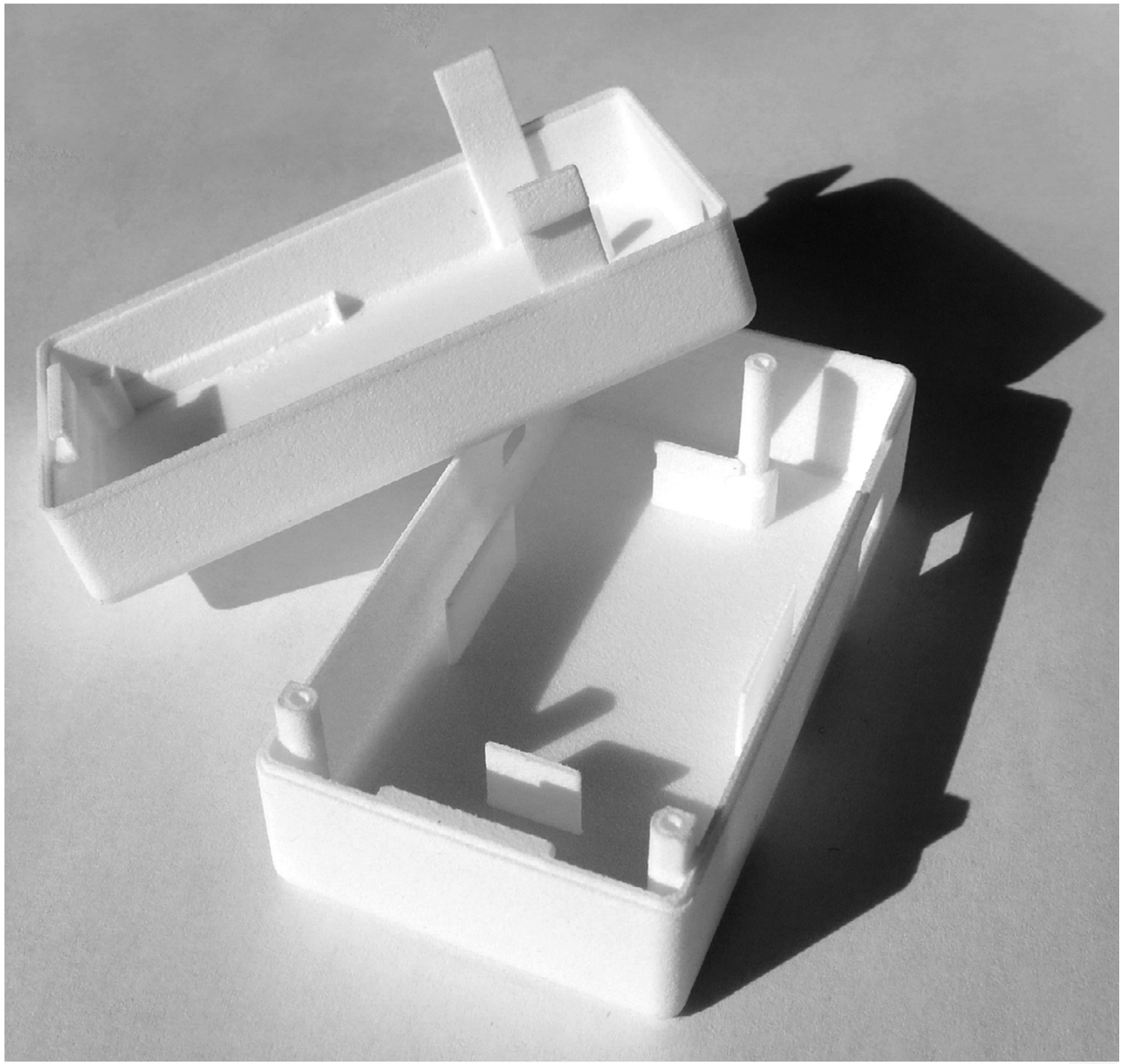
- 3D printing is not limited by traditional manufacturing methods, designs can be customized to the individual user without additional cost

2. Consider the requirements of the electronic assembly. Where does the circuit board go? Where will the port openings go, how big do they have to be, how far apart from each other? What about heat dispersion?

- You can adjust the enclosure exactly to fit complex circuit boards

3. Consider the housing itself. Will the electronics need to be accessible? What kind of fasteners will be used? Are there some legal requirements for safety?

- Eliminate additional assembly and fastening with **snap fits and joints** which are already integrated in the design
- Metal inserts can be added for screw fastenings



THE 3D PRINTING PROCESS

Which material should I use?

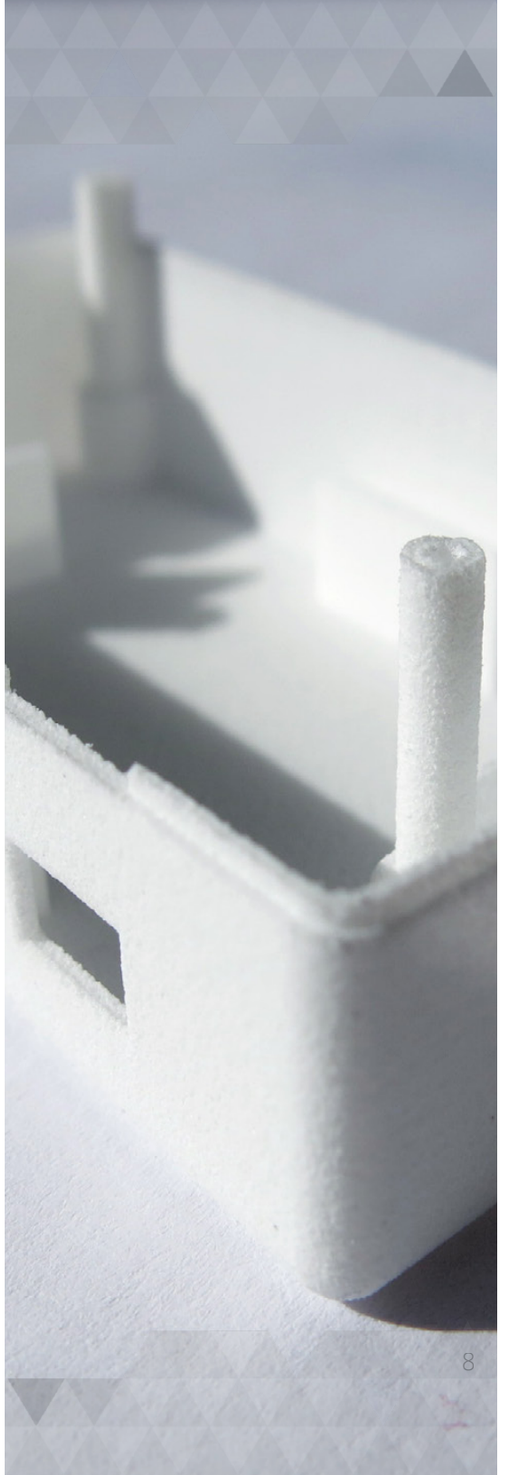
Based on our experience in 3D printing for consumer electronics, our 3D printing experts recommend these materials:

White Plastic: Nylon PA12	SLS	- dying or painting finishing other than black color
Grey Plastic: Nylon PA11/12	SLS	- internal components or mechanical part housings
Black Plastic: Jet Fusion PA12	Jet Fusion	- internal components or dying/finishing in black color
Black Resin: Rigid Polyurethane (RPU)	DLS/CLIP	- strong parts with the look and feel of injection molding
Multi-Purpose Resin: UMA 90	DLS/CLIP	- look and feel of injection molded parts

How fine can I make the details?

With 3D printing you are able to get very fine details but it is important to respect the minimum detail tolerance so that the materials maintain their properties, such as strength, at their full capacity. Here are the minimum detail values for the recommended materials.

Nylon PA12	0.3 mm
Nylon PA11/12	0.3 mm
Jet Fusion PA12	0.2 mm
RPU	0.5 mm
UMA 90	0.5 mm



Will there be varience in the size of 3D printed parts?

In some cases, shrinkage can occur during the 3D printing process. While designing your parts, it is essential for you to remember about this factor and adjust your model accordingly.

DLS/CLIP: some shrinkage may occur. DLS/CLIP is capable of printing above 95% of features falling within a +/-0.1mm tolerance in the XY plane and +/-0.5mm in the Z direction.

Shrinkage *is inconsequential* for SLS and Jet Fusion printing technologies.

How will the printing process affect the surface quality?

For SLS the standard layer thickness is 100 µm with high definition of 60 µm also possible. This allows you to have a quite smooth surface finish even before polishing. DLS/CLIP has a layer thickness of 100 µm and Jet Fusion PA12 comes with a standard layer thickness of 80 µm. While the finished look will be sufficient for most housings in the raw form, you can also polish the part to get an even smoother finish.

With SLS and Jet Fusion technologies, the orientation of the piece during the printing process can affect the look and feel of the top and bottom surface. This occurs due to the cooling process after printing and results in a slight concave (upskin) look on the top surface and a slight convex (downskin) look on the bottom surface. In many cases, it doesn't affect the model, but if it will influence the functionality or esthetics of your design, set the orientation beforehand.

SPECIAL PROPERTIES OF 3D PRINTING MATERIALS

How durable are 3D printed parts?

With industrial 3D printers, 3D printed parts are as strong as injection molded parts and are capable of withstanding long-term use.

For SLS and Jet Fusion technologies, Nylon PA11/12 and PA12 are the strongest and most durable materials. These Nylons are also the strongest of all plastic materials.

For DLS/CLIP, RPU is slightly stronger than UMA 90 for Resins; however a lot depends on your design, such as wall thickness.

Are there waterproof materials?

Nylon PA12 and Jet Fusion PA12 are water resistant, and Nylon PA12 with Smoothing Beautifier finish is waterproof. You can also decrease water absorption by adjusting the design (thicker walls perform better) or by applying varnish as an extra layer of protection between the part and water.

Material	**Water Absorbtion**		
	Temp. 22° C for 6 hrs	**Temp. 52° C for 6 hrs**	**Temp. 22° C for 48 hrs**
Nylon PA12	2%	2%	absorbed water
Nylon PA12 with Smoothing Beautifier	2%	2%	less than 1.4%
Jet Fusion PA12	2%	2%	absorbed water

How heat resistant are 3D printing materials?

For housings which will be exposed to high temperatures, it is notable that 3D Printing materials offer excellent resistance to heat.

Jet Fusion PA12 has a melting point of 172- 180°C; however, a test performed by HP certified that the material can resist exposure to a range of 700 to 800 °C depending on the dimensions and thickness of the part.

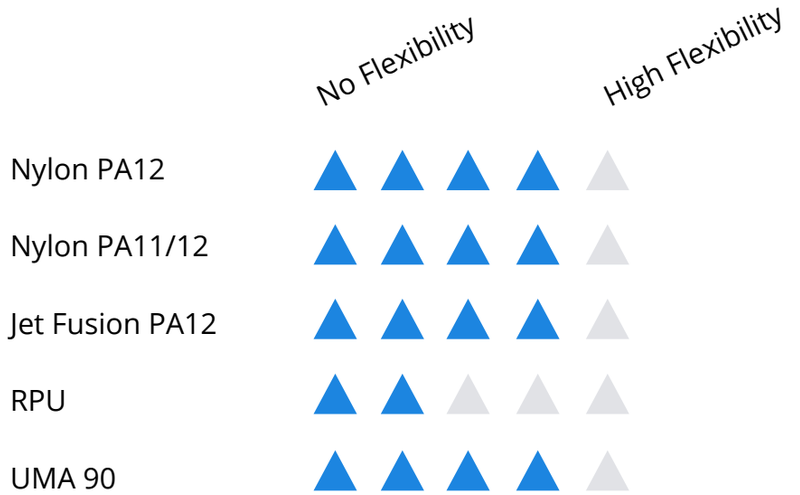
Nylon PA12 has a melting point of 172 - 180°C

RPU has a heat deflection temperature of 70°C

UMA 90 has a heat deflection temperature of 51°C

Are there flexible 3D printing materials?

For some electronics applications housings must be quite flexible to adapt to movement; in other cases, the housing needs slight flexibility to allow for snaps, joints, and closures but must also maintain its strength.

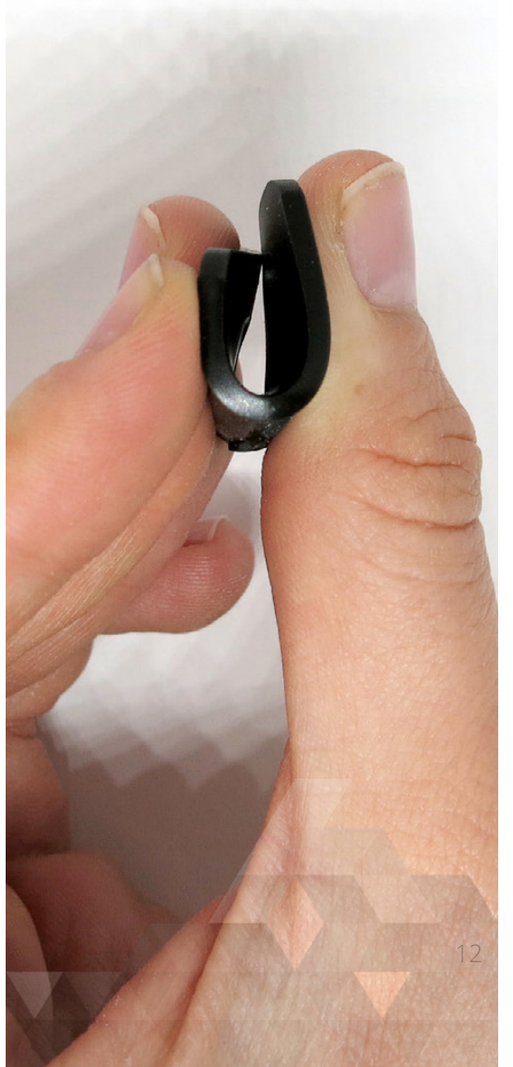


Are 3D printing materials food safe?

Nylon PA12 (except for high alcohol content foods) and Jet Fusion PA12 meet safety requirements and are biocompatible. For certification of materials, refer to the manufacturer's datasheets available on our website.

There are a few factors to keep in mind before 3D printing parts come in contact with food:

- The growth of bacteria (particularly in between layers)
- Chemical products from the printing process
- Chemical additions of the materials
- Using the 3D printed parts in microwaves and dishwashers

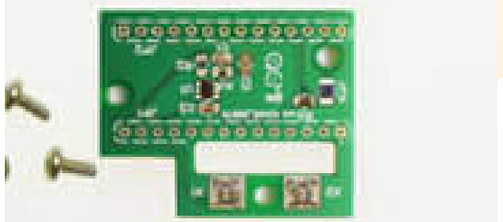


POST PRINTING MODIFICATIONS

Can 3D printed parts have the look and feel of injection molding?

Yes! depending on your application, we can recommend several finishing options.

Application of Housing	**Recommended Finish**
Internal /mechanical	Raw parts are sufficient
In contact with water	Smoothing Beautifier finish - waterproofing for Nylon PA12
Components which will be exposed to UV rays	Color Resist/Touch - Dyed finish which also provides UV protection and either a matte (Resist) or satin (Touch) look
Components which come into contact with food	Polished - smooths layers to reduce pockets for bacteria to grow
End-use consumer goods	Color Touch - Dyed finish available in a number of colors that is polished to give a satin look and smooth touch



Can parts be drilled after manufacturing?

Yes. The easiest to modify are parts printed with SLS technology. However, to assure that your parts won't break during drilling, we recommend designing a smaller hole in the place where it needs to be drilled. This, just like with traditional manufacturing methods, will assure the impact of the drill on the part is smaller.

Can 3D printed parts be glued?

Connecting 3D printed parts with glue is possible, however due to the chemical properties of both 3D printing materials and different glues, it is recommend to contact glue manufacturers to get the best information.

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