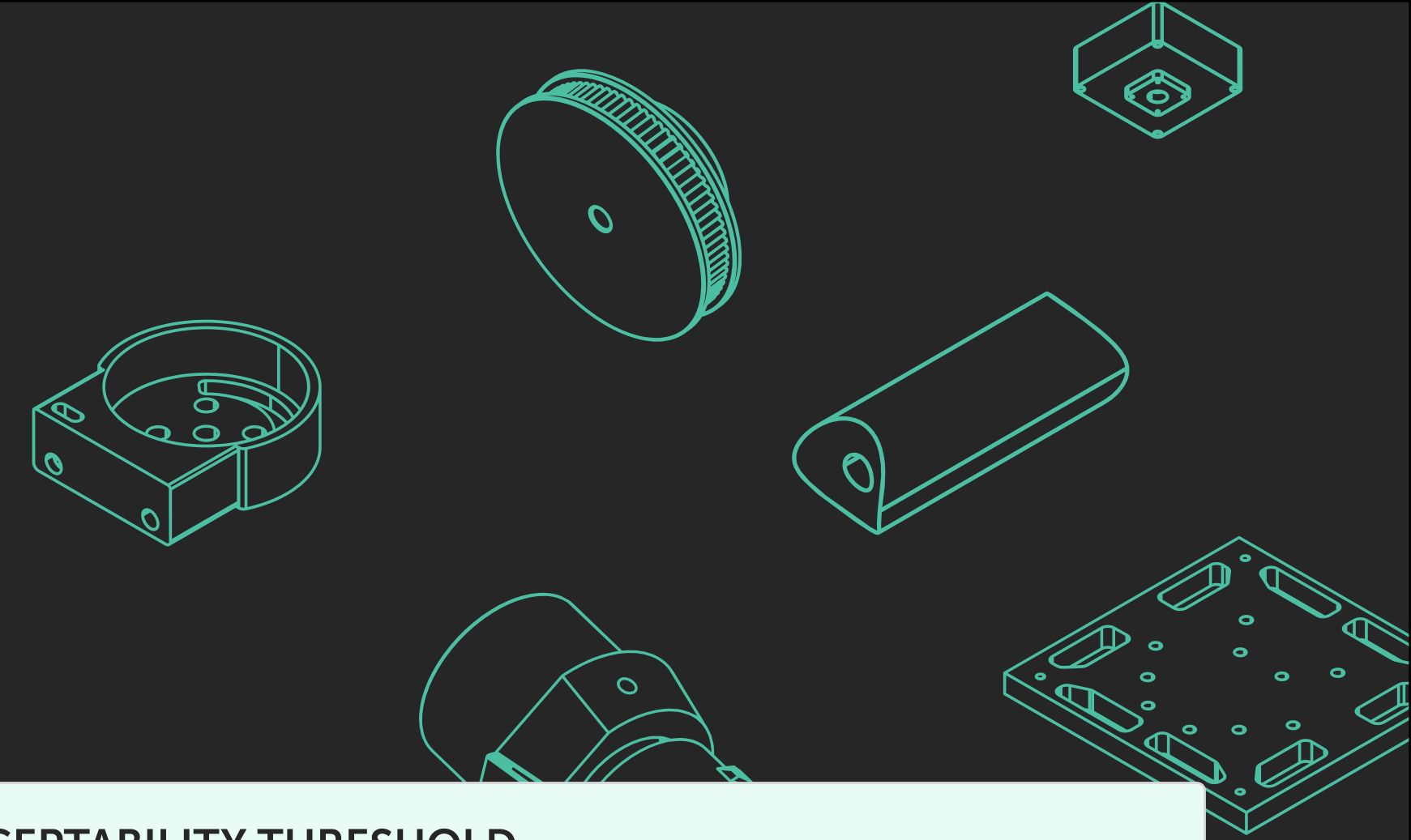


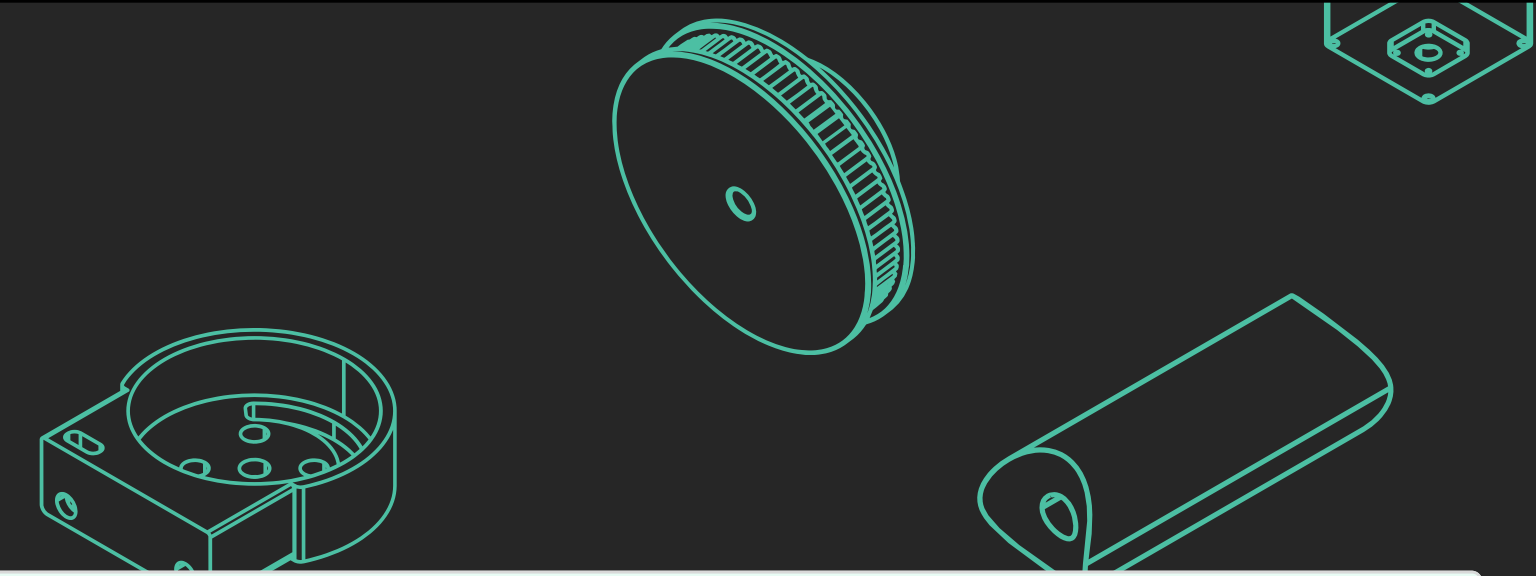
COSMETIC STANDARDS

CNC



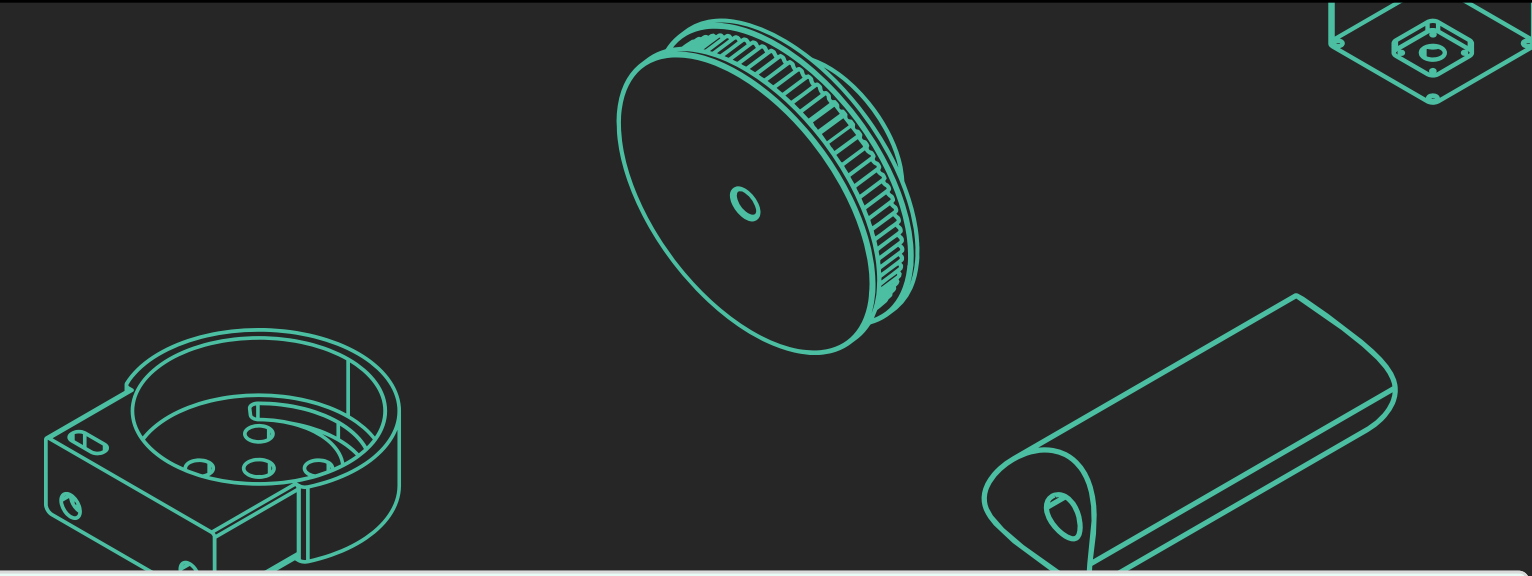
COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD
Scratch	Visible line or mark.	< 10mm and can't be felt with a fingernail or ≤ 1mm and can be felt with a fingernail.
Dent or Ding	Local material impression.	≤ .5mm in any dimension.
Gouge	Surface imperfection, deeper than a scratch, that penetrates 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



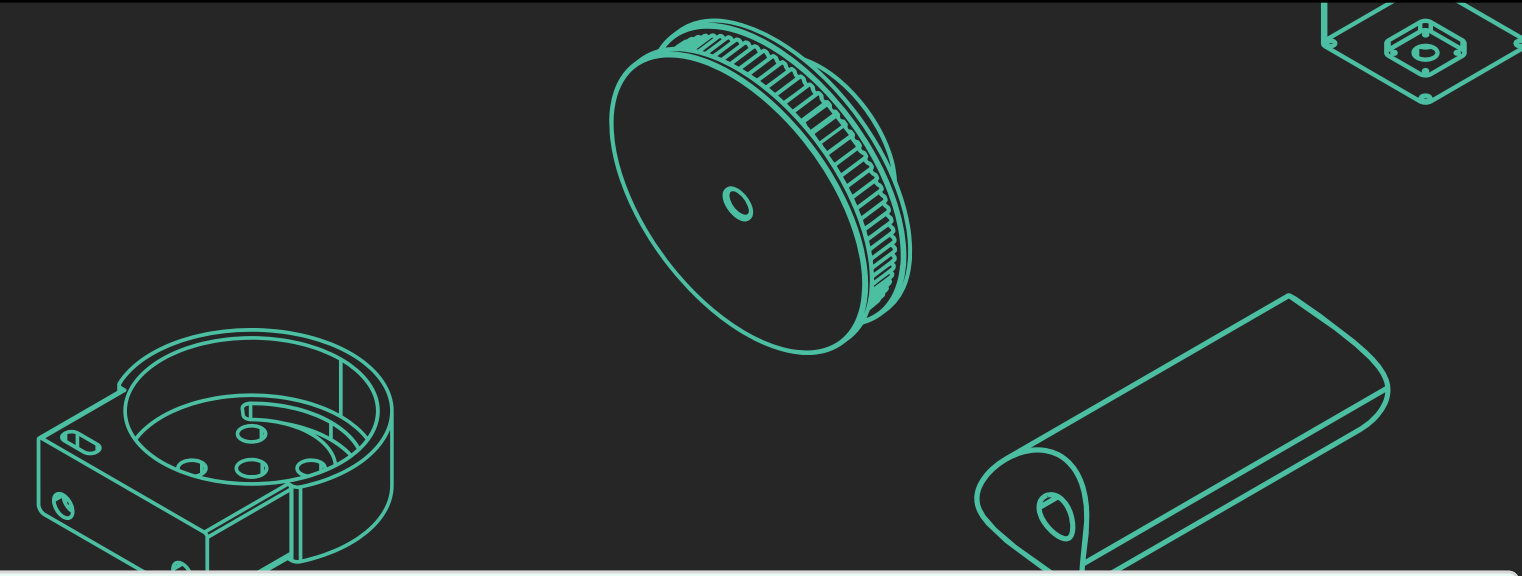
COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD				
		FDM	POLYJET	SLS	MJF	SLA
Scratches	Visible line or mark.	< 10mm and can be felt with a fingernail.	< 5mm and cannot be felt with a fingernail, or $\leq 1\text{mm}$ and can be felt with a fingernail.	< 10mm and cannot be felt with a fingernail, or $\leq 1\text{mm}$ and can be felt with a fingernail.	< 10mm and cannot be felt with a fingernail, or $\leq 1\text{mm}$ and can be felt with a fingernail.	< 5mm and cannot be felt with a fingernail, or $\leq 1\text{mm}$ and can be felt with a fingernail, or there are < 2 scratches within 1cm^2
Gouge	Surface imperfection, deeper than a scratch, that penetrates into the surface, often with raised edges.	Unacceptable.	Unacceptable.	Unacceptable.	Unacceptable.	Unacceptable.
Leftover Support	Support structure that has been left on final part.	Unacceptable, unless the risk was surfaced during order placement or lifetime.	Unacceptable, unless the risk was surfaced during order placement or lifetime.	Unacceptable, unless the risk was surfaced during order placement or lifetime.	Unacceptable, unless the risk was surfaced during order placement or lifetime.	Unacceptable, unless the risk was surfaced during order placement or lifetime.
Discoloration	Change from original color or inconsistent color within the same part.	Unacceptable.	Unacceptable.	Unacceptable.	Unacceptable.	Unacceptable.

3D PRINTING (cont'd)



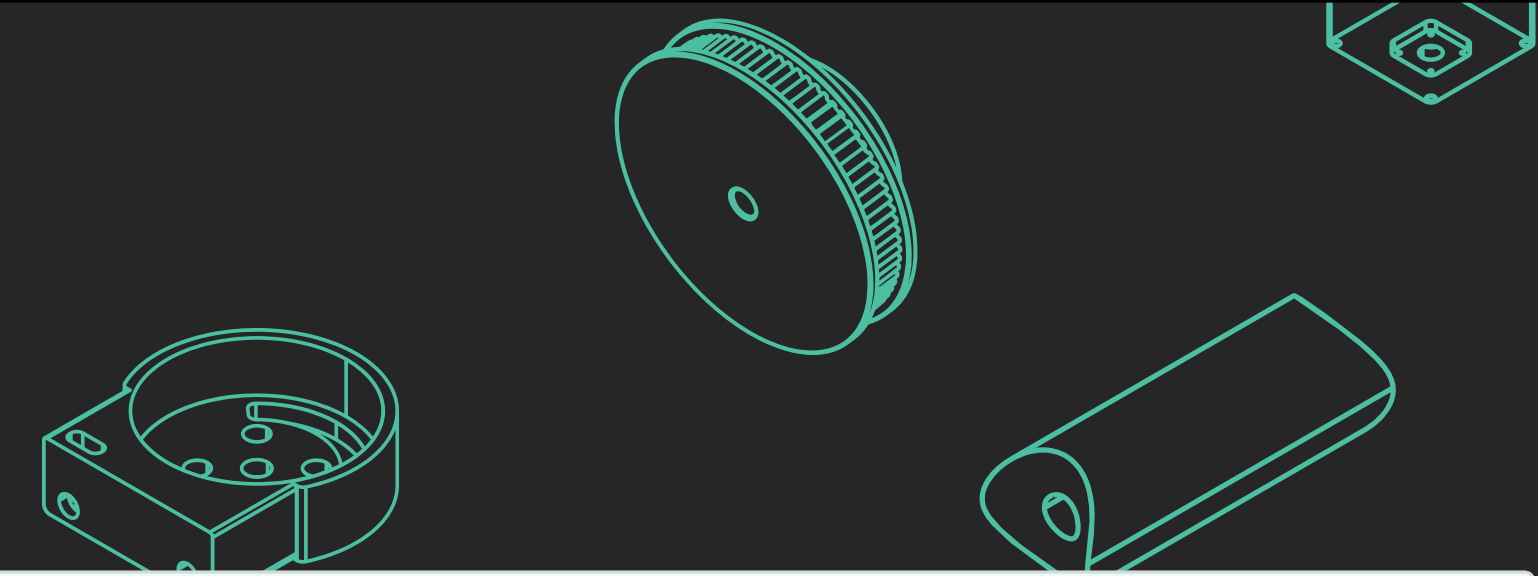
COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD				
		FDM	POLYJET	SLS	MJF	SLA
Warpage	Curved wall or feature that should otherwise be straight.	Unacceptable.	Unacceptable.	≤ 1mm from nominal or the risk has been accepted during order placement or lifetime due to the part geometry.	≤ 1mm from nominal or the risk has been accepted during order placement or lifetime due to the part geometry.	≤ 1mm from nominal or the risk has been accepted during order placement or lifetime due to the part geometry.
Seam Line	Small clump on every layer that indicates the start and end of a layer.	Acceptable.	-	-	-	-
Minor Stringing	Stray, hair-thin filaments protruding from a surface or existing between two features.	Acceptable for PETG. Must be minor for PLA and ABS.	-	-	-	-
Elephant's Foot	Slight lip on bottom-most layer.	Unacceptable.	-	-	-	-
Excessive Clumping	Blobs or small bunches of material, usually 1mm or more in diameter, typically due to over-extrusion.	Unacceptable.	-	-	-	-

3D PRINTING (cont'd)



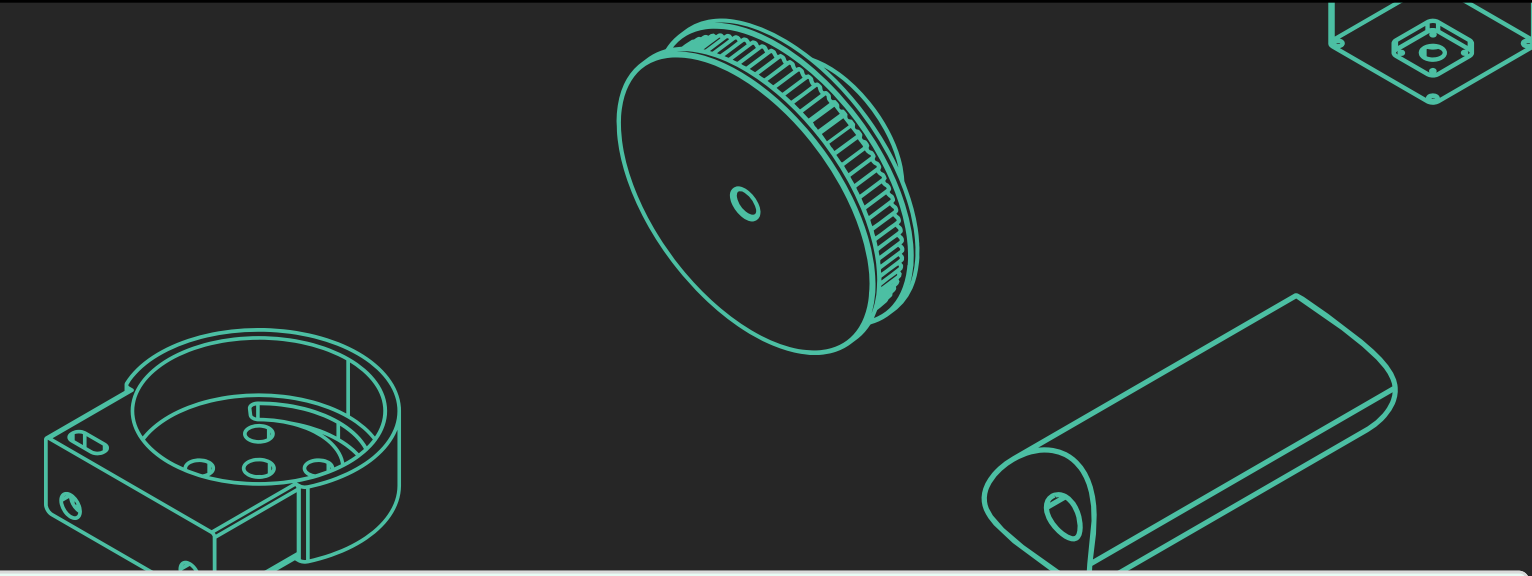
COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD				
		FDM	POLYJET	SLS	MJF	SLA
Non-Adhesion	Slight lift of bottom-most layer as a result of the part cooling and pulling off from the build bed.	Must be <1mm from nominal.	-	-	-	-
Under-Extrusion	Missing material within or between layers as a result of the nozzle path.	Only acceptable if the under extruded feature is ≤ 2 mm thick.	-	-	-	-
Missing Layer Or Portion Of	Incomplete or missing layer.	Unacceptable.	Unacceptable.	-	-	-
Roughness	Coarseness of surface due to support removal or handling that can be felt by touch.	Acceptable for difficult geometries or where support may have been.	Unacceptable.	-	-	Unacceptable.
Delamination	Poor adhesion between layers.	Unacceptable.	Unacceptable.	-	-	Unacceptable.

3D PRINTING (cont'd)



COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD				
		FDM	POLYJET	SLS	MJF	SLA
Sinking	Slump or gradient along a modeled flat surface that can be felt by touch.	Unacceptable.	Unacceptable.	Sunken area must be $\leq 1\text{mm}$ deep.	Sunken area must be $\leq 1\text{mm}$ deep.	-
Layer Shift	Misalignment of consecutive layers.	Unacceptable.	-	Unacceptable.	Unacceptable.	-
Under Sintering	Gap or missing material on a surface as a result of powder not properly sintering to the main part.	-	-	Lack of material must be $\leq 1\text{mm}$ from nominal.	Lack of material must be $\leq 1\text{mm}$ from nominal.	-
Over Sintering	Extra material on a surface or feature as a result of surrounding powder heating up to the point of adhering to the main part.	-	-	Extra material must be $\leq 1\text{mm}$ from nominal.	Extra material must be $\leq 1\text{mm}$ from nominal.	Unacceptable.
Elephant Skin	Peeling of the dye when a section of the part cools too quickly in the printing process	-	-	-	Unacceptable.	-

3D PRINTING (cont'd)



COSMETIC CHARACTER	DEFINITION	ACCEPTABILITY THRESHOLD				
		FDM	POLYJET	SLS	MJF	SLA
Raised Bumps	Visually raised material on what should be a smooth surface that can be felt by touch.	-	-	-	Must be $\geq 0.5\text{mm}$ from nominal in height and $\geq 1\text{mm}$ in width.	-
Nubs	Small dots on a part as a result of support removal, typically 1mm^3 .	-	-	-	-	Acceptable.
Air Bubbles	A process limitation where air bubbles are trapped as a new layer of resin covers a part after the build bed lowers.	-	-	-	-	Acceptable.
Under Curing	Gap or missing material on surface as a result of resin not properly cured to the main part.	-	-	-	-	If the missing resin changes the feature geometry by $\geq 1\text{mm}$ from nominal, fail. If the part texture is sticky, fail.
Elephant Skin	Holes and ruptures in a wall.	-	-	-	-	Unacceptable, unless risk has been accepted during order placement or lifetime due to the part geometry.

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