



DYEING OF MJF PARTS PRINTED ON HP 500/300 SERIES

Like an artist prefers to draw on a white sheet, you get the most beautiful color results with dyeing on white 3D printed parts. Due to the new HP Jet Fusion 500/300 3D printers you are able to produce brilliant white parts. This white paper introduces the new opportunity of finishing parts from HP 540/340 and 580/380 printers with the DyeMansion Print-to-Product workflow and giving them brilliant and long-lasting colors.

EXECUTIVE SUMMARY

So far HP's Multi Jet Fusion-technology (MJF) from the well-known 4200 series produced grey parts only, which limited customers especially in terms of dyeing to mostly black and dark shades. This led to customers choosing other powder bed fusion technologies over MJF for applications that require color. With the new 500/300 Series HP enables to produce white parts. From now on, DyeMansion is able to apply their well-established Print-to-Product workflow to finish HP's white raw parts without any limitations in every color, UV-stable, reproducible and ready for series production.

In the course of this whitepaper the color options are explored and the color and weight variation of parts is examined, both before and after the dyeing process. There is only a minimal increase in weight of about 0.3 %, which is in the same range as experienced with Polyamide 12 parts produced by other polymer powder bed fusion technologies. A color variation (ΔE) between each of the white raw parts before dyeing can be detected. After the dyeing process the color variation is reduced compared to the white raw parts and a very uniform color impression can be observed.

PROCESS

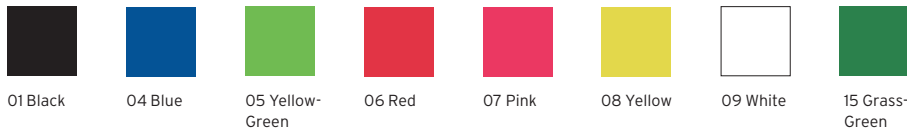
The raw parts used for the test in this whitepaper were produced with a 4-agent HP Jet Fusion 540 Printer. The printhead resolution was 1200 dpi and the layer thickness 0.08 mm. For more information see the table below.

TECHNOLOGY	PRINTER	MATERIAL	MATERIAL NAME	RESOLUTION	LAYER THICKNESS
HP Multi Jet Fusion	HP Jet Fusion 540	Polyamide 12	HP 3D HR CB PA 12	1200 dpi	0.08 mm 0.0003 inch

All MJF raw parts went through the DyeMansion Print-to-Product workflow. See the cycle times below.

STEP	SYSTEM	PROCESS	CYCLE TIME
1	POWERSHOT C	Damage-preventive, automated part cleaning	15 min
2	POWERSHOT S	PolyShot Surfacing (PSS) for improved properties	15 min
3	DM60	Coloring under pressure and heat	2.5 h
4	POWERSHOT S	PolyShot Surfacing (PSS) for brilliant finish	15 min

Each individual step of this end-to-end workflow is automated. The parts are treated with the damage-preventive cleaning as well as the PolyShot Surfacing before the dyeing process. Five parts are dyed in the same run in the following DyeMansion standard colors.



During this process, the dyes infiltrate the parts under pressure and with temperatures rising up to 115 °C. No material layer is added and the surface is dyed homogeneously.



TEST RESULTS

HOMOGENITY WITHIN A SINGLE BATCH

The color variation that indicates the particular color difference is listed as ΔE for each part before and after dyeing is shown in table 1. The first part of each color batch is served as a reference, logically resulting in a ΔE of 0. The parts were measured in a white and raw state before the coloring as well as after the process on the exact same spot to observe the homogeneity within a single dyeing batch.



COLOR	PART	ΔE RAW MJF PARTS	ΔE COLORED MJF PARTS
WHITE	1 (reference part)	0	0
	2	1.53	0.89
	3	1.63	1.06
	4	1.31	0.63
	5	0.98	0.53
PINK	1 (reference part)	0	0
	2	1.08	0.85
	3	1.46	1.06
	4	1.80	1.42
	5	2.06	1.94
GREEN	1 (reference part)	0	0
	2	0.34	0.57
	3	1.97	0.77
	4	4.32	1.69
	5	2.12	0.94
GRASS-GREEN	1 (reference part)	0	0
	2	3.41	1.55
	3	0.81	0.27
	4	2.70	0.54
	5	1.04	0.32

Table 1: Color variations before and after dyeing indicated with ΔE

The value ΔE allows the quantified examination of a color difference. As listed in table 1 the different parts from the same batch show slight color variations. It can be observed that the variance of the ΔE values after the dyeing process is smaller than it is between the raw white MJF parts.

Since all dyeing parameters were originally developed on white selective laser sintered (SLS) parts, it is remarkable that the first coloring runs with white MJF parts produce such sophisticated results. The overall appearance is very homogenous and color differences between up- and downskin surfaces are almost not present.

COLOR OPTIONS

Only slight adjustments of the dyeing parameters for MJF parts lead to a color appearance comparable to SLS parts. Thus, the unlimited range of colors is available for MJF parts as already for SLS parts including colors according to color systems like RAL, Pantone and optional customized as well as corporate colors. In most cases a color development will achieve results within a ΔE of 1.5 compared to the original sample.

In order to eliminate any development costs and waiting time for customers, DyeMansion developed the complete RAL palette for SLS parts. This color selection of more than 200 colors will also be available for white MJF soon.

WEIGHT

A minimal increase (0.3 %) in weight after coloring the parts is also detected. Compared to spray painting the effect on weight is insignificant. This is due to the infiltrative dyeing process where the dyes penetrate the plastic parts through pressure and heat in the high temperature range as well as water absorption of the polyamide. This infiltration process enables a geometry independent homogeneous coloring of 3D-printed MJF parts.

CONCLUSION

With the HP 500/300 Series the limiting factor of grey raw material for brilliantly dyed HP parts has been overcome. The interaction between HP's white parts and DyeMansion's industrial finishing technologies opens new possibilities for a wide range of high-end customer applications. The results of the first tests are stunning even though the parameters were initially developed for SLS PA12 parts. Through DyeMansion's color development process the homogeneity and brilliance of the color appearance will be further improved for MJF parts.



DyeMansion GmbH

Robert-Koch-Strasse 1
82152 Planegg-Munich
Germany

+49 89 4141705 00
hallo@dyemansion.com

For more information, visit:

www.dyemansion.com

Please contact us for free of charge benchmarking:



CONTACT EMEA & APAC

Philipp Ratza
Application Consultant
philipp.ratza@dyemansion.com
+49 179 6127259



CONTACT AMERICAS

Daniel Stroh
Sales & Operations North America
daniel@dyemansion.com
+1 415 9968115