Technical white paper

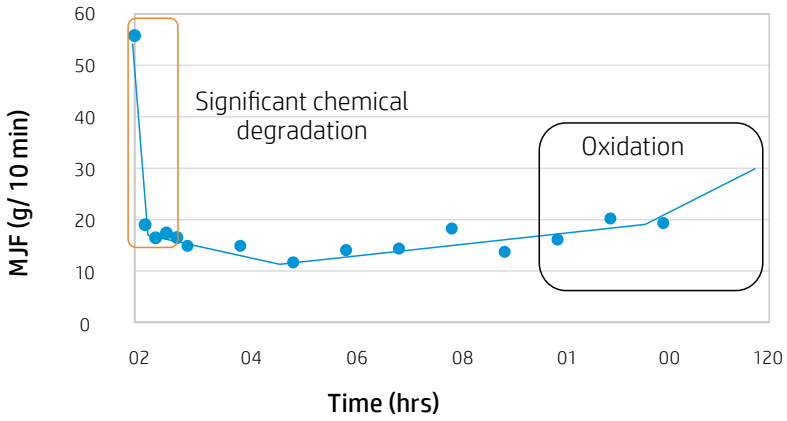
Aging of PA 12 powder

Chemical degradation and oxidation

Chemical degradation of Vestosint 3D Z773 PA 12[1]

Vestosint 3D Z773 PA 12[1] experiences chemical degradation; the molecules of this PA 12 start to grow when exposed to temperature with time and thereby the material becomes more viscous.
These type of materials are known as highly reactive materials.
Because viscosity is inversely proportional to MFI, the graph shows a strong MFI decrease from 60 to 20 g/10 min.

Vestosint 3D Z773 PA 12[1] oven aging

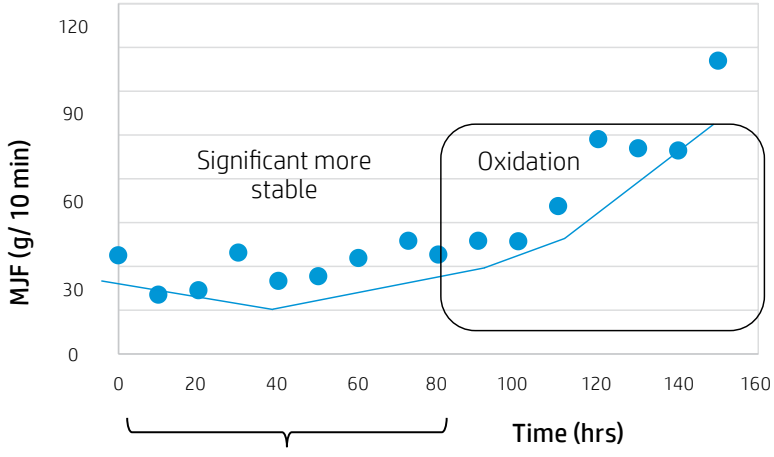


Some SLS PA 12 powders with recyclability ratios of 50/50 also behave this way which may distort part quality.
If the viscosity is too high, then problems like orange peel, higher part roughness, poor powder flowability, etc., start to show enhancing poor part quality of the printed parts.

Chemical degradation of the HP 3D High Reusability PA 12[2]

HP 3D High Reusability PA 12[2] has been designed to avoid the molecular growth while the material is exposed to temperature with time. These type of materials are known as medium to low reactive materials.

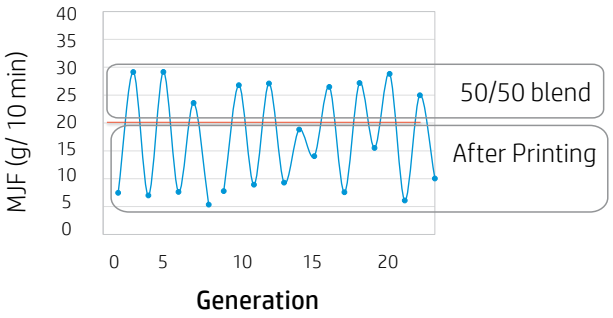
HP 3D High Reusability PA 12[2] oven aging



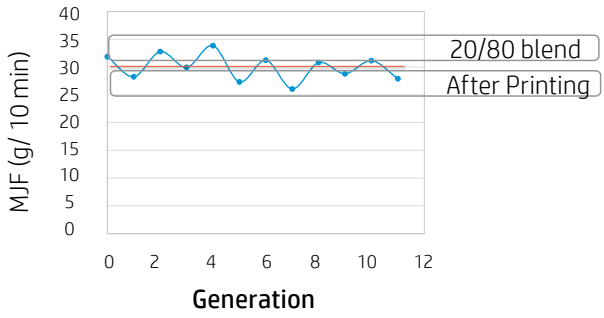
HP 3D High Reusability PA 12[2] viscosity does not strongly change and it can be recycled 20% fresh and 80% reused without degrading the material and consequently not affecting part quality.

Chemical degradation results from Multi Jet Fusion printed buckets

Vestosint 3D Z2773 PA 12[1] **aging in a print bucket** during half and full jobs
(8 -15 hrs at bed temperature of 165 ˚C)



HP 3D High Reusability PA 12[2] (3.1) **aging in a print bucket** during half and full jobs
(8 -15 hrs at bed temperature of 165 ˚C)



HP 3D High Reusability PA 12[2] shows a very small deviation of MFI values that justifies its highly reusability rates:

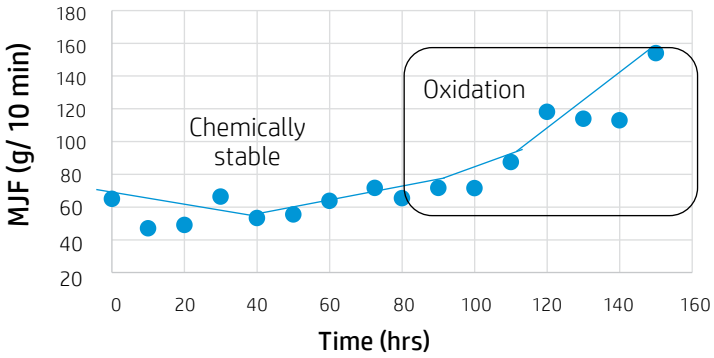
- After printing: Samples were taken during unpacking at the middle of the print bucket.
- 50/50: Samples were taken after loading the trolley with 50% fresh powder and 50% reused powder.
- 20/80: Samples were taken after loading the trolley with 20% fresh powder and 80% reused powder.

Oxidation of the HP 3D High Reusability PA 12[2]

The oxidation of HP 3D High Reusability PA 12[2] is first shown as the material turns from white to brown.

The HP Multi Jet Fusion technology does not work with nitrogen but air, thereby the material could oxidate.

HP 3D High Reusability PA 12[2] Oven Aging at a constant temperature of 165 ˚C



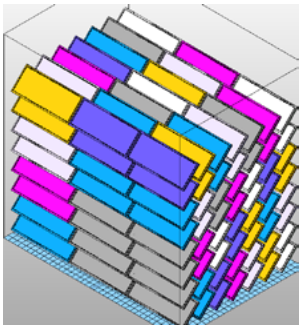
When HP 3D High Reusability PA 12[2] is exposed to 165 ˚C, the bed temperature in HP's Multi Jet Fusion technology, it takes 80 hours for the material to begin to oxidate.

Printing a full print bucket takes only 15 hours, so oxidation should not take place.

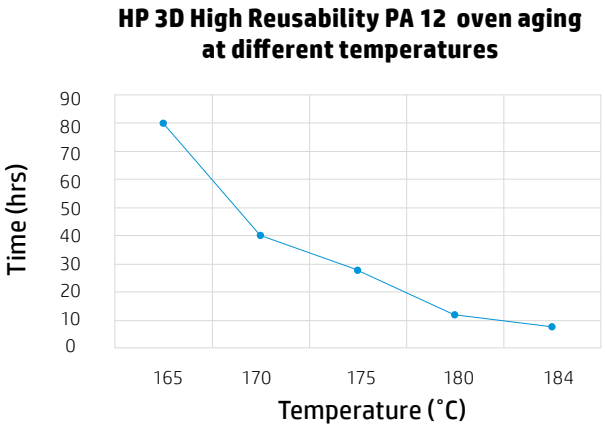
Occasionally, it is possible to see areas of brown powder underneath of printed parts or between parts.

*Example of brown powder in an HP Multi Jet Fusion printed bucket

This takes place only when the parts are printed too close to each other or the plot is too dense.



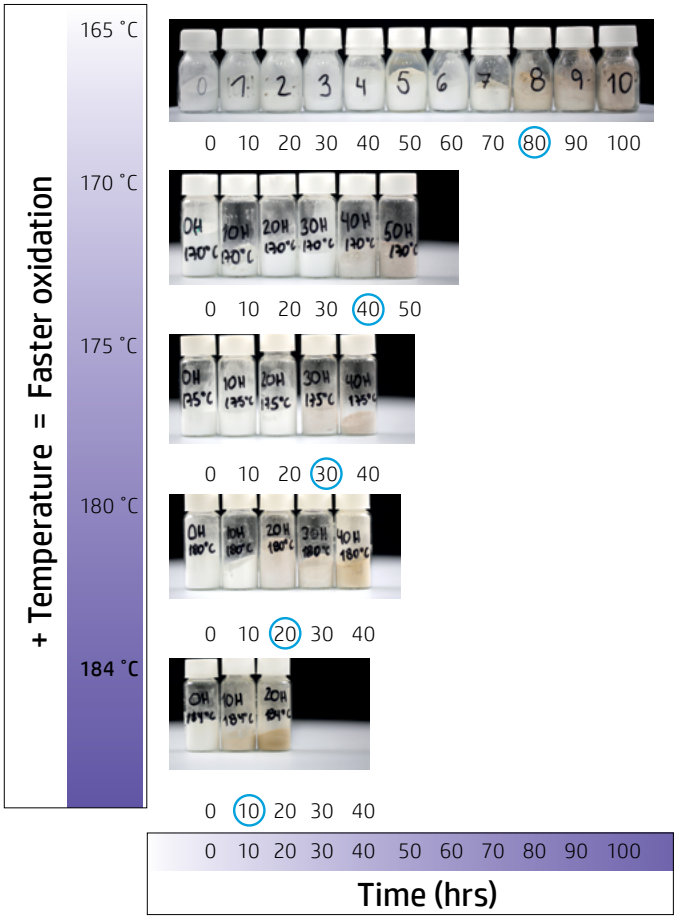
The printed parts are hotter than the white powder. If there is not enough distance between printed parts, the white powder trap between them, gets even hotter than 165 ˚C probably reaching 185 ˚C.



The higher the white powder temperature is, the faster the oxidation takes place.

This time vs. temperature oxidation trend is very sharp.

Then, if the powder is for example at 185 ˚C, it would take only 8 hours in heat before the material starts to switch from white to brown.



Oxidation with the HP Multi Jet Fusion technology: summary and recommendations

Local and light oxidation of the powder when printing long and dense plots

Powder in the middle of the HP Jet Fusion 3D Build Unit unit occasionally suffers of oxidation. This could make the powder to appear with a light brownish color.

In particular, this could occur when long and dense plots are printed. This is approximately 5000 layers or more and solid parts. The mass of oxidized powder under this conditions should be minimal and locally concentrated in the middle of the HP Jet Fusion 3D Build Unit.

Thanks to the HP 3D High reusability PA 12, the possible oxidized powder will mean a very low volume fraction of the total powder volume for next plots.

This is because,

- Initially, during unpacking the long and dense plots, the oxidized powder will be mixed with the non oxidized rest of the powder in the build unit. This means a negligible volume fraction of light brownish powder in a full print bucket plot.
- Later, during mixing printed (80 %) with fresh (20%) powder, the oxidized powder with a light brownish powder will dilute among the rest of the non oxidized white powder.

Therefore, no consequence on printing should be expected when this light oxidation occurs in local middle areas of the build.

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2. HP Jet Fusion 3D print solution with HP 3D High Reusability PA 12 has the highest post-production surplus powder reusability with 80% reusability vs any other powder based 3D printing technology using PA 12 material. Consistent performance with only 20% powder refresh rate.

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