Polymaker PC User Guide

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Innovation Simplified

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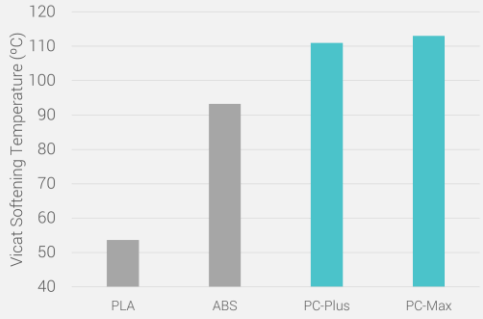
Introducing Polymaker PC

Key Features

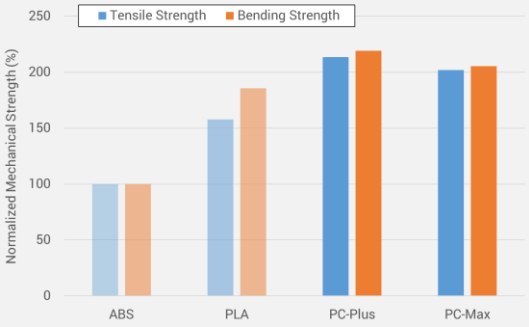
Polymaker PC is a new family of polycarbonate based filaments designed specifically for extrusion based (i.e. FDM/FFF) 3D printing. It offers superior printing quality, excellent mechanical strength and heat resistance, with moderate printing temperatures and great warping resistance.

Heat Resistance

Polymaker PC offers better heat resistance than almost all other 3D printing materials currently in the market. It can withstand temperatures well above 110 °C.



*Tests performed with 3D printed specimens (100% infill, standard Vicat conditions)



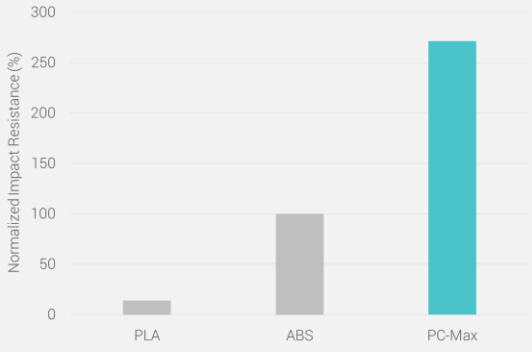
Tested with 3D printed specimens (100% infill)

Excellent mechanical strength

Parts made with Polymaker PC show significantly improved mechanical strength compared to ABS and PLA under almost any deformation mode.

Optical Clarity (PC-Plus™)

Polymaker PC-Plus™ shows good optical clarity, rendering parts with an attractive crystal shine!



Excellent Toughness (PC-Max™)

Polymaker PC-Max™ offers outstanding fracture toughness that is simply unobtainable from other 3D printing materials of similar stiffness. This makes Polymaker PC-Max™ an excellent choice for real-world, engineering applications.

Additional benefits

- Intrinsic flame retardance (V2 based on UL94:2006)
- Good chemical/solvent resistance
- High printing quality

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Printing with Polymaker PC

Preparations

Before you start for the first time, check the following to ensure you are fully prepared for printing with Polymaker PC:

The extruder of your 3D printer can operate in the temperature range of 250 – 270 ºC
(While printing at less than 250 ºC is also possible, it is recommended that Polymaker PC (both PC-Plus™ and PC-Max™) be printed at 250 ºC or above for better layer adhesion and consistency)

Your printer is equipped with a heated build plate (HBP)
(Printing with a non-heated build plate is possible, but a HBP is generally recommended)

*The build plate is covered with a BuildTak™ sheet
(Highly recommended. Other build surfaces such as the blue tape, Kapton tape, glass, etc., are not ideal for Polymaker PC)

Your printer is well calibrated
(Special care should be taken to ensure that the “zero” distance between the nozzle and the build plate is not overly small, especially when BuildTak™ is used; otherwise the adhesion may be too strong and removal of printed objects can be difficult. 0.3 – 0.4 mm or 1-2 “business card thickness” should be good)

Design by Daniel Noree
https://www.myminifactory.com/object/openrc-65t-spur-gear-vase-12628

Your printer is equipped with an enclosed printing chamber
(It is not a must, but having an enclosed printing chamber can lead to more consistent prints. If an enclosed printing chamber is not available, try to avoid large variations in environmental temperatures during printing)

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Printing with Polymaker PC

Slicer Settings

Temperature settings

- Nozzle temperature (for 0.2 mm layer height): 250 - 270 °C
  (255 °C was found to be optimum on most printers we have tested and is therefore a good starting point)
- HBP temperature: ~ 80 °C

Model cooling fan

- If your printer is equipped with a model cooling fan, **turn it off** completely or disable it in your slicer.
  (Unlike PLA, Polymaker PC solidifies rapidly and therefore does not need extra fan-cooling; over-cooling can lead to poor interlayer adhesion)

Raft settings

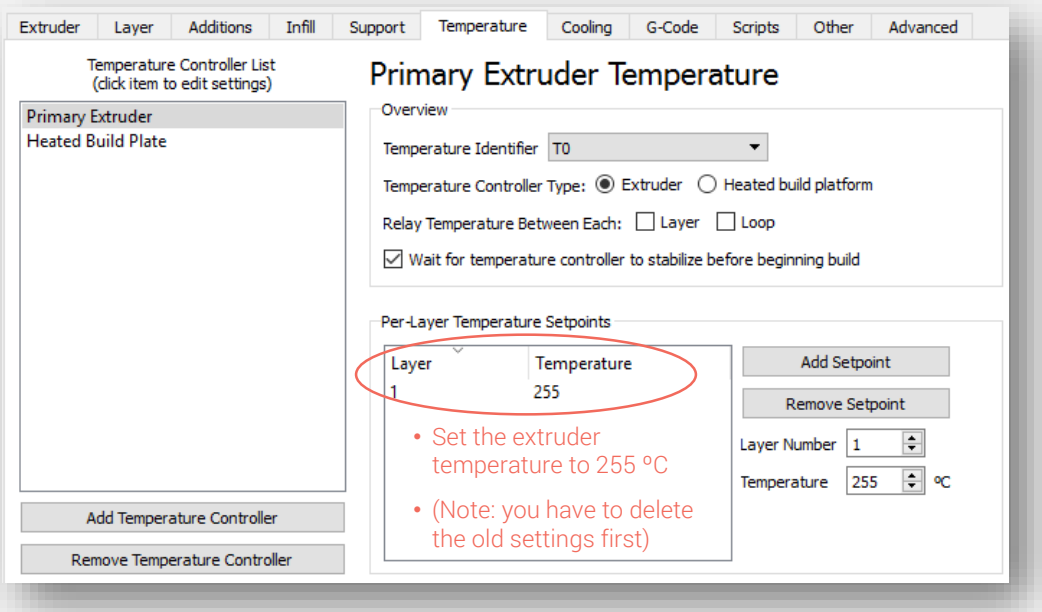
- **Always** print with a raft
  A raft ensures both good adhesion and easy removal from the build plate
- Separation distance between the raft and the part: 0.2 - 0.3 mm
  This relatively large value is to ensure easy removal of the raft after printing

Printing speeds

- Various depending on printers; in general 30 - 90 mm/s
  (In most circumstances the default speed settings of your printer should be good for Polymaker PC)

Slicer Settings Example: Simplify 3D

☐ Temperature Settings



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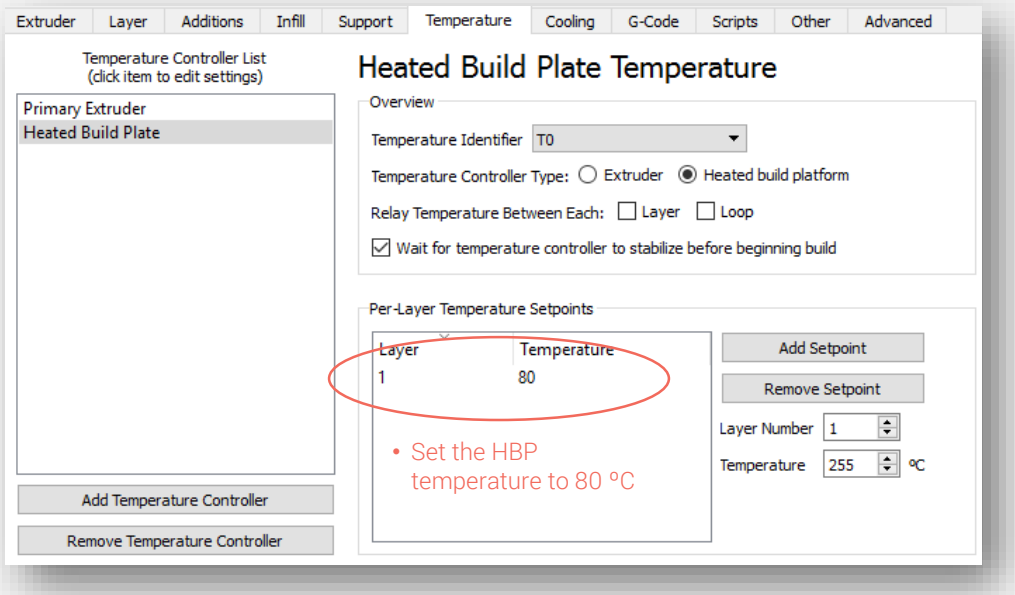
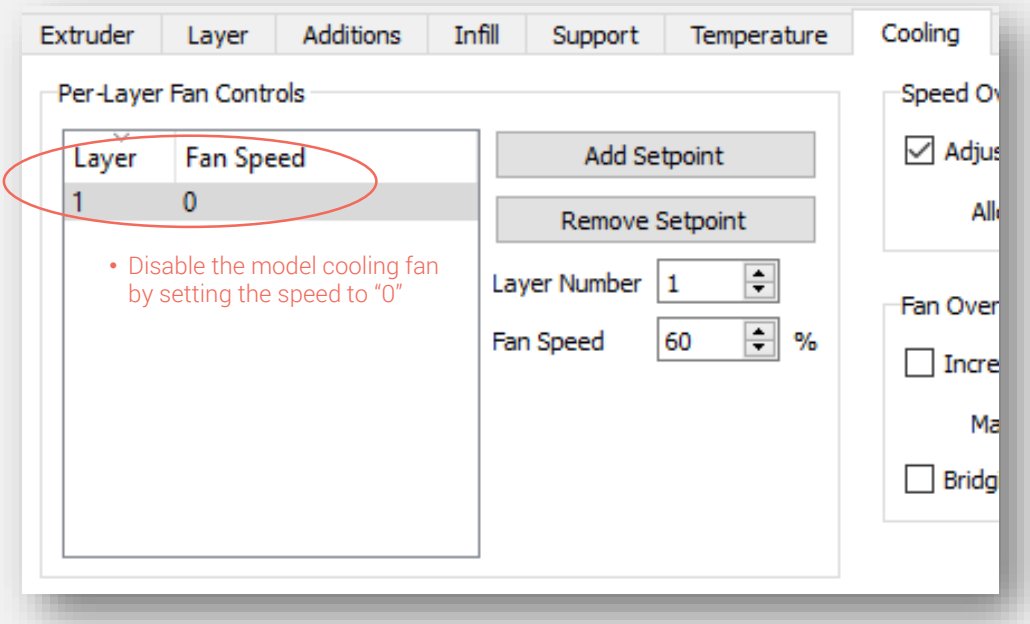
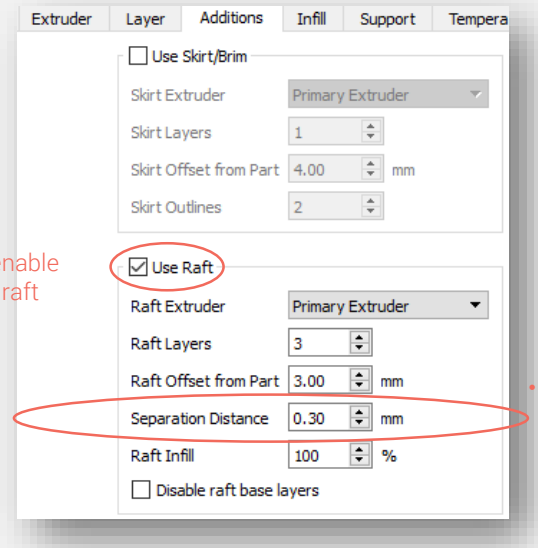
Printing with Polymaker PC



Cooling Settings



Raft Settings



• Check to enable the use of raft

* Only key settings are shown here; you can adjust other settings (e.g. speeds, Infill, shells, etc.) based on your needs

• Important: set the separation distance to between 0.2 - 0.3 mm for easy removal of the raft after printing

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Annealing of Polymaker PC

Why Annealing

- During 3D printing, the material is rapidly heated, extruded and cooled. This process can often times generate internal stress in 3D printed parts, resulting in compromised mechanical, and possibly other properties. Such an effect is more pronounced for polymers with high glass transition temperatures (T_g's) such as Polymaker PC-Plus™ and PC-Max™.
- Annealing is a commonly used technique to reduce or eliminate the internal stress of polymers. It typically involves holding the material at an elevated temperature close to, but lower than its T_g, during which the polymer chains undergo a process known as "relaxation" to substantially relieve the internal stress. In fact, annealing is widely used in conventional processing methods of polycarbonate, such as extrusion, injection molding and machining. Annealing can also be applied for 3D printing. Our study has shown that annealing parts printed with Polymaker PC (both PC-Plus™ and PC-Max™) can lead to improved mechanical properties and reduced tendency to crack or delaminate.

How to Anneal Parts Printed with Polymaker PC

- Annealing is quite simple to perform. What one needs is a convection oven that can heat to 100 °C or higher. Below is a recommended annealing procedure:

① Pre-heat the convection oven to 90 - 105 °C

② Place the part(s) in the oven and leave them for 1 hour

③ (Recommended but not critical) Slowly cool (with a cooling rate between 10 - 30 C/h) the parts down to ambient temperature.

- Tips

① Try to shorten as much as possible the time between 3D printing and annealing; mechanical properties may deteriorate over time if parts are left unannealed.

② Maintain the temperature below the T_g (112 - 113 °C) of Polymaker PC; Part deformation may occur if temperature surpasses the T_g.

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FAQs

- My printed parts appear stringy, any suggestions?
- That means either the retraction settings are insufficient, or your printing temperature is too high. First check your retraction settings, and if needed, reduce your printing temperature.
  The "fine positive features" model by Andreas Bastian is a good testing model for retraction settings:
  http://www.thingiverse.com/thing:533472

- I found it difficult to remove the part from the build plate, what shall I do?
- As we mentioned earlier, you should always print a raft with Polymaker PC. If the part is difficult to remove even with a raft, try increasing the initial nozzle-plate distance.

- Why is the removal of the raft from the printed part so difficult?
- You need to correctly set the distance between the raft and the model (~ 0.3 mm recommended). Under the correct settings the raft should peel off easily. If you still experience difficulty with removing the raft, try increasing the distance (e.g. by 0.05 mm increment) until the result is satisfactory. However the distance cannot be overly large as adequate adhesion between the part and the raft is still needed to prevent part warping.

- I printed a tall part and found the interlayer adhesion in certain areas to be rather poor, what shall I do?
- For tall parts (> 10 cm), as there is less heat compensation from the HBP for taller sections, it is recommended that the printing temperature be slightly raised (e.g. 260-270 °C) to ensure better interlayer adhesion. Or if the slicer allows, you can increase your printing temperature with increasing heights.
  Having an enclosed printing chamber can greatly minimize this issue, and therefore is essential for getting consistent results particularly for large, tall parts.

More questions or comments?

Please email ts@polymaker.com

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Model shown in the background:
Design by loubie
http://www.thingiverse.com/thing:238806

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