

COSMETIC STANDARDS

CNC

COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD
Scratch	Visible line or mark.	< 10mm and can't be felt with a fingernail or ≤ 1mm and can be felt with a fingernail.
Dent or Ding	Local material impression.	≤ .5mm in any dimension.
Gouge	Surface imperfection, deeper than a scratch, that penetrates into plating, often with raised edges.	Unacceptable.
Tool Chatter	Tangible surface roughness or waviness as a result of a tool vibration.	Unacceptable, unless the risk was surfaced during order placement or lifetime.
Tooling Marks	Normal process marks created by the holding clamps.	Cannot be felt with a thumbnail, but is visible.
Burrs	A rough edge or ridge of material left on a part from the machining process.	Unacceptable.
Discoloration	Change from original color or inconsistent color within the same part.	Discoloration due to oxidation of Copper, Bronze, Brass, Steel, and Cast Iron. Stock Material is acceptable.
Rust/Oxidation	Chemical reaction of exposed metal with oxygen (air). Rust has a noticeable texture and penetrates the metal.	Minor rust is acceptable on Copper, Bronze, Brass, Steel, and Cast Iron.

3D PRINTING

COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD					
		FDM	POLYJET	SLS	MJF	SLA	CARBON DLS
Scratch	Visible line or mark.	Unacceptable if greater than 10mm long and is apparent to the touch OR If excessive (more than 2 scratches within 1cm ²)	Unacceptable if greater than 10mm long and is apparent to the touch OR If excessive (more than 2 scratches within 1cm ²)	Unacceptable if greater than 10mm long and is apparent to the touch OR If excessive (more than 2 scratches within 1cm ²)	Unacceptable if greater than 10mm long and is apparent to the touch OR If excessive (more than 2 scratches within 1cm ²)	Unacceptable if greater than 10mm long and is apparent to the touch OR If excessive (more than 2 scratches within 1cm ²)	Unacceptable if greater than 10mm long and is apparent to the touch OR If excessive (more than 2 scratches within 1cm ²)
Gouge	Surface imperfection penetrating into a surface with raised edges.	Unacceptable if present.	Unacceptable if present	-	-	-	-
Leftover Support	Support structure that has been left on final part.	Unacceptable unless risk approved prior to job acceptance	Unacceptable unless risk approved prior to job acceptance	Unacceptable unless risk approved prior to job acceptance	Unacceptable unless risk approved prior to job acceptance	Unacceptable unless risk approved prior to job acceptance	Unacceptable unless risk approved prior to job acceptance
Discoloration	Inconsistent coloring. *For dyed or painted parts, the appearance may not be identical across different orders. If uniform color is important, customers should make this clear before ordering so that Fictiv can take steps to ensure the best possible outcome.	Unacceptable if present from part to part Unacceptable if present within part	Unacceptable if present	Unacceptable if present	Unacceptable if present within part *For dyed or painted parts, the appearance may not be identical across different orders.	Unacceptable if present	Unacceptable if present

3D PRINTING (cont'd)

COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD					
		FDM	POLYJET	SLS	MJF	SLA	CARBON DLS
Warpage	Deflection of part due to internal material stresses associated with part design or orientation	Unacceptable unless risk approved prior to job acceptance	Unacceptable unless risk approved prior to job acceptance	Unacceptable if deflection is greater than 1mm *Thin parts with length above ~6"(152mm) are at risk for warping. If warping is unacceptable, customers should communicate this in advance so Fictiv can address the concern with our manufacturing partners.	Unacceptable if deflection is greater than 1mm	Unacceptable if deflection is greater than 1mm	-
Seam Line	Small clumps on every layer that indicate the start and end of a layer	Acceptable	-	-	-	-	-
Stringing	Stray, hair-thin filaments protruding from a surface or existing between two features.	Unacceptable unless material is PETG	-	-	-	-	-

3D PRINTING (cont'd)

COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD					
		FDM	POLYJET	SLS	MJF	SLA	CARBON DLS
Elephants Foot	Slight lip on bottom layer of a print	Unacceptable if greater than 1mm protrusion	-	-	-	-	-
Non-Adhesion	Slight lift of bottom layer as result of the part cooling and pulling off from the build bed	Unacceptable if greater than 1mm lift height	-	-	-	-	-
Under Extrusion	Missing material within or between layers as a result of the nozzle path	Unacceptable unless the feature is less than 2mm thick** **Thin wall regions may be imperfect or sometimes absent due to limits of process and software	-	-	-	-	-

3D PRINTING (cont'd)

COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD					
		FDM	POLYJET	SLS	MJF	SLA	CARBON DLS
Missing Layer	Incomplete or missing print layer as a result of support material removal process or part orientation	Unacceptable if present	Unacceptable if present	-	-	-	-
Roughness	Coarseness of surface due to support removal or handling that can be felt to the touch	Unacceptable unless due to support material removal	Unacceptable unless due to support material removal	Texture should be uniform and not excessively rough	-	Unacceptable unless nubs due to support removal	Unacceptable unless nubs due to support removal
Delamination	Failure of adherence amongst print layers	Unacceptable if present	-	-	-	Unacceptable if present	Unacceptable if present
Sinking	Slump or gradient along a modeled flat surface that can be distinguished to the touch	Unacceptable if present	Unacceptable if present	Unacceptable if present	Unacceptable if present	-	-
Layer Shift	Misalignment of consecutive layers	Unacceptable if present	Unacceptable if present	Unacceptable if present	-	-	Unacceptable if present

3D PRINTING (cont'd)

COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD					
		FDM	POLYJET	SLS	MJF	SLA	CARBON DLS
Under Sintering	Gap or missing material on the surface as a result of powder not properly sintered to previously sintered material	-	-	Unacceptable if feature geometry is greater than 1mm of nominal	-	-	-
Over Sintering	Extra material on a surface or feature as a result of surrounding powder heating to the point of adhesion to previously sintered material	-	-	Unacceptable if feature geometry is greater than 1mm of nominal	-	-	-
Elephant Skin	Uneven surfaces resulting from the uneven shrinking of the material during curing.	-	-	-	Unacceptable if present	-	-
Raised Bumps	Visually raised material on what should be a smooth surface that are apparent to the touch	-	-	-	Unacceptable if greater than 1mm in diameter	-	-

3D PRINTING (cont'd)

COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD					
		FDM	POLYJET	SLS	MJF	SLA	CARBON DLS
Nubs	Small dots on a part as a result of support removal	-	-	-	-	Acceptable	Acceptable
Under Curing	Gap or missing material on the surface as a result of powder not properly adhered to previously sintered material	-	-	-	-	Unacceptable if feature geometry is greater than 1mm of nominal	-
Cupping Blowout	Holes and ruptures of a wall	-	-	-	-	Unacceptable if present	Unacceptable if present
Over Extrusion	Blobs or small bunches of material, typically 1mm or less in diameter typically due to over-extrusion	Unacceptable if present	-	-	-	-	-

3D PRINTING (cont'd)

COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD					
		FDM	POLYJET	SLS	MJF	SLA	CARBON DLS
Powder	Unmelted raw material remaining after the job is completed	-	-	Unacceptable if excessive powder remains ***Narrow holes and channels, especially blind holes are at risk for incomplete removal of powder.	-	-	-
Missing Material	Material not printed or where a printed feature has broken	-	-	Unacceptable unless due to customer agreeing to best effort attempt at walls thinner than the process specification	-	-	-
Over Adhesion	Extra material on a surface or feature as a result of surrounding powder heating to the point of adhesion to previously adhered material	-	-	-	Unacceptable if feature geometry is greater than 1mm of nominal	-	-

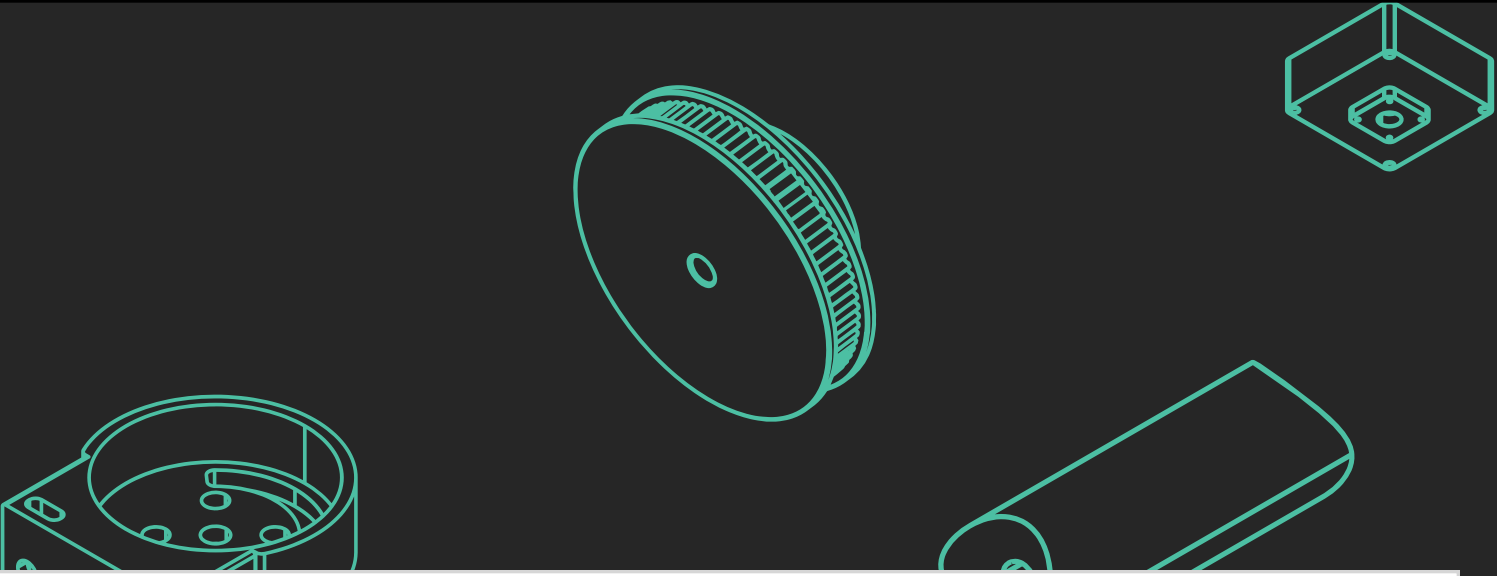
3D PRINTING (cont'd)

COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD					
		FDM	POLYJET	SLS	MJF	SLA	CARBON DLS
Under Adhesion	Gap or missing material on the surface as a result of powder not properly adhered to previously sintered material	-	-	-	Unacceptable if feature geometry is greater than 1mm of nominal	-	Unacceptable if feature geometry is greater than 1mm of nominal
Ragging	Cured/partially cured resin forms small disks or fins attached to the print	-	-	-	-	Unacceptable if present	-
Caping	Capes or sheets of resin that form on and between parts	-	-	-	-	-	Unacceptable if present
Resin Flow Bands	Changes in resin flow dynamics cause horizontal bands	-	-	-	-	-	Unacceptable if apparent to the touch (fingernail test)
Shrink Line	Lines in the part corresponding to changes in geometry	-	-	-	-	-	Unacceptable if apparent to the touch (fingernail test)

3D PRINTING (cont'd)

COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD					
		FDM	POLYJET	SLS	MJF	SLA	CARBON DLS
Smokiness	Marbled pattern of light and dark swirls on part surface	-	-	-	-	-	Unacceptable if present
Under Supported	Part feature is not properly supported resulting in distorted or missing features	-	-	-	-	-	Unacceptable if present
Veining	Ridges on the part in the build direction	-	-	-	-	-	Unacceptable if apparent to the touch (fingernail test)
Vertical Channel	Recessed lines in the part that appear parallel to the build direction	-	-	-	-	-	Unacceptable if greater than 10mm long and is apparent to the touch
Vertical Rib	Raised line in the build direction	-	-	-	-	-	Unacceptable if greater than 10mm long and is apparent to the touch

Cosmetic Criteria: Vapor Smoothing



General Requirements :

- Cosmetic visual inspection shall be conducted considering inspection guidelines described in 3DP Cosmetic Standards (PP-0019-001) Section 6.1.
- Related Cosmetic visual standards described in 3DP Cosmetic Standards (PP-0019-001) Section 6.5 also apply to the Vapor Smoothing parts (e.g. discoloration, scratches, etc).
- Conditions detected not fitting any of the defect definitions provided in the following tables, shall be consulted with Fictiv for acceptance.
- Manufacturing Partners should reference the drawings for specific part requirements (if drawing is provided). In instances where requirements on a drawing differ from this standard, the drawing requirements should take precedence.

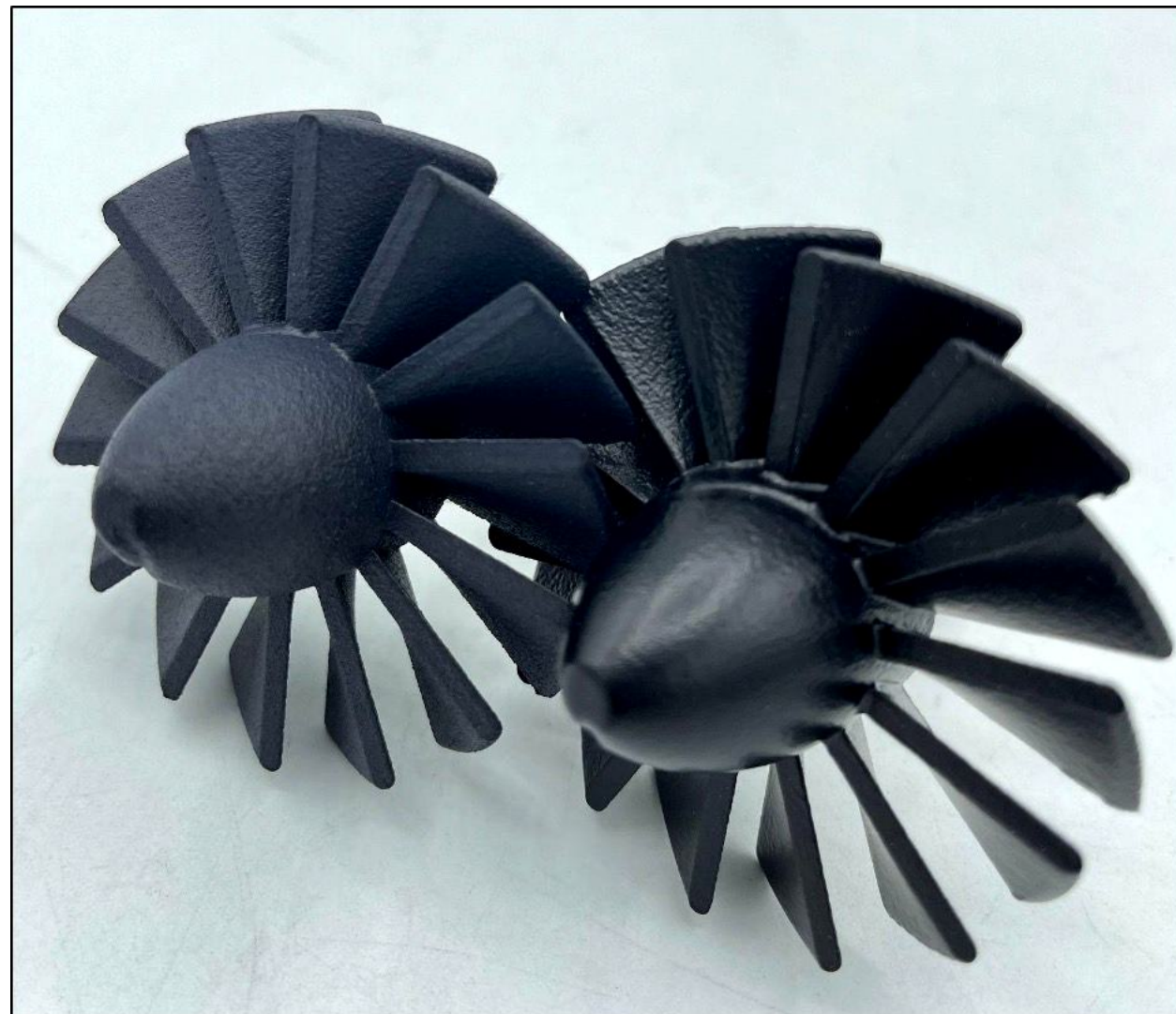
Vapor Smoothing Part Acceptance Criteria Table:

DEFECT	DESCRIPTION	Acceptability
Hanging Mark(S)	Contact point with hook (or in some cases, a clip) from hanging inside the chamber during the process. Depending on part geometry, a hook mark may be necessary, but should be limited to the inside of holes or other features where the hook mark can be hidden.	Unacceptable if greater than 1mm in diameter, 0.5mm in depth, OR If excessive (more than 2 voids within 2cm2)
Underprocessing	Entire part or sections of part still resemble a raw MJF part - not smoothed enough	Unacceptable if present
Voids (Bridging)	The surface may bubble to leave a small gap, usually in a corner or sharp edge of a part. This can be mitigated by designing in radii to sharp corners where possible	Unacceptable if greater than 1mm in diameter OR If excessive (more than 2 voids within 2cm ²)

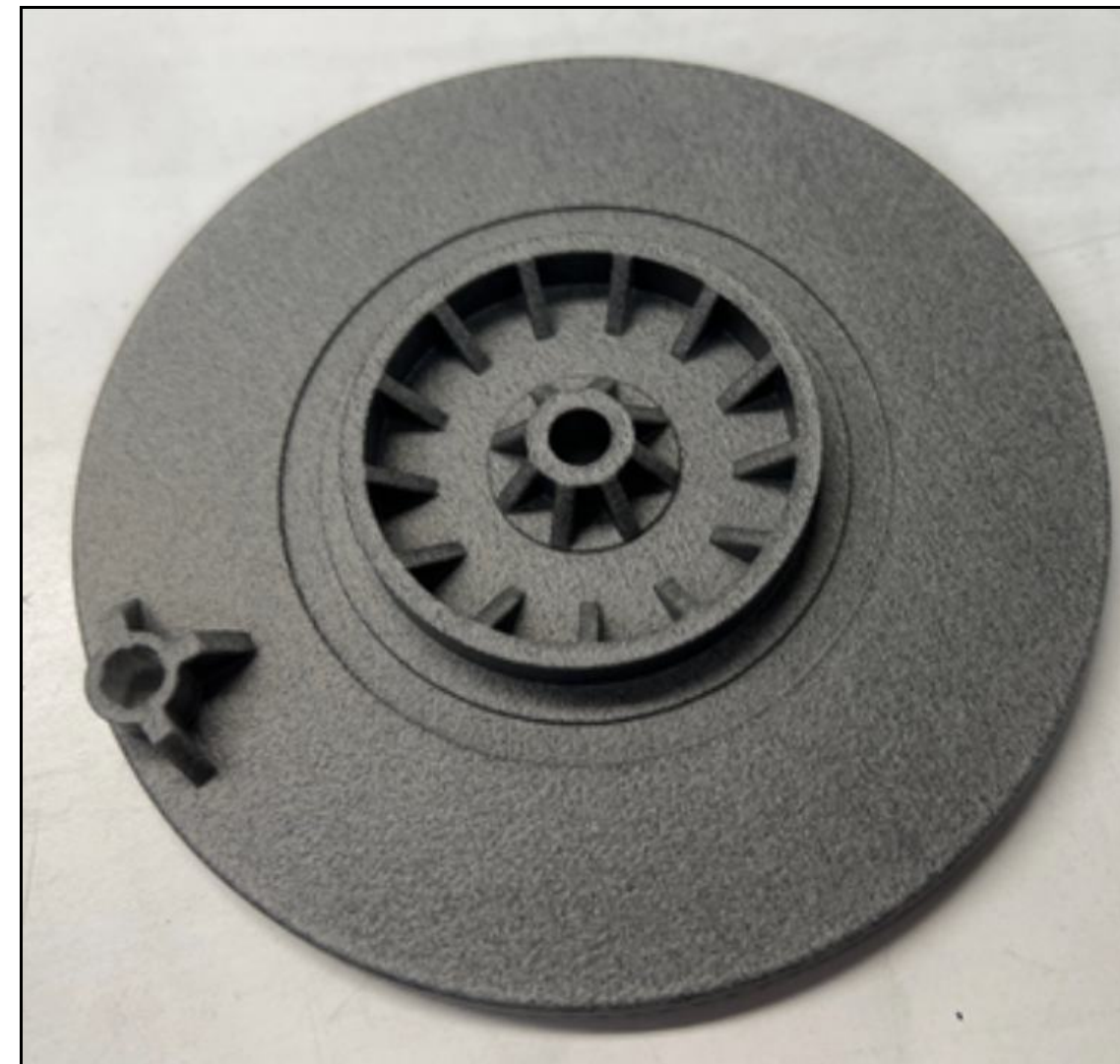
Cosmetic Criteria: Vapor Smoothing

Visual References:

*Note that a gray (raw) MJF part with no black dye will turn nearly black if vapor smoothed. The finish will look like a marbled gray/black, as the black material beneath the surface has reflowed and mixed with the gray surface material during the process. Parts that have been both dyed black and vapor smoothed will be more glossy, smooth, and have a jet-black finish.



Black dyed MJF and vapor smoothing



Gray (raw) MJF and vapor smoothing



Cosmetic Criteria: Vapor Smoothing

Defect Picture Examples:



Figure #1: Hanging marks

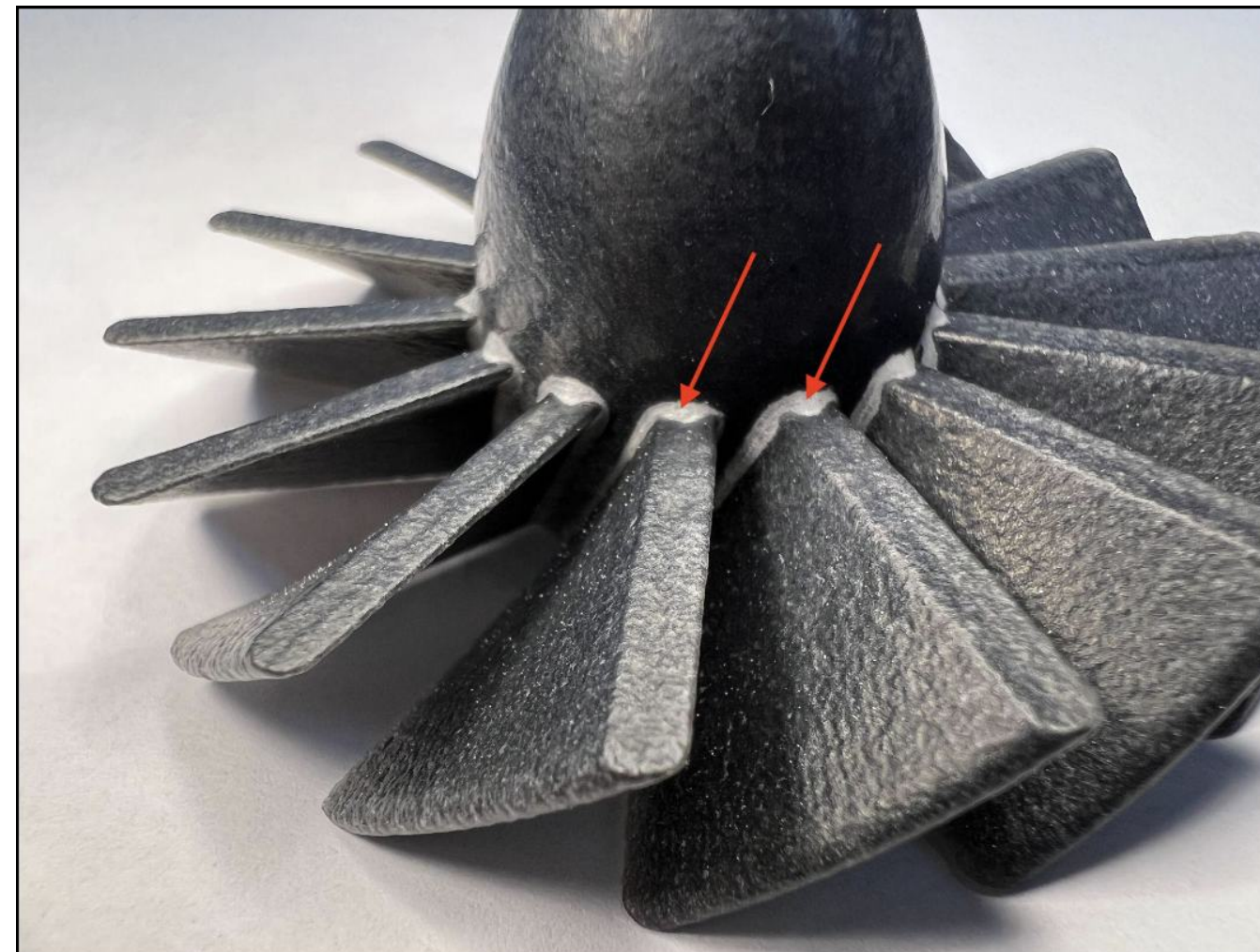


Figure #2: Discoloration after vapor smoothing (white stains)



Figure #3: Voids (bridging)

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