# Maintenance for FFF
## Fused Filament Fabrication
## 3D Printers (Prusa MK4)

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# Overview

- Safety Concerns *(Video: 0:34-1:54)*
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- Parts of the Printer *(Video: 4:03-7:50)*
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- Loading and Unloading Filament *(Video: 10:19-12:51)*
- Common troubleshooting *(Video: 12:52-17:22)*
  Prusa MK4 Handbook- https://help.prusa3d.com/downloads/mk4/handbook

# Safety Concerns with Fused Filament Fabrication (FFF) Printers

- Burning
  - Heated nozzle and/or build plate
  - Hot material while printing
- Typically not food safe
  - Not only does the material need to be food safe, but the nozzle also has to be food safe
- Fumes from heated plastic
  - Printing should take place in a well ventilated area and/or with a filtration system
  - Article from CDC- https://www.cdc.gov/niosh/newsroom/feature/2022print3D.html
- Pinch points
  - Motors move the extruder and build plate so hands and other objects should not be in the printer workspace while it is operating

# Tools for FFF printers

- Heat Gloves
  - Wear if chance of coming in contact with heated nozzle/build plate
- Snips
  - For cutting filament for loading
- Hex Keys
  - For simple maintenance of the printer
- Pliers/Tweezers/Carving knife kit
  - For removing support material and using acupuncture needle
- Spatula/Scraper
  - For removing excess material from build plate
- Brass Brush
  - Removing debris and excess filament from components
- Acupuncture Needle
  - Breaking up clogs in the nozzle
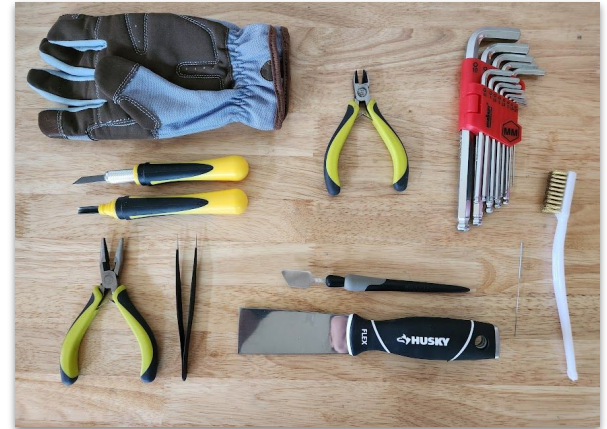
# Maintenance Materials for Prusa FFF Printers

- Paper Towels
  - For wiping print sheet
- Rubbing Alcohol (IPA 90%+)
  - For cleaning print sheet
- Windex or Glue Stick
  - Release agent for printing with PETG
- Spools of filament
  - To verify material is loading properly
- Compressed Air
  - Blowing dust and filament debris out of extruder and fans
- Grease
  - Lubricating components every ~200 hours of printing



Note: Other FFF printers may use a different print bed surface and require different prep procedure for cleaning

Image from Prusa MK4 Manual

# Introduction to Prusa MK4 3D Printer

In this guide, we will focus on the Prusa MK4 3D Printer.

Prusa has several models of 3D printers.

The MK4 is a Fused Filament Fabrication (FFF) 3D Printer.

FFF 3D Printers are common hobby class printers that heat up solid filament of material and extrudes the material to build the part.

Other FFF printers will have similar components, but may look a little different and have slight differences in their processes.

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Image from prusa3d.com

# Parts of a Prusa MK4 3D Printer

1. Filament
2. Frame
3. Z- axis
4. Extruder
5. X-axis stepper motor
6. Electronics box
7. Z-axis stepper motor
8. LCD screen
9. Spool (filament) holder
10. X-axis
11. Power supply unit (PSU)
12. Print sheet (Print bed, Build plate)
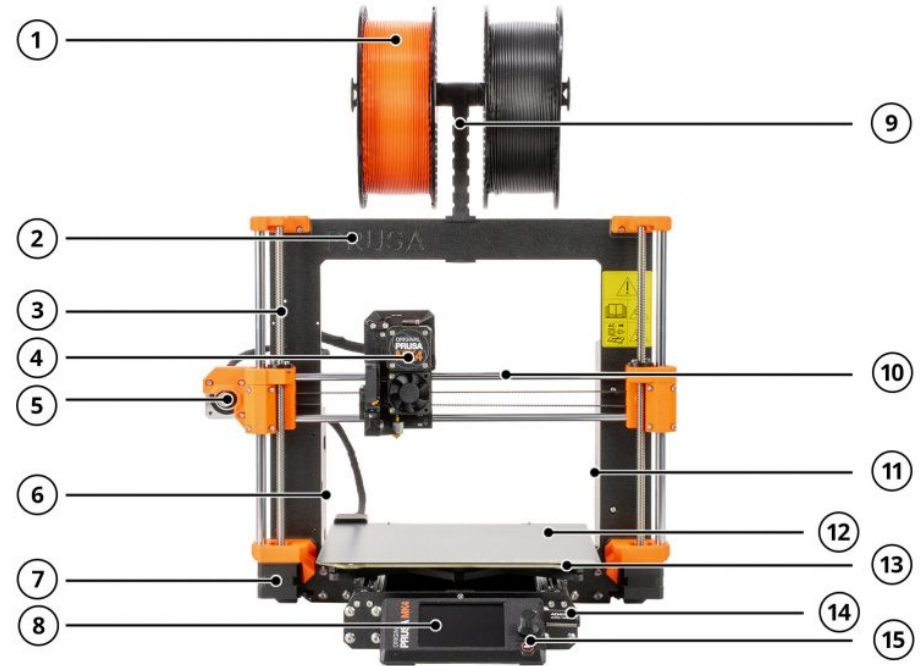13. Heatbed
14. USB port
15. Control knob



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# Parts of a Prusa MK4 Extruder (Nextruder)

1. Filament insertion point
2. Idler lock
3. Idler (maintains pressure on the filament)
4. Gearbox and Extruder motor
5. Print fan
6. Thumb screws
7. Fan shroud (directs air towards printed object)
8. Electronics cover
9. Idler screws (adjust pressure on the filament)
10. Heatsink fan
11. Heater block
12. Nozzle



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Image from Prusa MK4 Manual
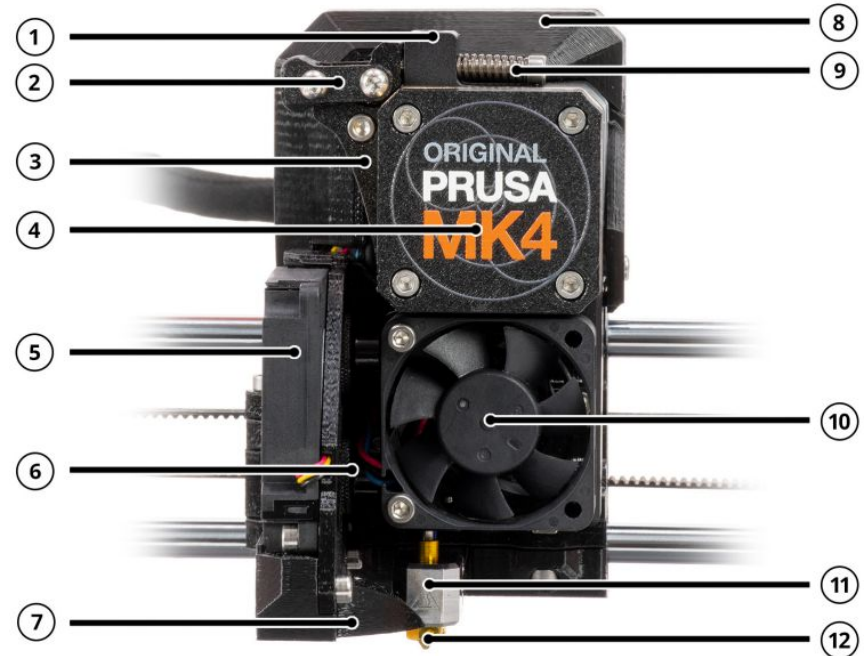
# Preparing Printer for Printing

1. Check filament
   a. Material type loaded (PLA, PETG, etc.)
   b. Amount of material
2. Print bed is clear or debris or damage
   a. Excess material from previous print removed
   b. Check for damage to print bed
3. Cleaning print sheet
   a. Every few prints, wipe print sheet to remove dust/skin oils
      i. Smooth* sheet with PLA- IPA 90%+
   b. If printing PETG on the smooth sheet, wipe print sheet with windex or apply glue stick so part will release.

\* Prusa has smooth and textured print sheet options



A Prusa MK3S was used in the video

# Loading (Inserting) Filament
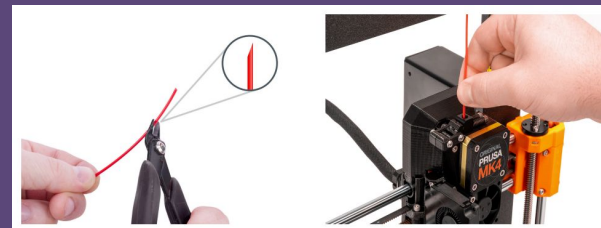


1. Make sure the filament on the spool isn't tangled
   a. Spools often have holes around the edge for you to secure the end of the filament when it isn't loaded
2. Cut the end of the filament
   a. Make sure there are no kinks or bends in the filament as they may cause the filament to jam in the extruder
   b. It is recommended to cut the filament at an angle to make it easier to load
3. Insert the filament into the top of the extruder
   a. If the Prusa Filament sensor is on, this will trigger the preheat menu
   b. If the Prusa Filament sensor is off, select the LCD Menu - Filament - Load Filament and confirm with the rotary button.
4. Preheat menu will appear, select the material type you are loading
5. Once the nozzle reaches the desired temperature, press the rotary knob to start feeding the filament
   a. You may have to push the filament into the extruder lightly until the extruder gear grabs it
6. After material extrudes, the screen ask if the color is okay for you to select Yes/Purge More/Retry
7. Check if filament extruded from the nozzle
   a. If filament extruded and the correct color, select Yes
   b. If filament is not extruded or contaminated with another color, select Purge More
   c. If filament is not extruded and Purge More doesn't help, repeat the loading procedure by choosing Retry
   *Video from Prusa on Autoloading filament on the MK4-* *https://www.youtube.com/watch?v=Bk_5aOqzMcg*

Image from Prusa MK4 Manual

# Unloading (Removing) Filament

1. Select LCD Menu - Filament - Unload Filament
2. The printer will preheat automatically. Once it reaches temperature, the filament will be unloaded from the extruder
3. Once the extruder stops unloading the filament, remove it from the extruder by hand
4. Carefully wind the filament back on the spool being careful it does not tangle and secure it.
   a. If there is a tangle, the filament will get stuck and unable to be pulled through the extruder resulting in the print failing and potentially causing a clog in the extruder
   b. Spools often have holes around the edge for you to secure the end of the filament when it isn't loaded to help prevent tangles



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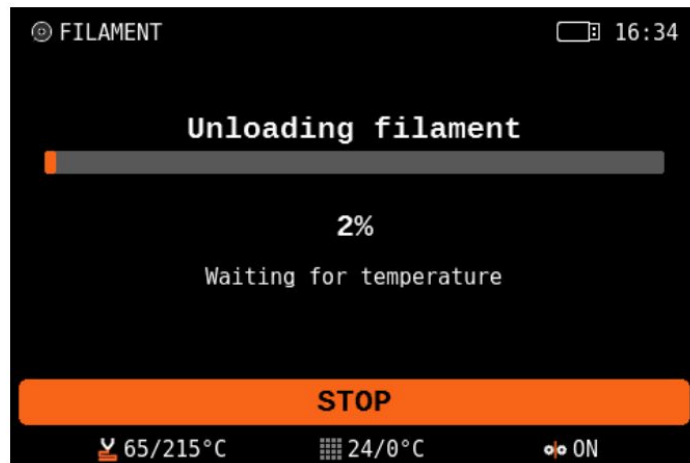
# Troubleshooting– Print isn't sticking

The print sheet may be have oils preventing part from sticking

1. Verify print sheet is clean of skin oils
   a. Use a clean paper towel and IPA 90%+ to clean skin oils off of the print sheet
   b. Re-apply windex or glue stick if using PETG

The nozzle height calibration may be off

2. Check the first layer calibration
   a. Go through the Prusa steps for adjusting the nozzle height for the first layer
   https://help.prusa3d.com/article/first-layer-calibration-i3_112364

Part might not have enough surface area

3. Check if the part is small and simply doesn't have enough surface area on the print sheet
   a. Add a brim or raft in the print settings if only using a skirt
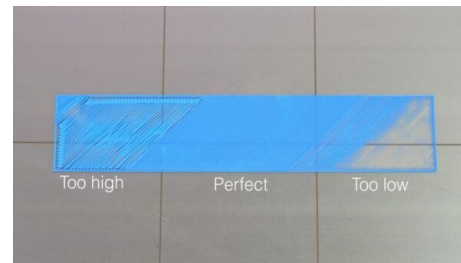


Example of first layer print if nozzle is too high (too far from the print sheet), perfect, or too low (too close to the print sheet).

Image from prusa3d.com

# Troubleshooting– Mesh Bed Leveling Fails

The Prusa MK4 automatically checks that the print bed is level before the print starts by verifying the height of the print sheet at various points. The printer will alert you if the level check fails.

The print sheet may not be correctly placed on the heatbed.

1. Verify the print sheet is sitting level on the heatbed
    a. If sitting on one or both of the screws at the back of the heatbed, lift the sheet up and place it back down on the heatbed butted up against the screws. (The screws are there for alignment)
    b. Make sure there is no debris or object between the print sheet and heatbed making it not sit level.

The Z-axis threaded rods may be out of alignment with each other

2. Use the menu to perform calibration check
    a. Run the Auto Home and Z-axis calibration from the LCD control menu.
    b. Make sure the Z-axis moves all the way up and hits the end stops. You will hear a couple clicks from the motors. This verifies that the horizontal axis is level on the Z-axis threaded rods.

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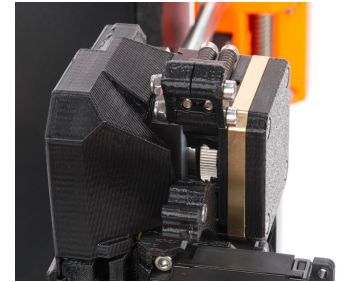
# Troubleshooting– Filament isn't extruding properly

A tangle could be preventing the extruder from feeding in the filament

1. Check that the spool of filament isn't knotted or tangled
   a. Unload the filament
   b. Untangle then unwind the spool 5-10 feet. If it still looks tangled, continue to unwind. Once it doesn't look tangled, wind the filament back on the spool.
   c. Load the filament
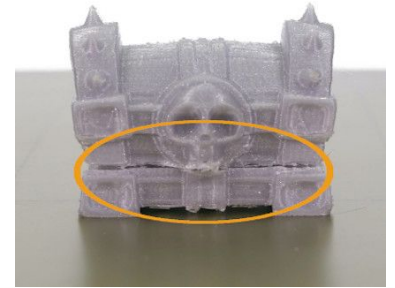
Debris can be caught in the idler gears preventing it from feeding in the filament

2. Clean debris from the idler gear
   a. Unload the filament
   b. Lift the Idler Nut and then move the Idle Shaft
   c. Blow away debris using compressed air or brass brush using the access hole on the side of the extruder





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# Troubleshooting– Filament isn't extruding properly (cont'd)

Excess material in the nozzle could be causing a clog

1. Use an acupuncture needle to break up the clog in the nozzle
    a. Heat the nozzle to temperature for the filament material you will be using
    b. Try to load the filament then insert an acupuncture needle into the nozzle approximately 1-2 cm
       **Use protective gloves as the nozzle and material that may come out will be hot and can cause burns**
        i. Use pliers to hold the acupuncture needle to help keep your hands away from the nozzle
    c. Remove the needle and select Load Filament from the LCD menu to see if filament can extrude now
    d. If needed, repeat the process a few times until filament is extruded correctly

If needle doesn't clear the clog, try a cold pull to clean the nozzle and hotend

2. Perform a cold pull to clean the nozzle and hotend (only if nozzle is partially clogged)
    a. Follow the instructions for a cold pull found
       https://help.prusa3d.com/article/cold-pull-mk3-9-mk4-13702_445071

Cold pull removing build up (top) and cold pull coming out clean (bottom)

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