Co-polyester for 3D printing

colorFabb & 3DHubs workshop
Choosing the right material for the job.

Fairphone case

Print+

3DLabprint
Why 3D Hubs customers need co-polyesters.

- Tough & durable printed parts
- Heat resistance temperature starting at 75C up to 110C
- Complies with certain FDA food contact regulations
- Chemically resistant
Why you (the 3DHub) should print with co-polyesters.

- Odor neutral printing, no funny smells in your maker space
- Low fine particle emissions
- Traceable source, Amphora 3D Polymer
- Range of co-polyesters to choose from, mechanical properties and temperature resistance (75C to 110C)
What’s a co-polyester?

Copolyester ≠ PET
What’s a co-polyester?

- PET is a crystalline material mostly dedicated to Injection Stretch Blow Molding (ISBM) to produce bottles (soft drink and water).

- PET copolymerization gives a wide range of transparent materials suitable for:
  - Injection
  - Extrusion blow molding
  - Injection blow molding
  - Sheet extrusion
  - Glass Polymer
What’s a co-polyester?

The challenge for Eastman & colorFabb

Number of grades is virtually infinite. EASTMAN & colorFabb select and tweak the best ones for FFF 3D printing.
**colorFabb nGen**
- Processing temperature: 220C / 240C
- Bed temperature: 80C/90C
- Tg: 87C
- Toughness: +
- Ease of printing: +++

**Durable**
**Visual prototyping**
**Good printability printing**
**Chemical resistance**

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**colorFabb XT**
- Processing temperature: 240C / 260C
- Bed temperature: 65C/75C
- Tg: 75C
- Toughness: ++
- Ease of printing: +

**ABS alternative**
**Functional prototyping**
**Toughness**
**Chemical resistance**

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**colorFabb 910A**
- Processing temperature: 250C / 280C
- Bed temperature: 90C/110C
- Tg: 110C
- Toughness: +++
- Ease of printing: +/- (warping)

**High temp resistance**
**Toughness**
**Chemical resistance**
What’s a co-polyester?
What’s a co-polyester?
When to choose a copolyester. … and which one.

Applications which need heat resistance.

Chemical resistance, acids, base, oils etc.

Creep resistance
*Parts under constant load*

Durable applications

Toughness, impact resistant.
Which settings should you adapt for printing with copolyesters?

- 1. Speed | temperature | layerheight
- 2. Bridging
- 3. Retraction
- 4. Part cooling
- 5. Warping
Layerheight \times\text{ nozzle width} \times\text{ print speed} = \text{ Volume per second}
1. Speed, temperature and layerheight.

https://www.youmagine.com/designs/test-print-for-ultimaker--2
1. Speed, temperature and layerheight.

Make your own speed test – Solid cylinder

- No infill
- Spiralize mode (vase)
- No top / bottom
- Disable speed overrides, layer time, slow down for outer perimeters etc.

- Set speed
- Set temperature
- Set layerheight
- Set nozzle width

*Look for under extrusion
*Test layeradhesion with nail
1. Speed, temperature and layerheight.

**Too fast printing** -> under extrusion, material collecting on the nozzle instead of the layer, bad layer adhesion, not connecting perimeter lines

**Too slow printing** -> residence time too long, bubbly effect
1. Speed, temperature and layerheight.

Speed is a dynamic setting and therefore flow mm3/s varies, but temperature stays constant...
1. Speed, temperature and layerheight.
1. Speed, temperature and layerheight. Is there a minimal extrusion speed for a certain material + hot-end combination?
2. Bridging with copolyesters

Slicers have different ways of handling bridges.
2. Bridging with copolyesters

Simplify3D – lines in bridge direction
Perimeter line not recognized as bridge, no speed adjustment.
2. Bridging with copolyesters

MakerWare – regular infill lines
2. Bridging with copolyesters

Cura 16.04 – lines in bridge direction  
*Perimeter line not recognized as bridge, no speed adjustment.*
2. Bridging with copolyesters

Slic3r – lines in bridge direction, even overlap to infill
Perimeter recognized as bridge.
3. Bridging

Bridging too fast -> break the melt, material collects on the nozzle.

Bridge multiplier too low can give similar result.

Parameters to tweak: bridging speed and bridge flow multiplier
3. Bridging

Bridging too slow -> material tends to drool and drop in loops.

Too much material gives the same result.

Parameters to tweak: bridging speed and flow multiplier
3. Bridging

Tip – use extra bottom / top layers to make sure bridge is fully closed.

Tip – check cooling settings, 100% cooling for bridging usually helps.

Tip – Play with bridge multiplier / speed
3. Bridging
4. Retraction

Usually higher retraction speed and distance compared to regular PLA settings.
4. Retraction

Also test bigger travel distances.
4. Retraction

Are the stringing a result of retraction settings or other reasons?

• Not enough cooling leads to upwards smearing leads to stringing.
• Travel moves over print can cause stringing.
• Failed bridges can result in stringing.

Parameters to tweak:
Travel speed – speed of movement without extruding
Retraction distance
Retraction length
Temperature
5. Part cooling / minimal layertime

cooling down below heat resistance temperature from processing temperature.

- Upwards bending of layer
- Rough surface
5. Part cooling / minimal layertime
5. Part cooling / minimal layertime

- Minimal Layertime too short / cooling to little?
- Minimal layer time too long / minimum print speed too slow
- Too much cooling? -> bad layer adhesion.
6. Warping

copolyesters need heated buildplate

• Good start point Heated bed around TG of material.
• 5/10 C lower or higher

• Buildsurface; 3DLac, BuildTak, Gluestick

• Add a brim or raft.

• Tip - Carefully check if you’re part needs cooling, if not leave it off.
• Tip - Check for airflow in the room, cold air makes it worse.
• Tip – more infill, more warping
• colorFabb 910A
  • - high bed temperature 100/110C for glass
  • 80/90C for PEI
  • 100C for BuildTak
6. Warping

Glass plate covered with 3DLac.
6. Warping

Glass plate covered with Buildtak
6. Warping

Glass plate covered with PEI
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Have fun experimenting!
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3dhubs.com/talk