MULTI MATERIAL HANDBOOK

USER MANUAL FOR 3D PRINTERS:
- ORIGINAL PRUSA I3 MK2/MK2S WITH MULTIMATERIAL UPGRADE

V1.00

QUICK GUIDE TO THE FIRST PRINT

1. Carefully follow upgrade steps (page 13)

2. Read about different filaments and print quality (page 11)

3. Learn how to load/unload filament - **it's different from MK2/S** (page 12)

4. Stopping the print is critical operation - read about it (page 17)

5. Learn about smart wipe tower (page 19)

About the author

Josef Prusa (born Feb 23rd, 1990) became interested in the 3D printing phenomenon before joining the Prague's University of Economics in 2009 - at first it was a hobby, a new technology open to changes and improvements. The hobby soon became a passion and Josef grew into one of the leading developers of Adrien Bowyer's international, open source, RepRap project. Today, you can see the Prusa design in different versions all around the world, it is one of the most popular printers and thanks to it, knowledge about the 3D printing technology significantly increased among public.

Jo's work on self-replicating printers (you can print the other printer parts with your printer) are still ongoing and currently there is Prusa i3 - the third iteration of the original 3D printer. It is constantly updated with the latest innovations and you've just purchased its latest version. In addition to printer hardware upgrades, the main goal is to make the technology more accessible and understandable for all users.

Josef Prusa also organizes workshops for the public, participates in professional conferences dedicated to the popularization of 3D printing. For example, he lectured at the TEDx conference in Prague and Vienna, at World Maker Faire in New York, Maker Faire in Rome or at the Open Hardware Summit hosted by MIT. Josef also teaches Arduino at Charles University and was also a lecturer at the Academy of Arts in Prague.

In his own words, he imagines 3D printers will be available in every home in a not too distant future. If anything is needed, you can simply print it. In this field, you just push the boundaries every day... We're glad you're part of it with us!

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 Important notice, tip, hint or information that helps you print with ease.

 Read carefully! This part of text has uppermost importance - either for user safety of for a proper printer service.

 This symbol indicates text related to printer kit only.

2 Product details

Title: Multi Material Upgrade for Original Prusa i3 MK2/S
Manufacturer: Prusa Research s.r.o., Partyzánská 188/7a, Prague, 170 00, Czech Republic
Contacts: phone +420 222 263 718, e-mail: info@prusa3d.com
EEE group: 3 (IT and/or telecommunication equipment), Device use: indoor only
Power supply: 90-135 VAC, 2 A / 180-264 VAC, 1 A (50-60 Hz)
Working temperature range: 18 °C (PLA)-38 °C, indoor use only
Working humidity: 85 % or less

3 Multi Material Upgrade introduction

Multi Material Upgrade (MMU) is an addition to the Original Prusa i3 MK2/MK2S 3D printer which enables printing with up to 4 different materials in one single print.

3.1 How it functions

Instead of traditional use of multiple independent extruders which is considered industry standard, MMU uses only one hotend with 4 extruder motors and Y splitter. When the material use is finished during the layer, it is pulled out of the hotend and next one is inserted back in.

This removes any need to calibrate the position of the nozzle tips and eliminates oozing from unused extruder or artifacts as only one nozzle is present. It is the first commercial solution like this.

4 Software

Install the driver package version 1.9.0 or the latest from http://www.prusa3d.com/drivers/ and during installation, select **Original Prusa i3 MK2 Multi Material** as one of the installed printers. Two additional programs will be installed compared to the standard MK2/S installation.
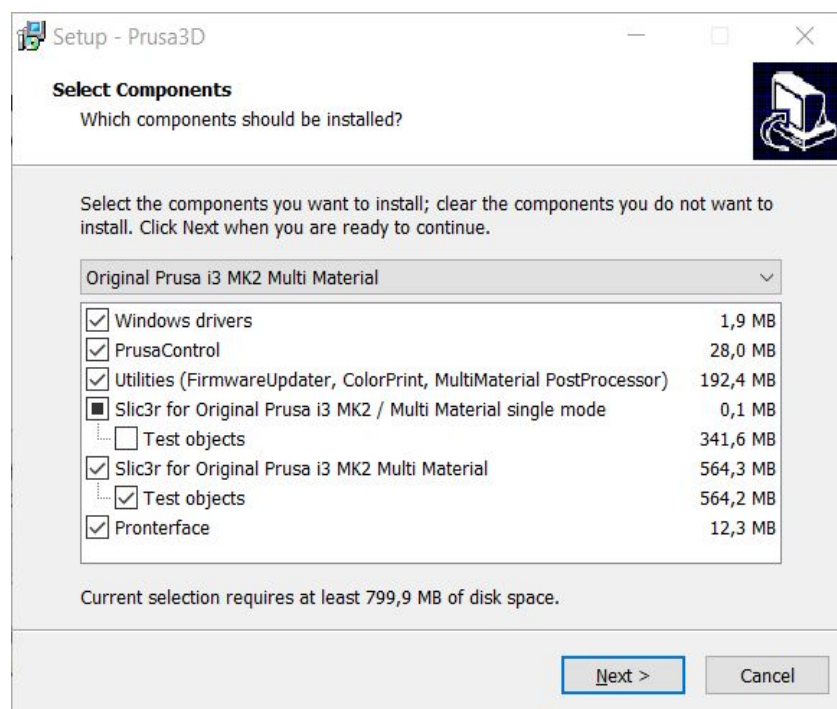
4.1 PrusaControl

PrusaControl is the easiest way how to dive into Multi Material printing with MK2. Open settings and choose "Original Prusa i3 MK2 MM" as your printer. Menu on the right will extend to accommodate more extruders.

Wipe tower is also shown, you can see and adjust the position of it (more info about how Smart Wipe Tower works can be found in 9.1 Smart Wipe Tower size and additional print time).
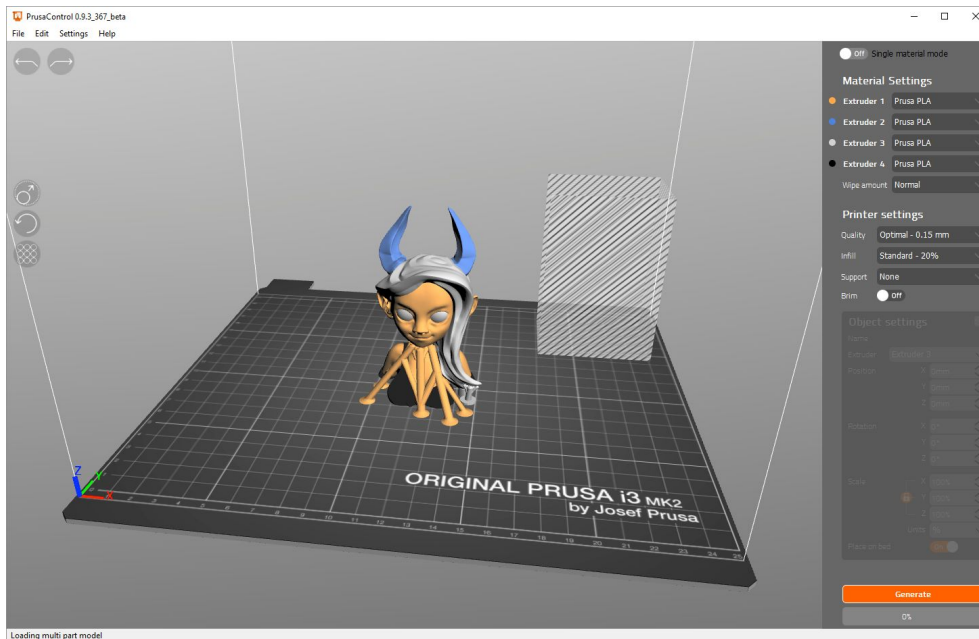
4.1.1 Slicing profiles

Print profiles for 150 um, 200 um and 300 um are preconfigured in the PrusaControl. Lower layer heights are not available yet, only when using single mode discussed in chapter **8 Printing in Single mode with one extruder**. **Single material mode** can be easily enabled by toggling a switch at the top of the right menu.

Additional print settings and materials can be used on the **Multi Material in single extruder mode.** The printer is as capable as regular MK2/MK2S in this mode so it can print flexible materials etc. without problems.

4.1.2 Basics

Materials
Assign materials to used extruders. By clicking on the color dot you can set filament color and see it on the final model. When one extruder contains soluble material, soluble supports options appear in support menu. All assigned extruders are displayed in bold.

Wipe amount
Sets the amount of wiping done on filament change. Increase the amount if your colors bleed into each other.

Printer settings
Select the print quality and infill you want to use. Soluble supports are enabled when one extruder contains soluble material.

Object settings
You can assign extruders/filaments to the object parts. Either click on the part and select extruder. Or select the part by name if the part is hard to select by mouse.

Single material mode

Single material mode can be enabled by switch at the top of the right menu.

4.2 Prusa3D Slic3r Multi Material

Slic3r enables more advanced control over the generated G-code. When you open the Prusa3D Slic3r Multi Material you can immediately see few differences. First you can see and adjust the position of Smart Wipe Tower (more info about how Smart Wipe Tower works can be found in 9.1 Smart Wipe Tower size and additional print time) marked as **1** on the picture and you can see 4 material select boxes marked as **2.**
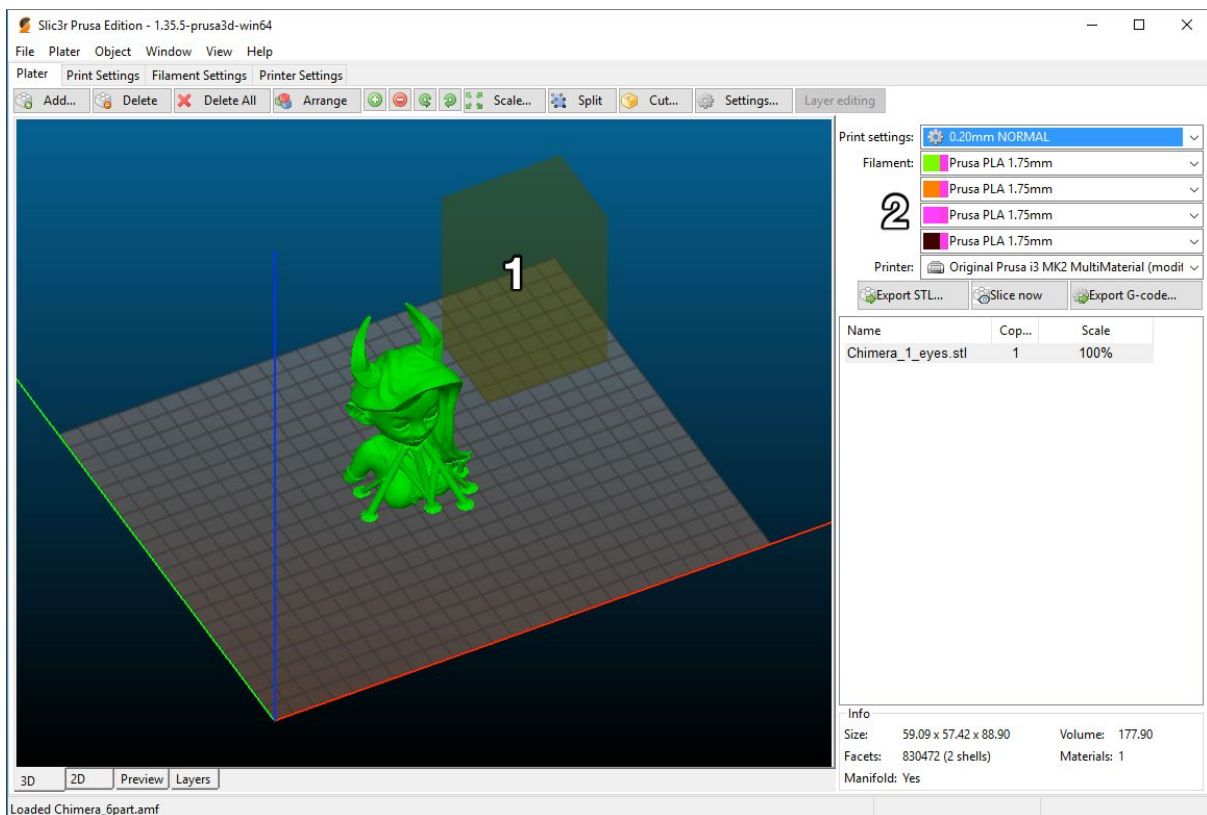
Material selectors have colored boxed on the left, by clicking on them you can assign color to each extruder and preview the model in final colors when the model is sliced in **Preview** tab.
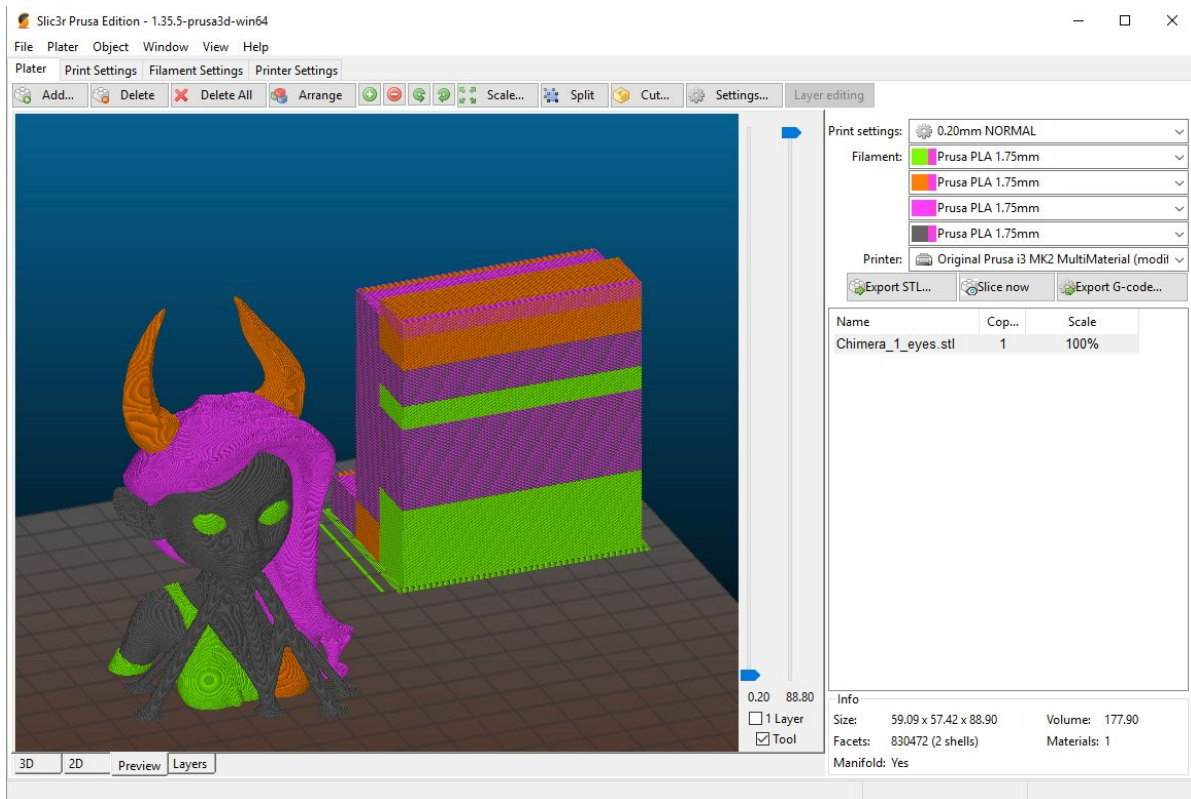
4.2.1 Slicing profiles

Print profiles for 150 um, 200 um and 350 um are preconfigured in the Slic3r PE for Multi Material. Lower layer heights are not available yet, only when using single mode discussed in chapter **8 Printing in Single mode with one extruder**.

Additional print settings and materials can be used on the **Multi Material in single extruder mode.** Just install normal MK2 from Drivers package (when selection Original Prusa i3 MK2 Multi Material, everything is automatically pre selected) and select Multi Material Single Mode from printer options. This will allow you to use Variable Layer Height and 100 um and lower layer heights. The printer is as capable as regular MK2/MK2S in this mode so it can print flexible materials etc without problems.

4.3 Multi Material post processor

Multi Material post processor is an application installed with Drivers package to generate Smart Wipe Tower and filament switching into the g-code file for the MMU equipped printer. G-code generated with Multi Material Slic3r and PrusaControl already has those since drivers release v1.7.8 so post processor is not needed, however **when using ColorPrint, G-code needs to be processed**. Post Processor will also be needed in the future to process G-codes from other slicing engines like Simplify3D. Official support for 3rd party slicers hasn't been released yet. More information about ColorPrint can be found in 8.3 Using web Color Print app.
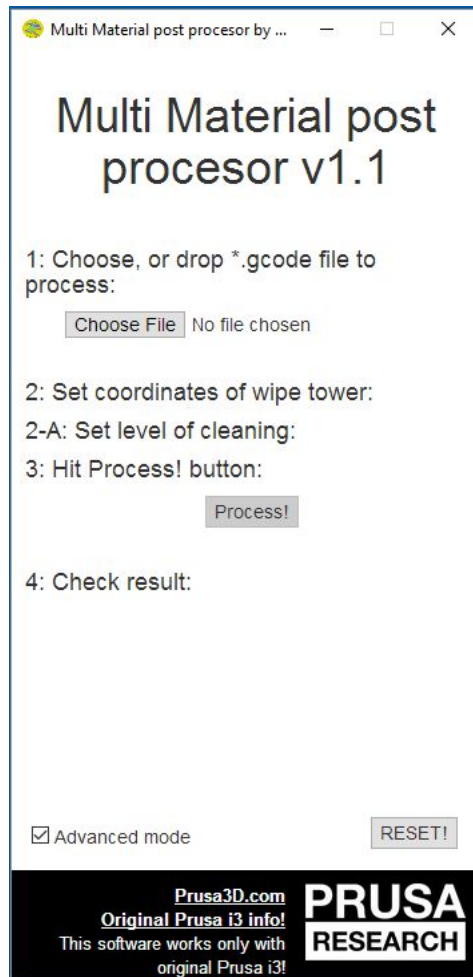
5 Supported materials

Currently only PLA, ABS and PVA/BVOH (Primaselect PVA or Verbatim BVOH works reliably) are supported in the Multi Material mode. Normal range of filaments can be used in single mode discussed at chapter 8 Printing in Single mode with one extruder. We're testing and preparing settings for more. Combinations of different temperature materials are possible, hotend can change temperature during the printing of Smart Wipe Tower.

Filaments which tend to be extremely stringy can however increase the chance of clogging the Y splitter and require cleaning.

5.1 Filaments and print quality

Some filaments are harder to print with than others. If you are having troubles, try a different brand or color. From our experience chalky feeling filaments with mineral filler are not as aesthetically pleasing. Same applies on MK2 but the effect is multiplied with multi material upgrade. Smooth and shiny looking filaments will produce the best results. See chapter 11 List of tested filament.

For some filaments or color combinations (such as black color together with white color) additional wipe area might be needed. In **Slic3r** that can be set up in Multiple Extruders menu under the Print Settings tab. Default value works with most materials and color combinations. In **PrusaControl** under the **Wipe amount** option.

Presets are:
- **Decreased** 60 mm / 7.5 mm
- **Normal** 60 mm / 15 mm
- **Increased/Soluble** 60 mm / 20 mm
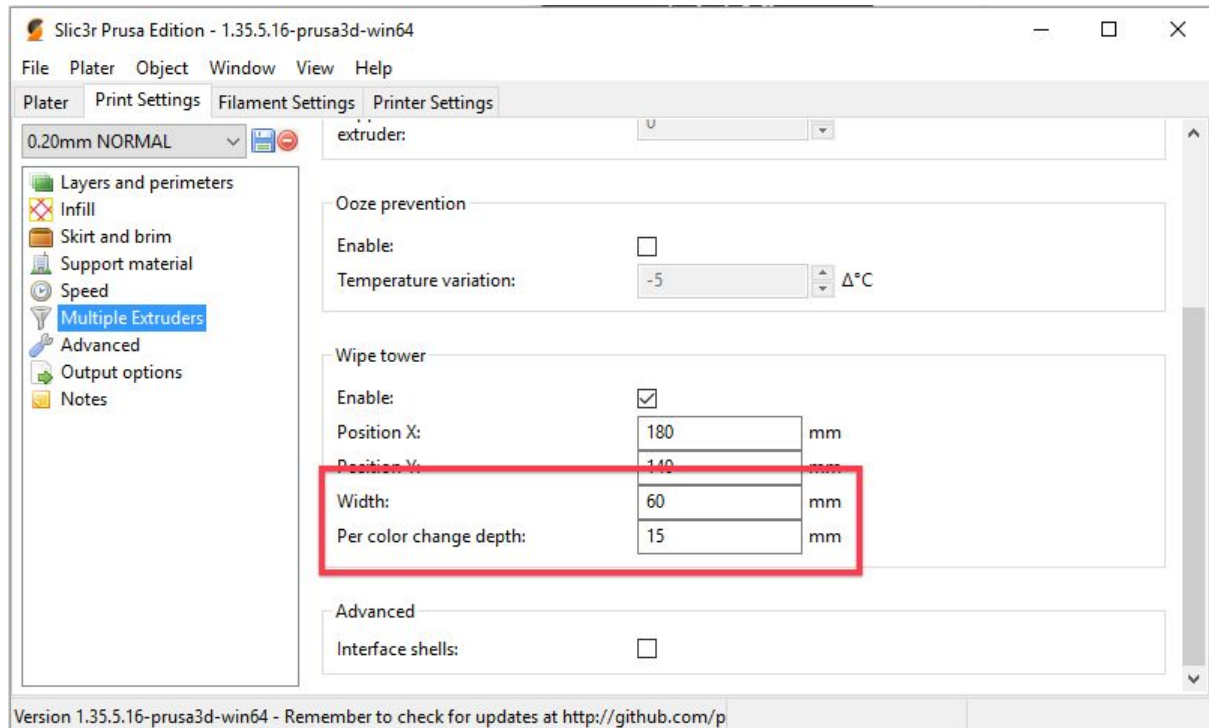
A better quality filament will yield much better results than a low cost filament from ebay. Good and well working brands are Prusa, ColorFabb, Fillamentum …

5.2 Loading/Unloading the filament

⚠️ **Always check the filament before the print for potential damage**, cut off all of the damaged part to be sure that filament can pass extruder pulleys and cooling tubes properly. **Pay special attention to this after every aborted print**.

FILAMENT TIP
front view
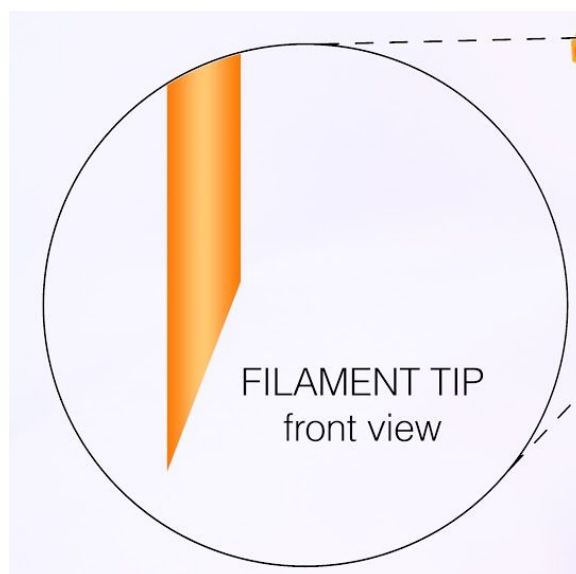
Loading filament now has slightly changed behaviour compared to regular MK2 and always load/unload it from menu.

When opening the Load or Unload menu, you have an option to Load/Unload all 4 automatically or each extruder separately.

First phase of automatic loading is slow feed (In this phase you just push the filament to the entry hole of the extruder and as soon as you feel that the extruder grabs it, press the knob).

Second phase is fast feed (This phase just loads the filament to the cooling tube and prepare it for the operation).

ⓘ **Printer tests all used extruders prior to the print** on the first layer at the front of the print bed to **verify proper filament insertion** (for G-codes generated from Slic3r/PrusaControl from Drivers 1.9 package). After all the filaments are primed, the printer beeps and waits for 10 seconds for the user to verify that all the filaments are primed properly. If the priming regions interfere with the print, the printer is paused indefinitely for the user to remove the priming material before the print starts.

6 Upgrade and first print

1. Assemble the upgrade according to http://manual.prusa3d.com/c/Original_Prusa_i3_MK2_to_Multi_Material_upgrade
2. **Upgrade firmware to 3.0.12** or the newer from www.prusa3d.com/drivers. Use the **Multi Material versio**n placed in folder "MK2-MultiMaterial".
3. Run **Calibrate XYZ** before continuing. It is not mandatory but can save some troubleshooting later. (Described in *3D Printing Handbook - chapter 6.3.5 Calibrate XYZ*)
4. Install **1.9.0 drivers** or newer with Prusa3D Slic3r MK2 Multi Material and Multi Material postprocessor from www.prusa3d.com/drivers
5. **Delete all files** from your printer SD card. They are no longer compatible.
6. Copy all sample G-codes from our driver package **Objects/MK2MM** folder to the SD card. You can check out the models at www.prusa3d.com/printable-3d-models/.
7. **Load filament**. See the section 5.2 Loading/Unloading the filament
8. Run **V2MM Calibration** from SD card and run Live Adjust Z like on a regular MK2/S. Described in chapter *6.3.9 First layer calibration* in our *3D Printing Handbook*.
9. Print a sample G-code. Gear Bearing is a good start model.

7 Printing in Multi Material mode

7.1 Loading the model in PrusaControl

Select all parts of the multipart object and drag and drop them on the PrusaControl, it will be automatically recognized as multipart object. Click **Yes** to finish the import.
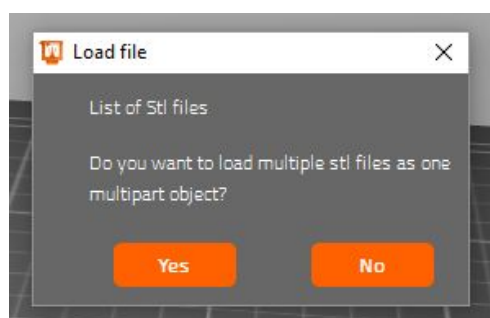
Select the parts of the object by clicking on them and assign **extruder** under **Object settings**. Hard to reach objects can be selected in the drop down menu by their **name**.
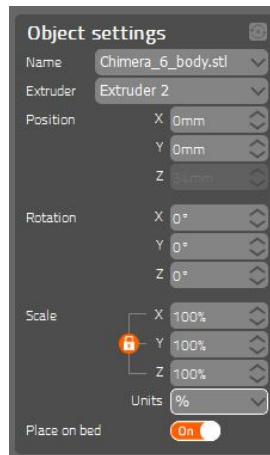
7.2 Loading the model in Slic3r Multi Material

Start by opening the main part of the model. In our example we use Chimera (it is copied to your hard drive during the Drivers installation) and **Chimera_6_body.stl.** Load the file as if printing with normal MK2 and double click the object afterwards. New dialog will open where you can load additional parts.
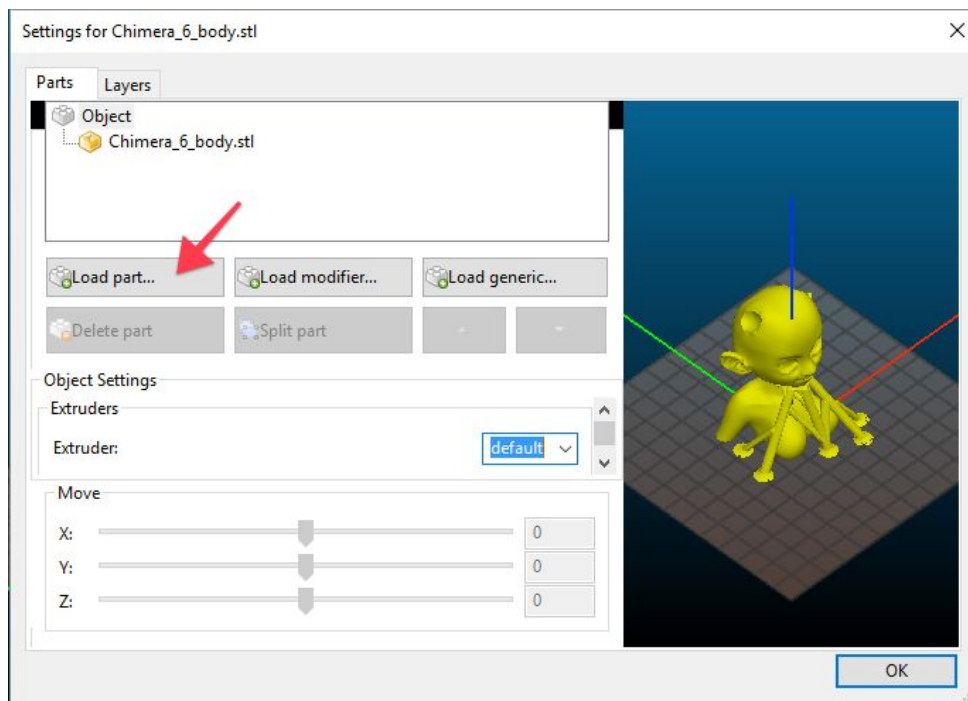
Click **Load parts...**, select all additional files and **Open**.
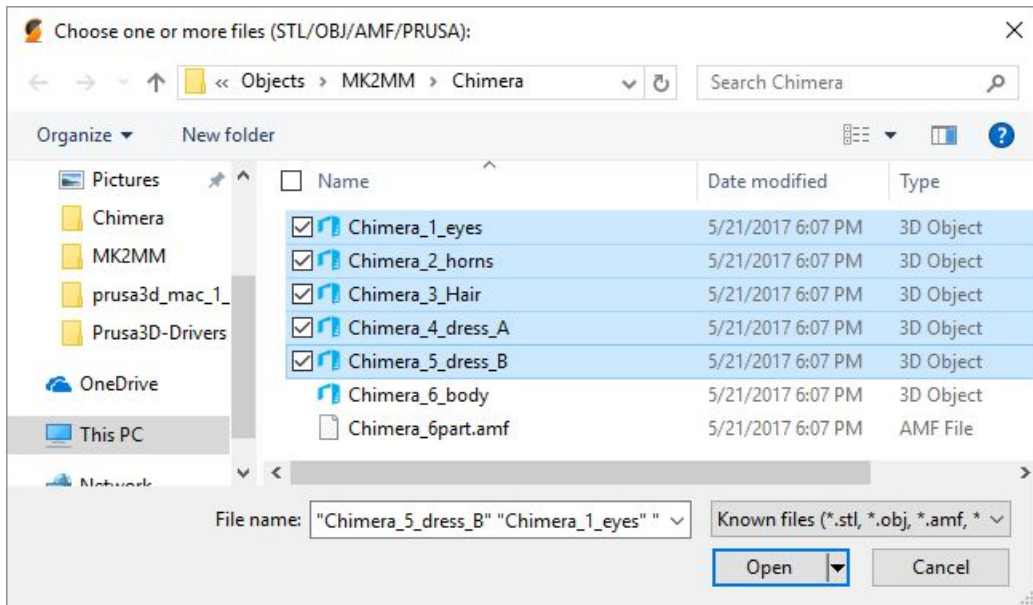
Now you can easily highlight every part and set the extruder with which it should be printed.
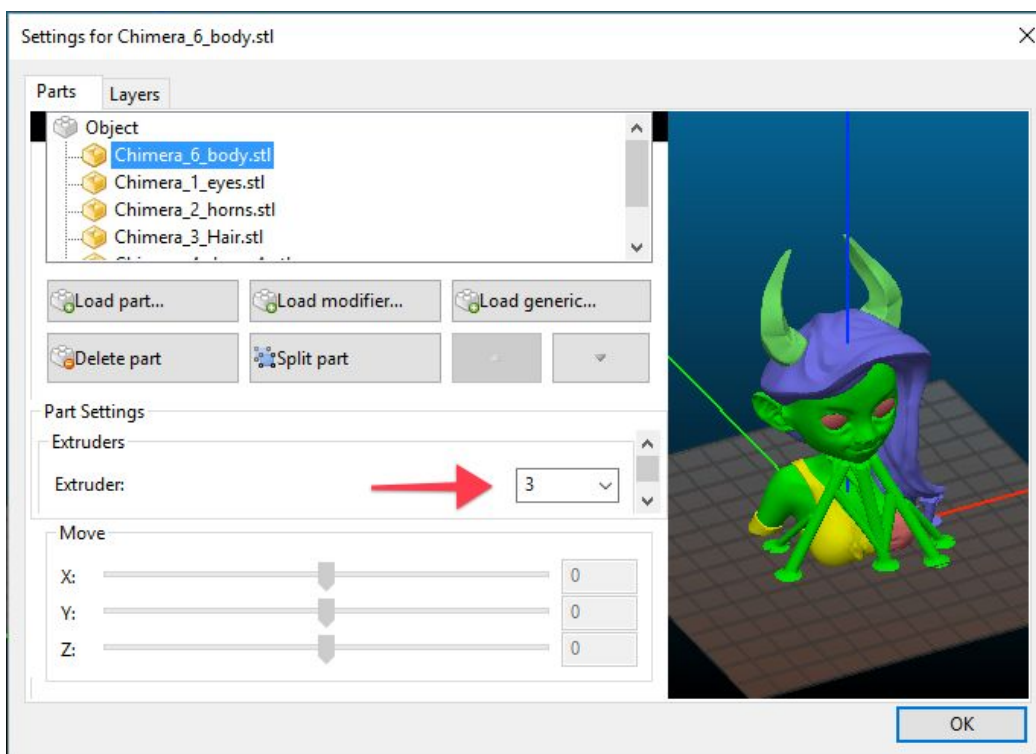
Easier to follow video guide how to prepare the g-code files is available at

http://www.prusa3d.com/MMUVIDEO

ⓘ Note: You can use the same system as used in PrusaControl with drag and dropping all the parts at the same time.

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7.2 Printing with soluble supports

We strongly suggest to use Verbatim BVOH support material. It is available on our eshop http://shop.prusa3d.com/en/special/161-verbatim-bvoh-soluble-support-05kg.html or as a second best option Prima Select PVA also available http://shop.prusa3d.com/en/special/169-primaselect-pva-soluble-support-500g.html. Unfortunately quality of different PVA brands vary greatly and we cannot guarantee anything from other soluble support brands :-/

(i) When cleaning soluble supports up, try to break away as much material as possibly while dry. Then continue peeling the material under running warm water. The last bits can be removed by letting the print soak in warm water. Water soluble supports **always** need to be stored in dry conditions.

7.2.1 Soluble supports in PrusaControl

Soluble material must be selected in one of the extruders first. Then two new options are available under the support menu:

1) **Everywhere, soluble** - soluble material is used everywhere
2) **Build plate only, soluble interface** - supports only starting from printbed from main material and with soluble interface
3) **Everywhere, soluble interface** - regular supports with soluble interface
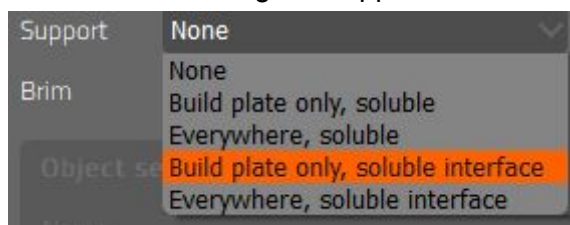
7.2.2 Soluble supports in Slic3r

Soluble support material always needs to be selected in the extruder number 4 (the rightmost one) and selected in **Prusa3D Slic3r MK2 Multi Material** as the fourth filament.

Special print setting with **"Soluble Supports"** appended to the name needs to be used. Apart from this change printing works as with regular multi material printer. Extruder 1 to 3 can be used as usual.

7.3 Stopping the print

⚠ Three options will be presented how to unload the filaments. For successful printing, **all filament ends must be nice and clean**, so printer will ask which

filaments to unload so you can check. Check out the chapter to see how the filament end should look.

```
Unload filament:
 All
 Used during print
>Current
```

1) **All** - All filaments will be unloaded to check the ends and user has to load all of them back.
2) **Used during print** - Only the filaments used in the print being stopped will be unloaded assuming the ones unused maintain perfect condition from the last loading
3) **Current** - The filament currently in use is unloaded. This should be used only when the print was running nicely and something else was problem, like a wrong color filament used.

8 Printing in Single mode with one extruder

Features like Smooth Variable Layer Height or finer print settings are not yet available in Multi Material mode yet. But they can be used in Single mode with just one extruder enabled. It makes the printer basically bowden version of MK2.

⚠ **WARNING: The G-codes generated for normal MK2/MK2S will either not work at all or produce very poor results. They need to be generated again.**

ⓘ Single material mode testing G-codes are present in the objects folder from the installation.

8.1 Single mode with PrusaControl

Enable Single material mode switch at the top of the right menu. New materials and print settings will load automatically.

On ◯ Single material mode
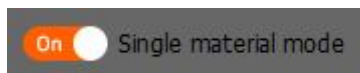
8.2 Single mode with Slic3r

Simply launch **Prusa3D Slic3r MK2** where additional printer config is available as **"MK2 MultiMaterial single mode"**.

When printing G-code generated like this, printer will ask you which extruder should be used to print the object.

8.3 Using web Color Print app

Slice the object as you are used to in **Multi Material Single mode.** Load the G-code into http://www.prusaprinters.org/color-print/ and select Multi Material.

You can add color changes as you are used to, but you will be able to select to which extruder printer will switch.

After downloading the .gcode, you need to use Multi Material Post Processor app to generate wipe tower as described in 4.3 Multi Material post processor

(i) Please note, all used colors need to be the same material.

9 Frequently asked questions

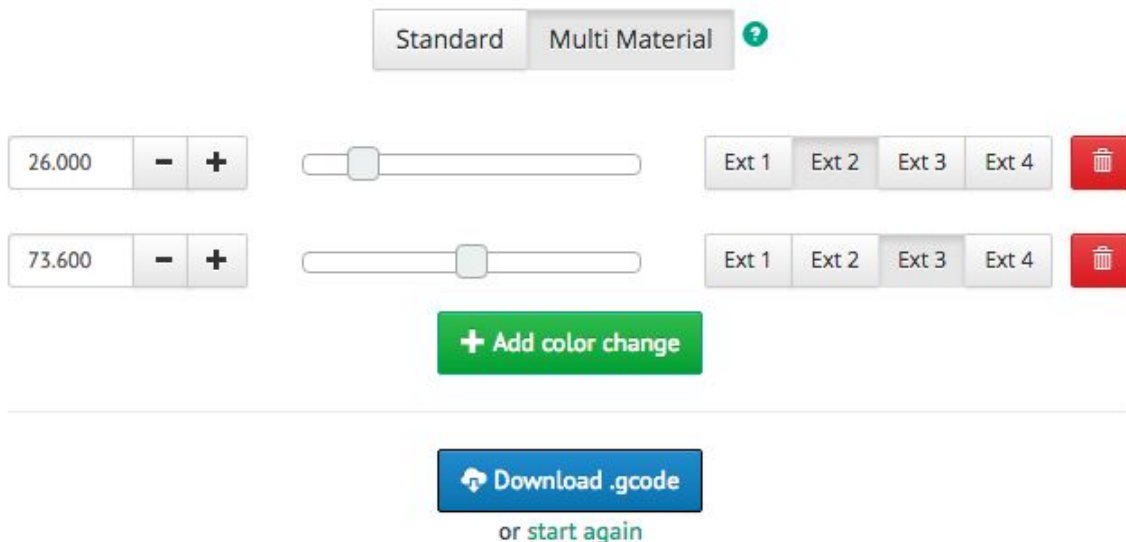## 9.1 Smart Wipe Tower size and additional print time

How big is the smart wipe tower?

Wipe tower is always 60 mm wide and contain between one and three by default 15 mm slots based on the model you are printing. If you only two materials are printed at one layer, one slot is used. Each additional material will add one slot and increase the size by another 15 mm. One slots takes approximately 1 minute per layer. The size of slots in the wipe tower can be changed, see chapter 5.1 Filaments and print quality.

In some prints, multiple materials during single layer are used later, but print starts with only one. In this case the smart wipe tower is still being printed with number of slots from the

most complex part of the model. However, before those slots are actually used, they are printed with sparse infill to save material. When slots are not needed anymore later in the print, the number is automatically reduced. This is the reason it is called "smart". The wipe ower is smaller than from all the competing technologies.

When filament change is not needed, smart wipe tower is hollow.
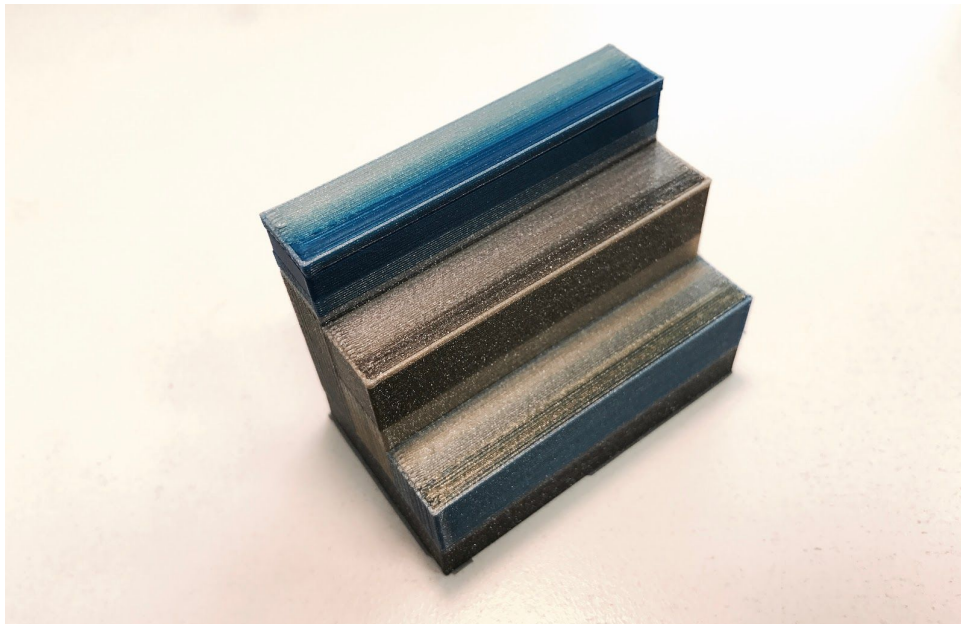
When number of filament changes needed decreases, tower will shrink.

Smart wipe tower prevents the need to use any sort of ooze shields as in traditional multi extruder systems! The size also remains constant, no matter how many copies of the objects you print or how big the object is.

We suggest to print more copies of the same object, if printing small parts as the Smart Wipe Tower will remain the same size.

Multiple objects with 4 materials wipe tower
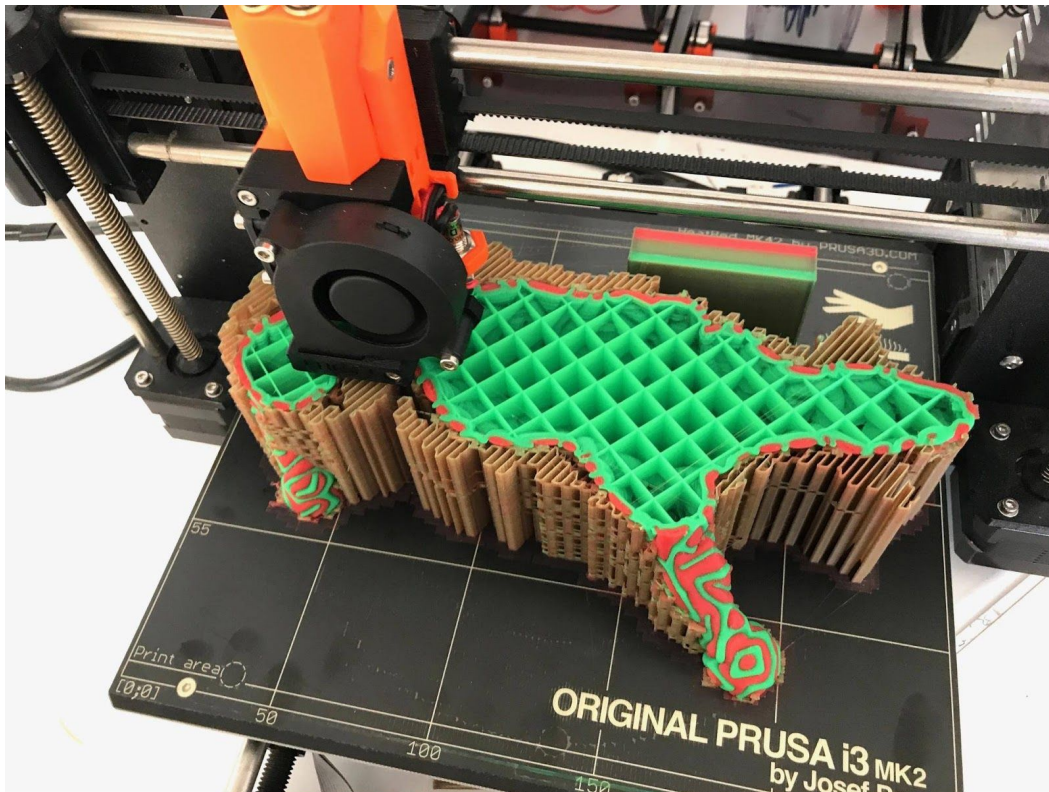
Large object with 3 materials wipe tower

10 Troubleshooting

In case of any problems, please first look here -
http://manual.prusa3d.com/c/Troubleshooting

10.1 Extruder jammed

The best way to diagnose a jammed extruder is to follow this checklist based on amazing work of our forum member **PJR**.

1. Check the filament diameter. It can't exceed 1.85mm, however, close the filament is to 1.75 mm the better it will work.
2. Check the spool is moving freely and the filament is **not tangled**.
3. **Ensure that the filament moves through the PTFE feeder tube with little resistance.**
4. Ensure that the drive pulleys are aligned perfectly with the filament path.
5. The grub screw on the motor pulley should be tight and held in place.
6. Check that the tensioner pulley moves freely and also make sure the "door" holding this pulley also moves easily.
7. Ensure that both filament drive pulleys are free from any debris.
8. **Ensure that the tension screws are not too tight** for the filament being used (this will cause filament damage and prevent proper feeding).
9. Check to make sure the cooling tubes are in place.
10. Take out the PTFE tube and remove any burr that may be present at the bottom end.
11. Insert the PTFE tube fully so that it makes a good seal with the heat break.
12. Remove all festos from the top of the MUX and **ensure filament passes through to the heat break easily**.

When you still experience jamming, try decreasing the hotend temperature by 5°C (can be done only in Slic3r).

Also try different spools of filament as the filament quality can vary.

10.2 Colour bleeding

If colours bleed into each other, increase the wipe amount according to 5.1 Filaments and print quality chapter.

11 List of tested filaments

We've tested all the filaments from our shop.prusa3d.com for Multi Material print quality and prepared recommended wipe tower settings. See chapter [5.1 Filaments and print quality](#) for how to change the smart wipe tower size. An updated list of materials can be found at help.prusa3d.com.

	Print quality	Wipe Tower
PLA Silver	Good	Normal
PLA Transparent/Clear	Good	Increased
PLA White	Not optimal	Normal
PLA Beige/Ivory	Not optimal	Normal
PLA Orange	Good	Normal
PLA Pink	Good	Normal
PLA Blue	Good	Increased
PLA Yellowgreen/Lime Green	Good	Increased
PLA Brass	Good	Normal
PLA Copper	Good	Normal
PLA Black	Good	Increased
PLA Glow in the Dark	Good	Normal
PLA Metalic Violet	Good	Normal
PLA Metallic Green	Good	Normal
PLA Green	Good	Normal
PLA Pearl White with Glitter	Good	Normal
PLA Yellow	Good	Normal
PLA Flourescent Orange	Good	Normal
PLA Red	Good	Normal
PLA Lila	Not optimal	Normal
PLA Brown	Good	Increased
PLA Orangebrown	Good	Normal
PLA Extrafill Purple Red	Good	Normal
PLA Extrafill Melon Yellow	Good	Increased
PLA Extrafill Luminous Orange	Good	Normal
PLA Extrafill Rapunzel Silver	Good	Normal
PLA Extrafill Metallic Grey	Good	Normal
PLA Extrafill Noble Blue	Good	Increased
PLA Extrafill Luminous Green	Good	Normal

PLA Extrafill Luminous Yellow	Good	Normal
PLA Extrafill Pearl Ruby Red	Good	Increased
PLA Extrafill Vertigo Grey	Good	Normal
PLA Extrafill Traffic Black	Good	Increased
PLA Extrafill Chocolate Brown	Good	Normal
PLA Extrafill Signal Brown	Good	Normal
PLA Extrafill Gold Happens	Good	Normal
Flexfill Signal Red	In works	
Flexfill Luminous Green	In works	
Flexfill Metallic Grey	In works	
Flexfill Signal Yellow	In works	
Flexfill Skyblue	In works	
Flexfill Black	In works	
Flexfill Natural	In works	
ABS-T White	Not optimal	Normal
ABS-T Orange	Good	Normal
ABS-T Transparent Red	Good	Normal
ABS-T Transparent Blue	Good	Normal
ABS-T Silver	Good	Normal
ABS-T Black	Good	Normal
ABS-T Pearl White with Glitter	Good	Normal
ABS-T Clear	Good	Normal
ABS-T Copper	Good	Normal
ABS-T Transparent Glitter	Good	Normal
ABS-T Blue with Glitter	Good	Normal
ABS-T Yellowgreen/Lime	Good	Normal
ABS-T Brass	Good	Normal
ABS-T Brown	Good	Normal
PETG Transparent	Good	Normal
PETG Black	Good	Increased
PETG Transparent Violet	Good	Normal
PETG Transparent Green	Good	Normal
PETG Transparent Yellow	Good	Normal
PETG Transparent Brown	Good	Normal
PETG Transparent Blue	Good	Normal
PETG Transparent Red	Good	Normal
PETG Orange	Good	Normal

PETG White	Good	Normal
XT CF20	In works	
XT Yellow	In works	
XT Black	In works	
XT Light Green	In works	
XT White	In works	
XT Pink	In works	
XT Light Blue	In works	
XT Purple	In works	
XT Orange	In works	
XT Red	Good	Normal
XT Dark Gray	In works	
Corkfill	In works	
Woodfill	In works	
Bronzefill	In works	
Copperfill	In works	
Brassfill	In works	
Steelfill	In works	
PLA/PHA Ultramarine Blue	Not optimal	Normal
PLA Green Transparent	Good	Normal
PLA/PHA Pale Gold	Good	Normal
PLA/PHA Sky Blue	Not optimal	Increased
PLA Red Transparent	Good	Increased
PLA/PHA Navy Blue	Not optimal	Normal

Print and share!

Do not forget to tag your prints with *#prusai3mk2* and *#mk2mm* while sharing so we can find, pin and showcase them with our

Pinterest

http://www.prusa3d.com/original-prusa-i3-prints/

Happy Printing :)