PLA 3D Prints Surface Smoothing Research Report

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Aim

This research aim as finding the most suitable chemicals for polishing PLA 3D prints surface with the best smoothing results and ease of color application.

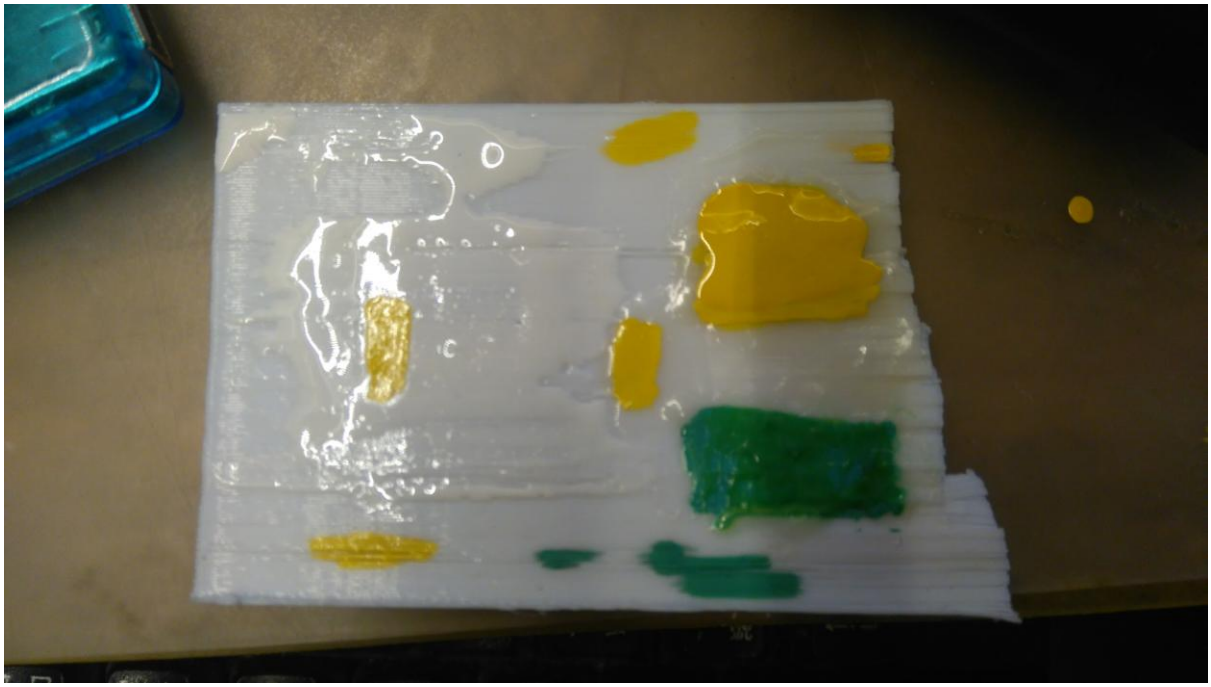
Samples for testing

1. 407 Silicon based Heat Resistant Silicone Adhesive Sealant (407 sealant)
2. Modified Acrylic Adhesive / Epoxy (MAA)
3. Ethylene-vinyl acetate (EVA)

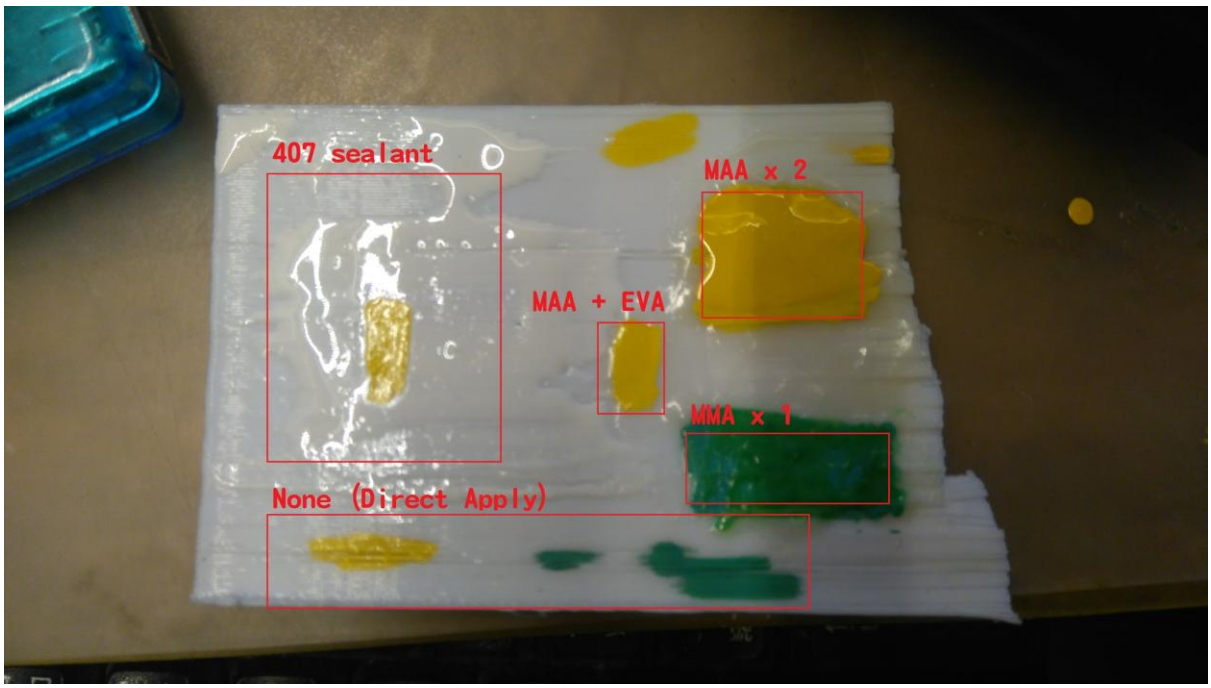
Application Methods for testing

1. None (Direct coloring onto PLA plastic)
2. Single layer 407 sealant
3. Single Layer MAA
4. Double Layer of MAA
5. One layer of MAA, One layer of EVA

Results



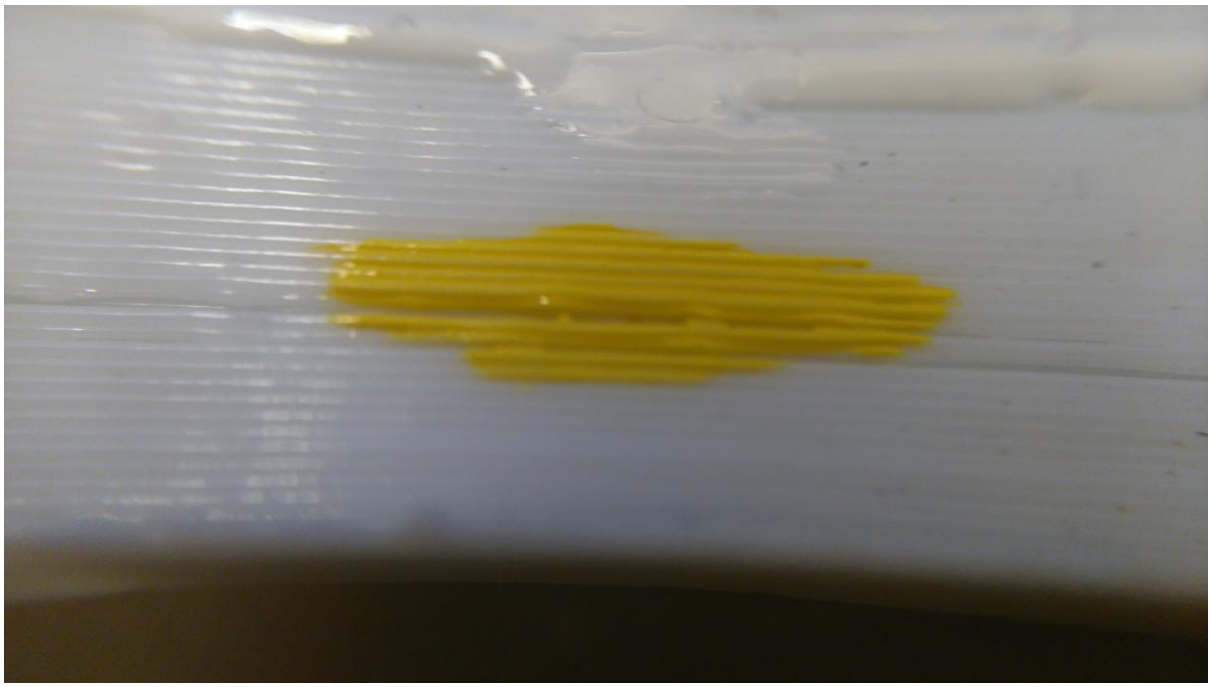
Analysis



Review of each application methods

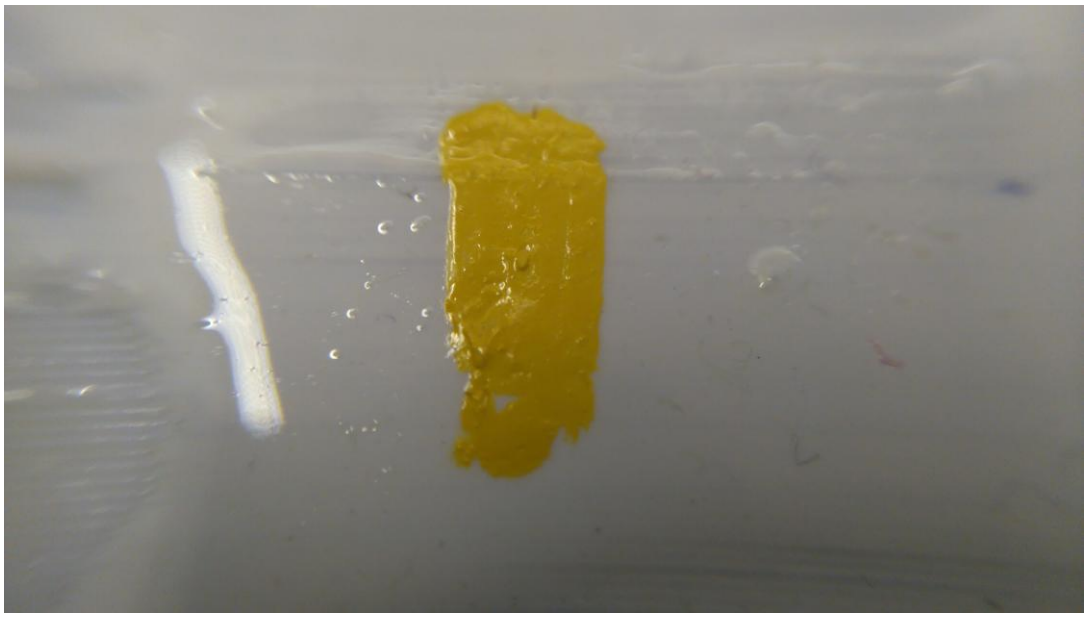
None

With direct application of paint onto raw PLA 3D prints, layer lines are clearly shown on the surface of the paint with some of the place are unpainted due to its position.



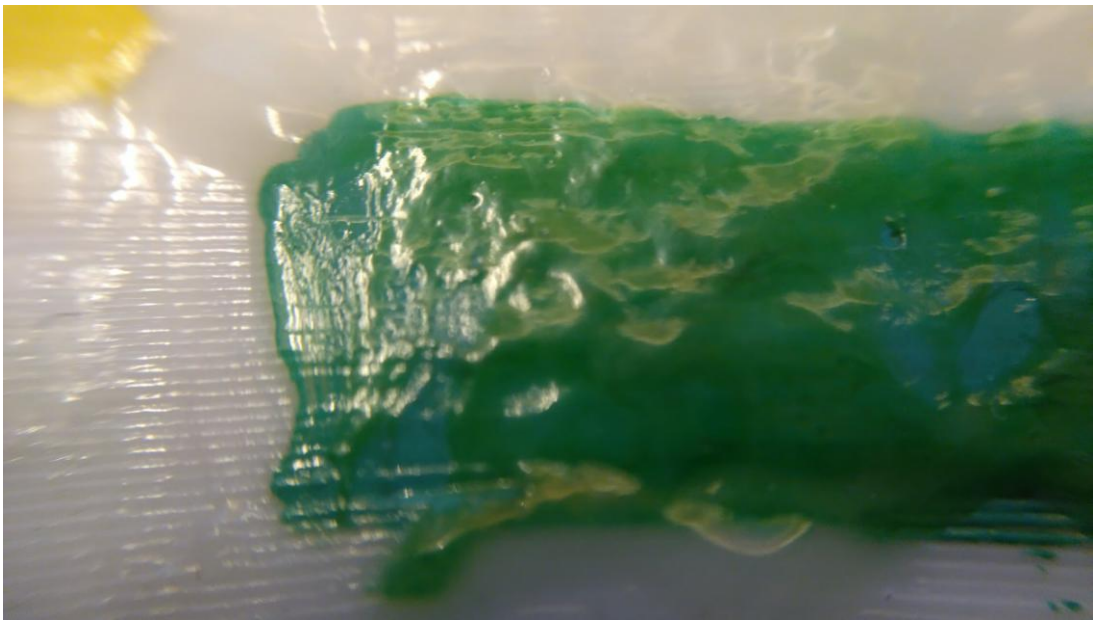
Single Layer 407 Sealant

407 Sealant originally was used to seal electronic circuits. Due to there is no need for good surface, 407 contains small chunks of non-dissolvable silicon based solid residue. 407 can hide most of the layer line but the residue created an non smooth surface for painting. Lead to non-smooth finished surface.



Single Layer of MAA

Single layer of MAA can hide some of the layer lines. However, due to MAA's properties, after mixing the coagulant with the glue, its viscosity started to increase. Leads to shiny but non-smooth surface.



Double Layer MAA

Double Layer of MAA configuration can solve part of the problem occurred in the single layer MAA. The 1st layer MAA has the viscosity same as the test in the Single Layer MAA, with the 2nd layer, the amount coagulant was reduced to reduce the mixture viscosity. As a result, it created a smooth and shiny surface with no layer lines was shown in the center of the dual layer MAA application sample. With the cheap price of MAA, this method is suitable for color application and surface smoothing for 3D prints with large surface area.

Single Layer MAA and Single Layer of EVA

This method can hide most of the layer lines with an extremely thin layer of glue. The only disadvantage of this method is the price of EVA glue are relatively expensive. (1.6HKD per gram of EVA compare to 0.088 HKD per gram of 407). Suitable for small surface application.

Conclusion

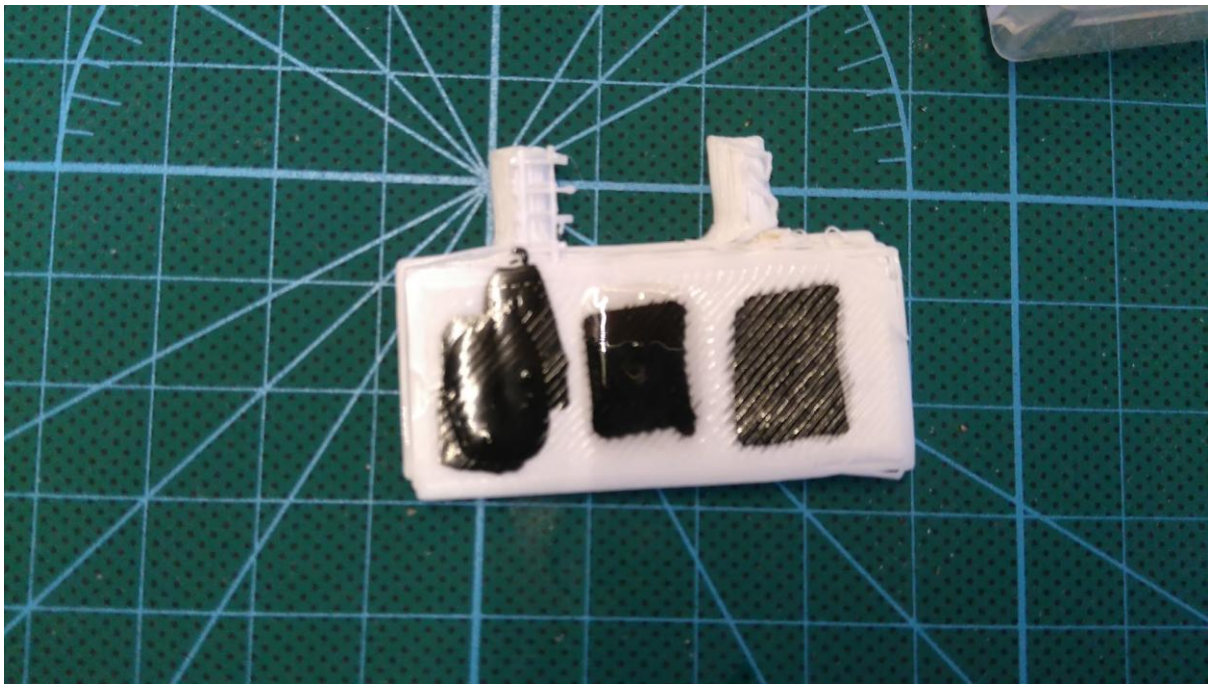
This research report suggested that the methods of smoothing PLA 3D prints and applying color are listed below.

Methods	Conditions
Dual Layer MAA Application	Large Surface Area / Thickness change < 1mm / Well Ventilated Environment
Single Layer MAA with Single Layer of EVA on top.	Small Surface Area / Thickness change < 0.3mm

Advanced Smoothing Experiment with PLA and Nail paint

This experiment provide further research over 3D printed PLA parts and its smoothing effect with oil based nail paint.
From left to right:

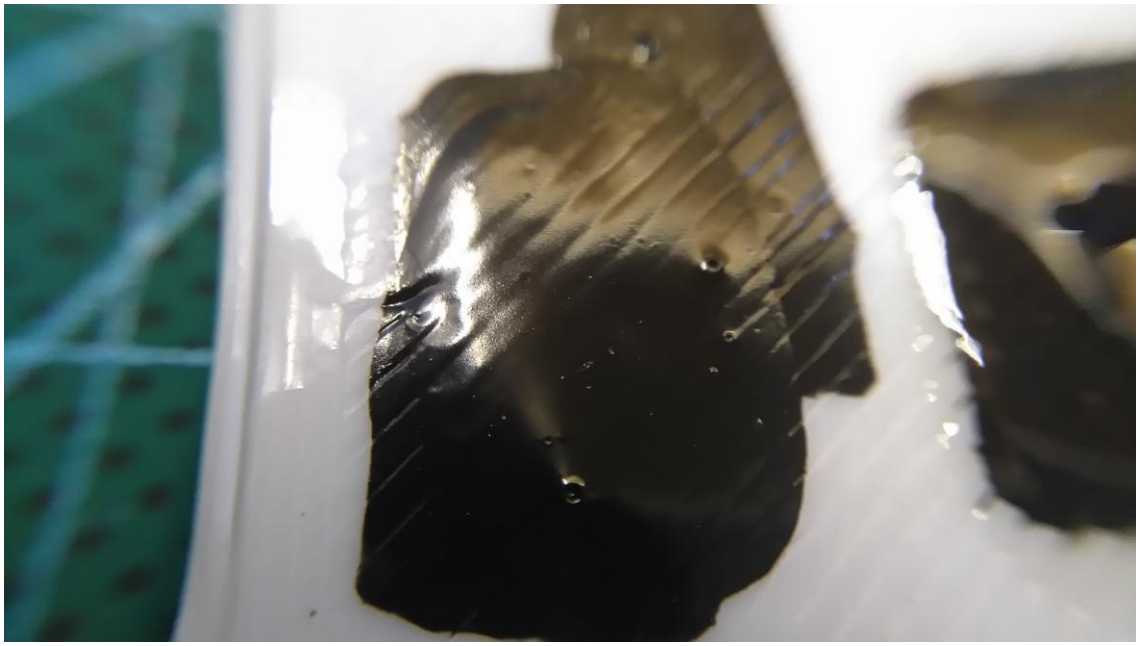
- Dual Layer Black nail Paint (DLBP)
- Black oil based paint (PAINT Marker) with single layer transparent nail paint (SOTO, Single-layer oil-based paint with transparent nail paint overlay)
- Single layer oil base black paint (PAINT Marker) (Control)



Results

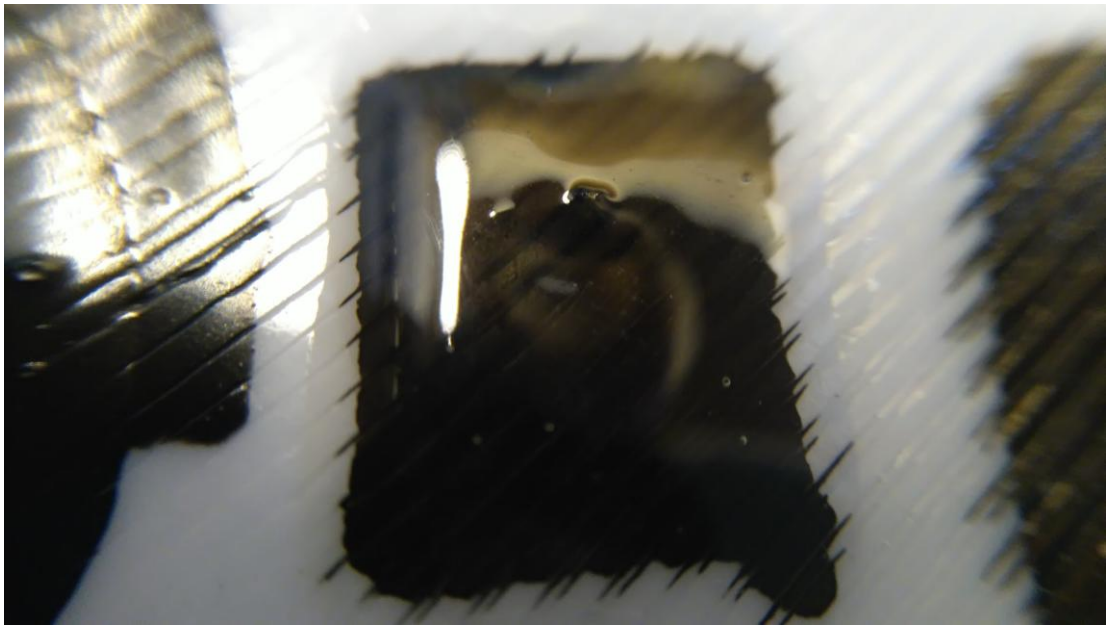
DLBP

Dual layer of black nail paint cannot cover the layer line of PLA prints as its viscosity is not high enough.



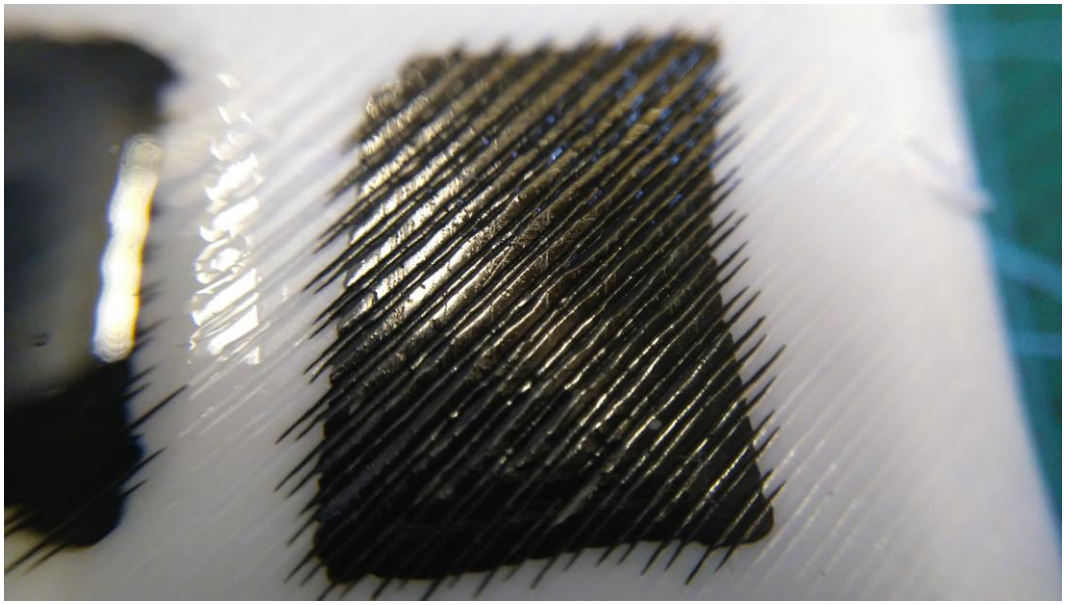
SOTO

SOTO created a smooth surface better than all the results before. However, as the nail paint layer is transparent and the layer lines cannot be covered by the PAINT Marker, the layer lines can still be seen on top.



Controls

Here is a reference image for the control group.



Conclusion

Nail paint cannot be the main factor to cover layer lines on PLA prints. However, Transparent Nail Paint may provide an alternative solution to the more expensive “Single Layer MAA with Single Layer of EVA on top” method.

Printer setting and sanding based smoothing experiment

This experiment provide references to manual sanding methods (the traditional and only way of smoothing PLA prints excluding primer application method).

This method used a 1cm ^3 cube printed with 0.1mm layer height (Minimum layer height can be achieved by Reprap Delta 3D printer) to perform the advanced sanding experiment. The smoothing compare 4 sides of the cube with the following treatments:

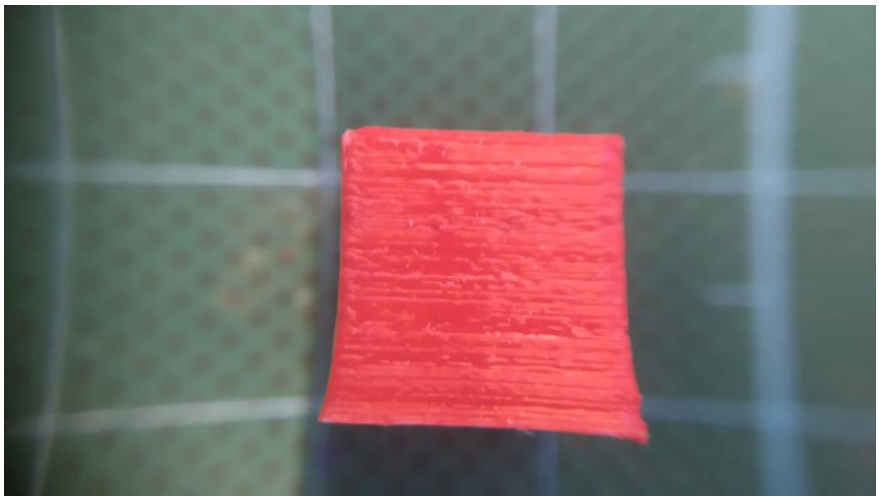
1. Direct color application (DCA)
2. Basic Smoothing Process (BSP)
3. Advanced Smoothing Process (ASP)
4. Advanced Smoothing Process with Nail Paint chemical treatment and oil based paint overlay (ASNOO)

Results

Images are wrapped due to the focus lens adjustment and magnification lens light diffraction.

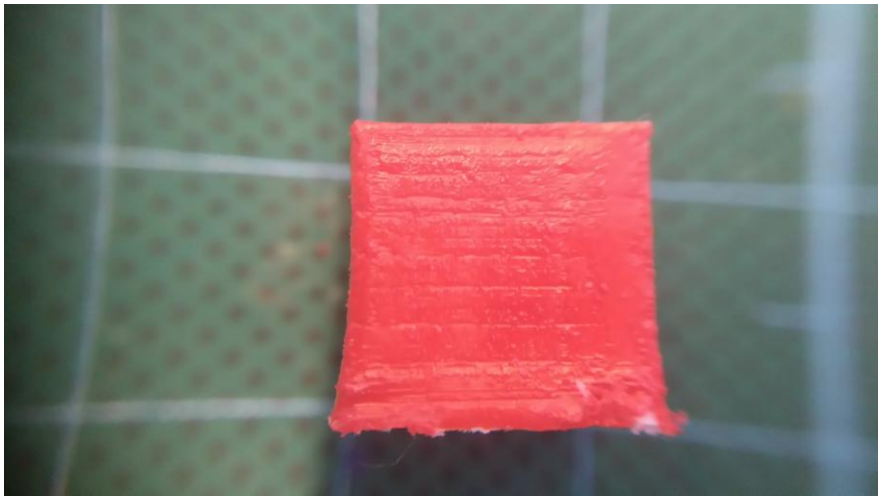
DCA (Control)

The oil based paint directly applied on the 0.1mm layer height 1cm ^ 3 cube.



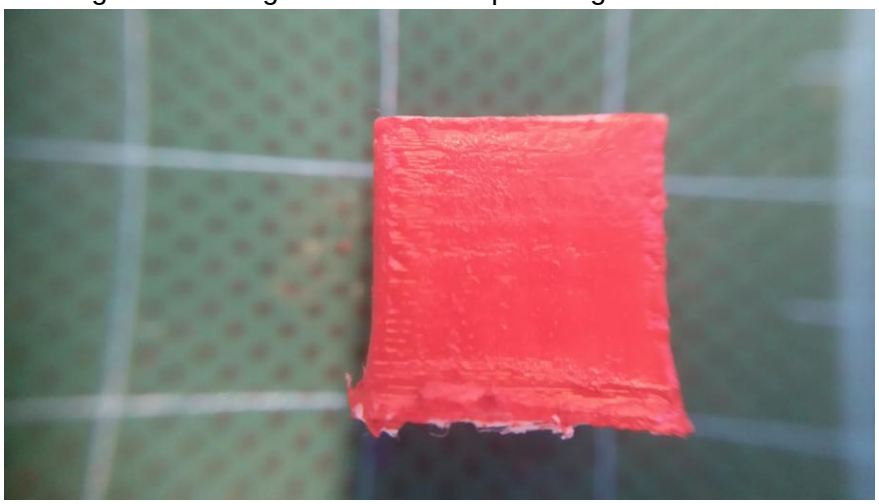
BSP

This side of the cube only performed simple sanding process with sand paper.



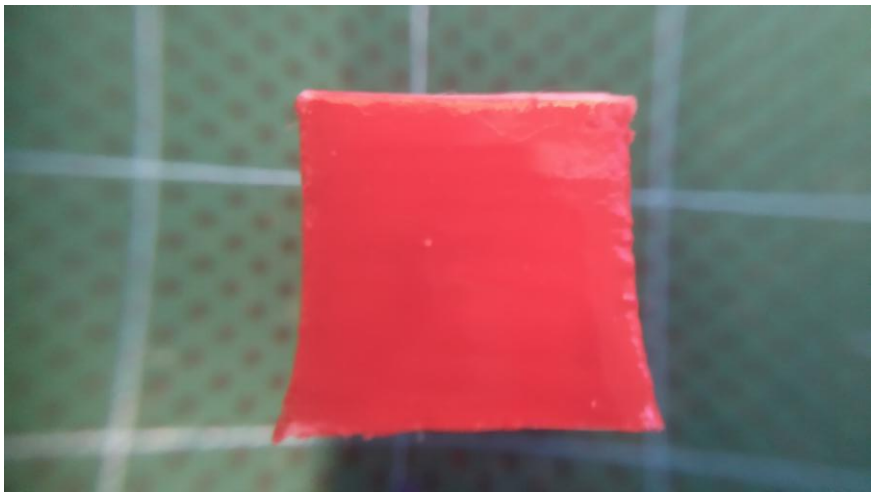
ASP

Advanced Sanding process has been performed on this side of the cube. Included electric sanding with sanding tools and basic polishing.



ASNOO

Advanced sanding process has been performed on this side of the cube. Followed by 1 layer of transparent nail paint process mentioned in the previous experiment and UV light treatment for 15 minutes. After the above process, oil based paint (PAINT maker) was put on top to overlay all layer lines. This shows the best result of all the experiment mentioned previously.



Conclusion

The “ASNOO” methods provided the best way to color a 3D printed object. This method can cover the majority of layer lines and create the best looking 3D printed object that has similar quality to mold injection objects.