forward-am.com

Get in Touch Now!

FORWARD AM
Innovating Additive Manufacturing

BASF
We create chemistry

3D Printing Materials & Solutions

Summer 2024

Innovating Additive Manufacturing

Discover one of the largest portfolios of high-performance materials for Additive Manufacturing

At Forward AM, we accompany you from first idea to final printed part. Our portfolio includes materials and solutions for all major Additive Manufacturing technologies - from powders to plastic and metal filaments to photopolymers.

Have a 3D printing project in mind?

At Forward AM, we drive the industrialization of Additive Manufacturing.

We accompany customers from first idea to final printed part - on global scale, at highest quality.

Get in Touch Now!

forward-am.com

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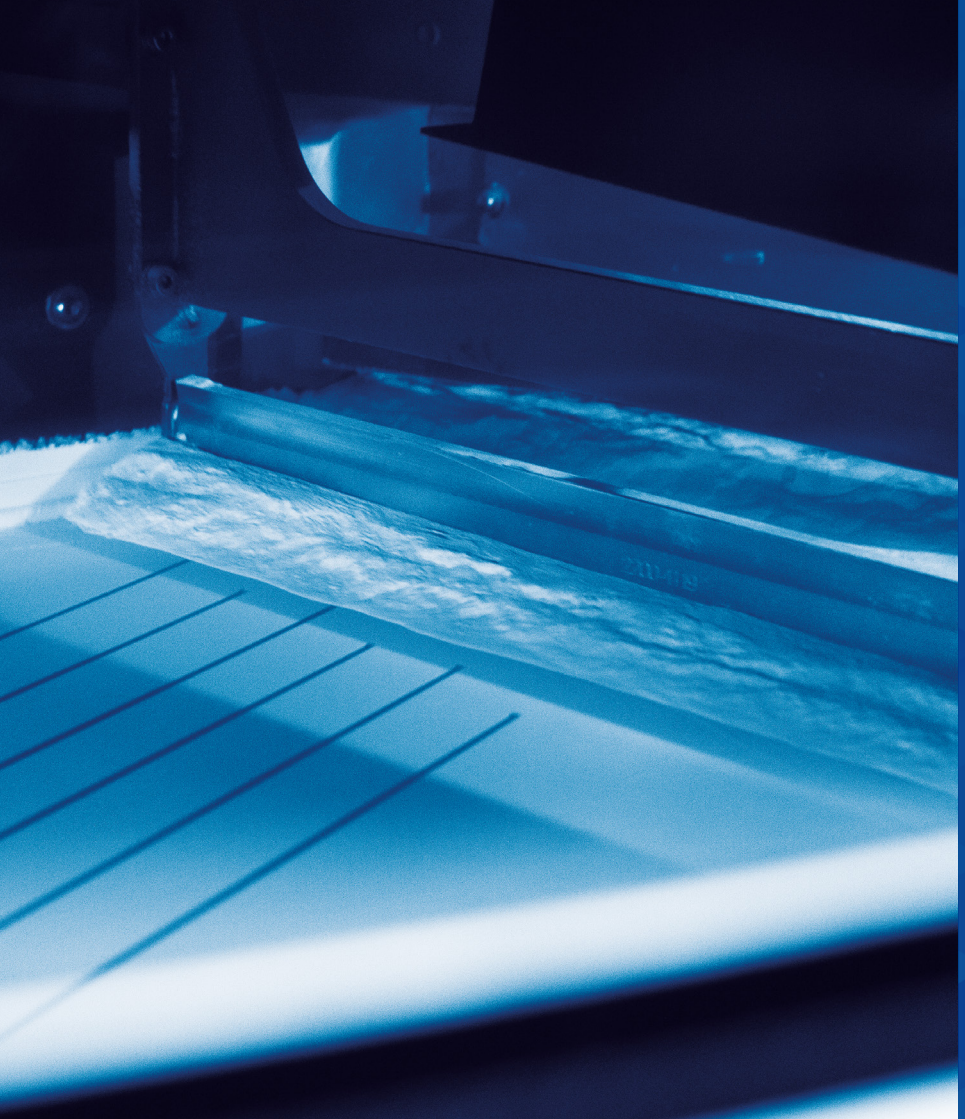


POWDER BED FUSION

Explore the Ultrasint® line of performance polymers that are perfectly adapted to scaled Additive Manufacturing production for any application.

Mechanical Properties Comparison

		PP Line	PA11 Line					TPU Line			
		PP 1400 Black	PA11 (Conditioned)	PA11 Black (Conditioned)	PA11 CF (Conditioned)	PA11 rCF (Conditioned)	PA11 ESD (Conditioned)	TPU01 for HP MJF	TPU 88A	TPU 88A Black	TPU 90A LT
HDT A [°C] ISO 75-2		62	76	62	151	182	111	97 (3)	98 (3)	101,7 (3)	
HDT B [°C] ISO 75-2		102	176	177	189	191	186				
Shore A Hardness DIN ISO 7619-1		-	-	-	-	-	-	88-90	88-90	86-88	90
Tensile Strength [MPa] ISO 527-2 (23 °C)	XY	29	45	45	71	69	55	9	8	8	9
	ZX	29	46	45	48	42	47	7	7	5	7
Elongation at Break [%] ISO 527-2 (23 °C)	XY	25	45	42	11	10	22	280 (1)	270 (1)	360 (1)	280 (1)
	ZX	25	31	34	17	9	31	150 (1)	130 (1)	100 (1)	120 (1)
E Modulus [MPa] ISO 527-2 (23 °C)	XY	1250	1100	1150	4500	4300	2300	85 (2)	75 (2)	85 (2)	110 (1)
	ZX	1300	1250	1200	2000	1750	1500	-	-	-	
Charpy Impact Strength (notched) [kJ/m^2] ISO 179-1	XY	4,0	8,3	11	6,7	7,2	7,3	No break	No break	No break	No break
	ZX	4,0	4,5	11	4,7	2,7	5,3	No break	No break	No break	No break
Charpy Impact Strength (unnotched) [kJ/m^2] ISO 179-1	XY	34	198	No break	63	52	101	-	-	-	-
	ZX	28	85	75	51	38	107	-	-	-	-

(1) DIN 53504, S2 (2) ISO 527-2, 1A (3) Vicat/A (10 N) / °C - DIN EN ISO 306 (4) Izod Test Method A with notched ASTM D256

Printer Compatibility

■ Compatible
□ Open parameter kit required

		PP Line	PA11 Line					TPU Line			
		PP 1400 Black	PA11	PA11 Black	PA11 CF	PA11 rCF	PA11 ESD	TPU01 for HP MJF	TPU 88A	TPU 88A Black	TPU 90A LT
HP	5200 Series							■			
Prodways	P1000 / P1000 S / P1000 X	□	□	□	□	□	□		□	□	□
3D Systems	Sinterstation / Vanguard / sPro 60	■	■	■	■	■	■		■	■	■
Nexa3D	QLS 230 / QLS 236 / QLS 260 / XYZprinting MfgPro Series		■	■	■	■	■		■	■	■
Farsoon	Flight Series	■		■	■	■				■	
	252P Series / 403P Series / eForm	■	■	■	■	■	■		■	■	■
EOS	P1 Series / P3 Series / P7 Series		□	□					□	□	□

Tests & Certification Summary

■ Statement Available
□ Test in Progress

		PP Line	PA11 Line					TPU Line			
		PP 1400 Black	PA11	PA11 Black	PA11 CF	PA11 rCF	PA11 ESD	TPU01 for HP MJF	TPU 88A	TPU 88A Black	TPU 90A LT
Product Statements	Skin Contact	■	■					■	■	■	■
	USP Class IV		■								
	Food Contact		■								
	UL Blue Card							■			
Application Specific Testing	Long Term Heat Aging										
	UV Resistance ISO 4892-2	■	■	■				■	■	■	■
	Hydrolysis Resistance							■	■		■
	Air Tightness / Burst Pressure							■	■		
	Temperature Performance High Temperature Mechanicals	■	■		■	■	■	■	■		

		PP Line	PA11 Line					TPU Line			
		PP 1400 Black	PA11	PA11 Black	PA11 CF	PA11 rCF	PA11 ESD	TPU01 for HP MJF	TPU 88A	TPU 88A Black	TPU 90A LT
Electrical	**Specific Volume Resistivity** IEC 62631-3-1	■	■	■	■	■	■	■			
	Specific Surface Resistivity IEC 62631-3-2	■	■	■	■	■	■				
	Dielectric Strength IEC 60234-1	■	■	■	■	■	■	■			
	CTI IEC 60112										
	Fatigue Rossflex							■	■	■	■
Flame Retardance	**Flammability** UL 94	■	■	■	■	■	■	■	■		
	Flammability FMVSS 302							■	■		

Sustainability Summary

■ Currently Available
□ In Progress

	PP Line	PA11 Line					TPU Line			
	PP 1400 Black	PA11	PA11 Black	PA11 CF	PA11 rCF	PA11 ESD	TPU01 for HP MJF	TPU 88A	TPU 88A Black	TPU 90A LT
Recyclable	■	■	■	■	■	■	■	■	■	■
Refresh Rate (Old/New in %) *	60/40	50/50	50/50	50/50	50/50	50/50	80/20	80/20	80/20	80/20
Take Back Program		■	■				■	■	■	■
Life Cycle Assessment	■	■	■				■	■	■	
Carbon Compensation	■						■	□	□	□

*Typical value. The exact refresh rate depends on the machine type and printing technology, processing parameters, material usage intensity, packing density, part geometry and individual part property requirements.

Life Cycle Assessment (LCA): Study that calculates how much environmental impact is associated with every step of a product. The environmental score for these materials is representative of the stages of “Raw material extraction and production” and “Material preparation for 3D printing”.

Carbon Compensation: A strategy to reduce carbon emissions by investing in practices that absorb or mitigate CO2.

Take Back Program: The collection of powder and end parts to reduce plastic waste and promote sustainability.

Refresh Rate: minimum ratio of fresh / virgin powder one needs to add to your pre-used, unsintered powder to maintain its best printing quality.

Post-Processing Summary

■ Compatible

	PP Line	PA11 Line					TPU Line			
	PP 1400 Black	PA11	PA11 Black	PA11 CF	PA11 rCF	PA11 ESD	TPU01 for HP MJF	TPU 88A	TPU 88A Black	TPU 90A LT
Chemical Smoothing	■	■	■	■	■	■	■	■	■	■
Ultracur3D® Coat F+		■	■				■	■	■	■
Dyeing		■					■	■		■

Materials enabled by BASF

Available through Printer Manufacturers

HP 3D HR PP

SINTERIT

FLEXA Performance
PA11 Onyx
PA11 CF
PA11 ESD

Ultrasint® PP 1400 Black

Technology:

Powder Bed Fusion

Color:

Black

Machine Compatibility:

SLS machines equipped with roller recoater Farsoon - Prodways - 3D Systems - Alternative laser systems (e.g. diode or fiber lasers)

Easy to Process
Time and cost savings

Isotropic Behaviour
Facilitates data preparation and gives printing flexibility

Chemical Resistance
Ideal for media flow and storage parts

Ultrasint® PP 1400 Black

Suited for:

Transportation

Industrial

Insoles

Automotive

Access all resources by scanning the QR code

This information and values are presented as guidance only and based on Forward AM knowledge and experience. It is believed to be accurate, however all guarantees are explicitly denied. This document was updated September 2023.

Technical Specifications

Mechanical properties	Standard	X / Z
Charpy Impact Strength Unnotched (kJ/m²)	ISO 179-1	34 / 28
E-Modulus (MPa)	ISO 527-2	1250 / 1300
Tensile Strength (MPa)	ISO 527-2	29 / 29
Elongation at Break (%)	ISO 527-2	25 / 25

Complete TDS

Post-Processing

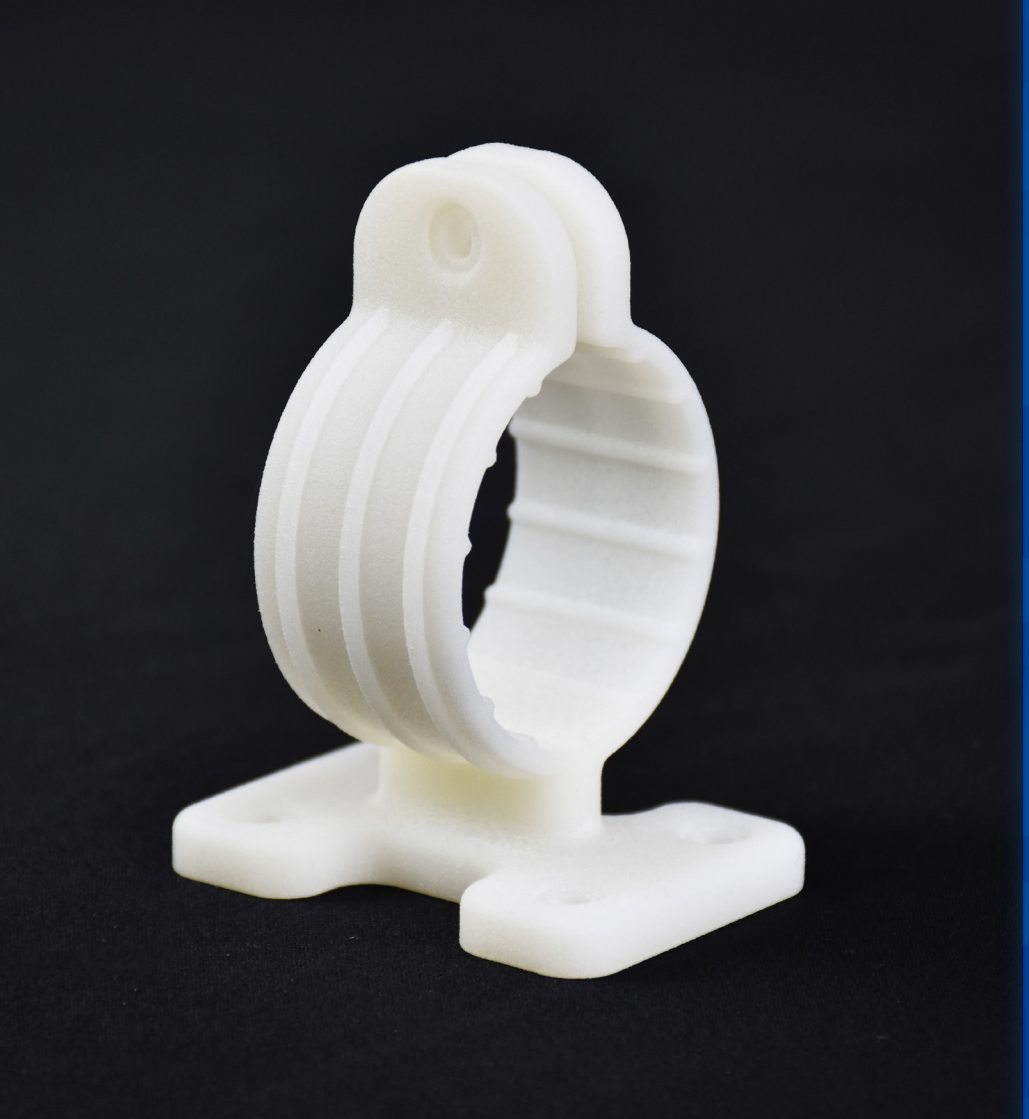
Chemical Smoothing

Read the whitepaper to learn in detail how to surface treat thermoplastic polymer 3D-printed parts and obtain parts with improved airtightness.

Whitepaper available.

Ultracur3D UV Adhesion Promoter

A solvent-borne UV-Primer to improve the adhesion for rigid 3D-Printing Materials. It is compatible with commercially available topcoats and clearcoats.



Ultrasint® PA11

Technology:

Powder Bed Fusion

Color:

White/Black

Machine Compatibility:

SLS machines

EOS - Farsoon - Prodways - 3D Systems - XYZprinting

High Toughness
Able to withstand high mechanical loads and not splinter

Bio-sourced
Bio-derived from sustainable castor oil

High Elongation at Break
Elongation at Break up to 45%

Ultrasint® PA11

Suited for:

Medical Applications

Industrial

Consumer Goods

Automotive

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	X / Z
Charpy Impact Strength Unnotched (kJ/m²)	ISO 179-1	198 / 85
E-Modulus (MPa)	ISO 527-2	1100 / 1250
Tensile Strength (MPa)	ISO 527-2	45 / 46
Elongation at Break (%)	ISO 527-2	45/31

Complete TDS

Tests & Certifications

Skin Contact / Biocompatibility	Food Contact
ISO 10993-10 ISO 10993-5 USP Class IV	Statement Available

Post-Processing

Chemical Smoothing

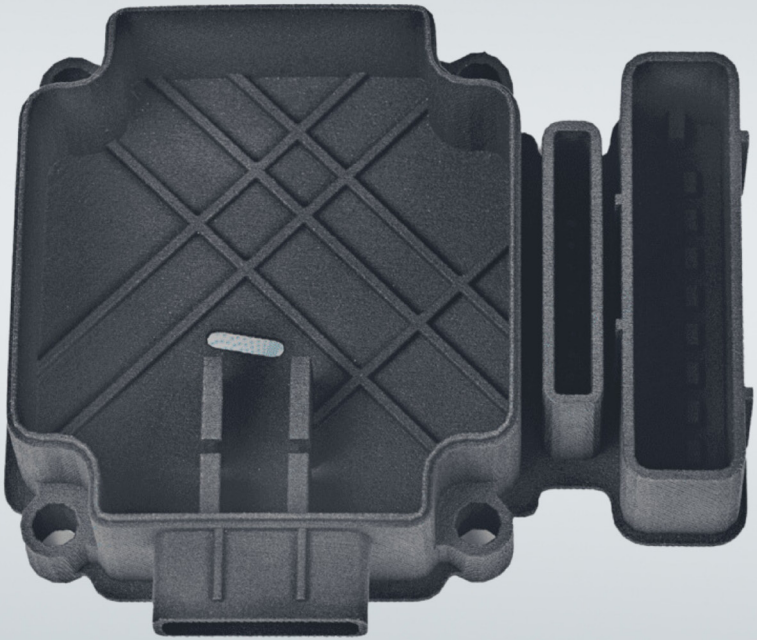
Both mechanical and chemical smoothing will improve material performance while enhancing the appeal, durability, surface roughness and overall quality.

Ultracur3D® Coat F+

The Forward AM Ultracur3D® Coat F+ is a flexible waterborn 2k-basecoat designed to offer exceptional flexibility for 3D Printing Materials and enables new possibilities for advanced applications.

Dyeing

Liquid dyeing ensures that color evenly reaches all surfaces of the parts including small cavities, lattices, and hollowed parts.



Ultrasint® PA11 Black

Technology:

Powder Bed Fusion

Color:

White/Black

Machine Compatibility:

SLS machines

EOS - Farsoon - Prodways - 3D Systems - XYZprinting

High Toughness
Able to withstand high mechanical loads and not splinter

Bio-sourced
Bio-derived from sustainable castor oil

High Elongation at Break
Elongation at Break up to 45%

Ultrasint® PA11 Black

Suited for:

Medical Applications

Industrial

Consumer Goods

Automotive

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	X / Z
Charpy Impact Strength Unnotched (kJ/m²)	ISO 179-1	no break / 75
E-Modulus (MPa)	ISO 527-2	1150 / 1200
Tensile Strength (MPa)	ISO 527-2	28 / 26
Elongation at Break (%)	ISO 527-2	42 / 34

Complete TDS

Post-Processing

Chemical Smoothing

Both mechanical and chemical smoothing will improve material performance while enhancing the appeal, durability, surface roughness and overall quality.

Ultracur3D® Coat F+

The Forward AM Ultracur3D® Coat F+ is a flexible waterborn 2k-basecoat designed to offer exceptional flexibility for 3D Printing Materials and enables new possibilities for advanced applications.

Ultrasint® PA11 CF

Carbon Fiber

Technology:

Powder Bed Fusion

Color:

Black

Machine Compatibility:

SLS machines

Farsoon - Prodways - 3D Systems

Carbon-Fiber Reinforced

Excellent for high strength and rigidity applications

High impact resistance

Charpy impact unnotched up to 63 kJ/m², good option to replace metal parts

High Strength to Weight Ratio

Key for lightweight structures

Ultrasint® PA11 CF

Suited for:

Manufacturing

Industrial

Consumer Goods

Automotive

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Technical Specifications

Mechanical properties	Standard	X / Z
Charpy Impact Strength Unnotched (kJ/m²)	ISO 179-1	63 / 45
E-Modulus (MPa)	ISO 527-2	4550 / 1700
Tensile Strength (MPa)	ISO 527-2	71 / 37
Elongation at Break (%)	ISO 527-2	11 / 5.2

Complete TDS

Tests & Certifications

Bio-sourced

Bio-derived from sustainable castor oil

Thermal Performance

Good heat-ageing performance

Post-Processing

Chemical Smoothing

Both mechanical and chemical smoothing will improve material performance while enhancing the appeal, durability, surface roughness and overall quality.

Ultracur3D® Coat F+

The Forward AM Ultracur3D® Coat F+ is a flexible waterborn 2k-basecoat designed to offer exceptional flexibility for 3D Printing Materials and enables new possibilities for advanced applications.

Ultrasint® PA11 rCF

Carbon Fiber

Technology:

Powder Bed Fusion

Color:

Black

Machine Compatibility:

SLS machines

Farsoon - Prodways - 3D Systems

Carbon-Fiber Reinforced
Excellent for high strength and rigidity applications

High impact resistance
Charpy impact unnotched up to 63 kJ/m², good option to replace metal parts

High Strength to Weight Ratio
Key for lightweight structures

Recycled Carbon Fiber

Ultrasint® PA11 rCF

Suited for:

Manufacturing

Industrial

Consumer Goods

Automotive

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	X / Z
E-Modulus (MPa)	ISO 527-2	4300 / 1750
Tensile Strength (MPa)	ISO 527-2	69 / 42
Elongation at Break (%)	ISO 527-2	10 / 9

Complete TDS

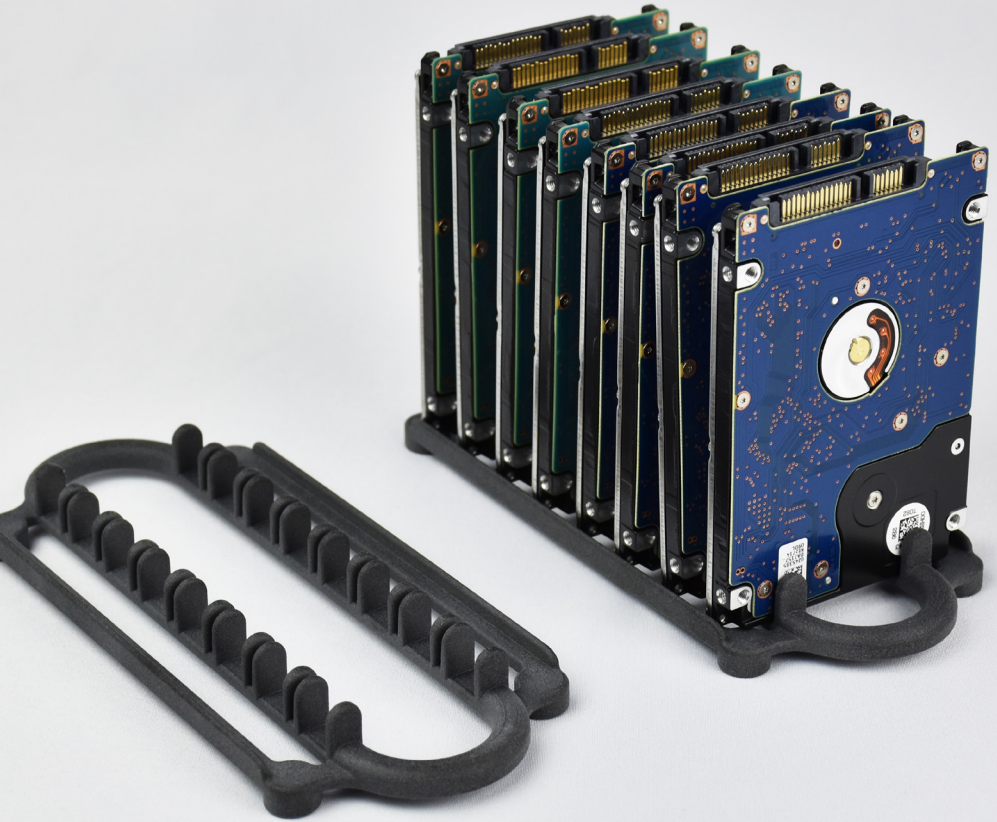
Post-Processing

Chemical Smoothing

Both mechanical and chemical smoothing will improve material performance while enhancing the appeal, durability, surface roughness and overall quality.

Ultracur3D® Coat F+

The Forward AM Ultracur3D® Coat F+ is a flexible waterborn 2k-basecoat designed to offer exceptional flexibility for 3D Printing Materials and enables new possibilities for advanced applications.



Ultrasint® PA11 ESD

Electrostatic Safety Discharge

Technology:

Powder Bed Fusion

Color:

Gray

Machine Compatibility:

SLS machines

Farsoon - Prodways - 3D Systems

High Toughness
Able to withstand high mechanical loads and not splinter

Electrostatic Safety Discharge
Reduces the risk of electrostatically induced damage or failure

Bio-sourced
Bio-derived from sustainable castor oil

Ultrasint® PA11 ESD

Suited for:

Electronics

Industrial

Robotics

Automotive

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	X / Z
Charpy Impact Strength Unnotched (kJ/m²)	ISO 179-1	101 / 107
E-Modulus (MPa)	ISO 527-2	2300 / 1550
Tensile Strength (MPa)	ISO 527-2	55 / 47
Elongation at Break (%)	ISO 527-2	22 / 31

Complete TDS

Tests & Certifications

Electrical Volume & Surface Resistivity	Thermal Performance
IEC 62631-3-1	Good heat-ageing performance
IEC 62631-3-2	

Post-Processing

Chemical Smoothing

Both mechanical and chemical smoothing will improve material performance while enhancing the appeal, durability, surface roughness and overall quality.

Ultracur3D® Coat F+

The Forward AM Ultracur3D® Coat F+ is a flexible waterborn 2k-basecoat designed to offer exceptional flexibility for 3D Printing Materials and enables new possibilities for advanced applications.

Ultrasint® TPU01

Technology:

Powder Bed Fusion

Color:

Gray

Machine Compatibility:

MJF Machines

HP Jet Fusion 5200 Series

Highly flexible

Shore A 88 hardness

High Reusability

Up to 80% of powder reusability

Lattice Structures

Enabled by BASF Ultrasim®

Ultrasint® TPU01

Suited for:

Footwear

Industrial

Sports

Automotive

Medical Applications

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	X / Z
Charpy Impact Strength Notched -10°C (kJ/m²)	ISO 179-1	46 / 44
E-Modulus (MPa)	ISO 527-2, 1A	85 / 85
Tensile Strength (MPa)	DIN 53504, S2	9 / 7
Elongation at Break (%)	DIN 53504, S2	280 / 150

Complete TDS

Tests & Certifications

Skin Contact	UV Stability
ISO 10993-10 & ISO 10993-5	ISO 4892-2B Cycle 3 ISO 4892-2A Cycle 1

Post-Processing and Related Services

Chemical Smoothing

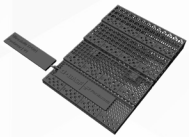
Both mechanical and chemical smoothing will improve material performance while enhancing the appeal, durability, surface roughness and overall quality.

Whitepaper available.

Ultracur3D® Coat F+

Flexible waterborn 2k-basecoat designed to offer exceptional flexibility for elastic 3D Printing Materials and enables new possibilities for advanced applications.

Ultrasim® 3D Lattice Design



Lattice engineering unlocks the potential of high-performance materials for any application. Customized lattices can be engineered to specific mechanical properties.

Ultrasint® TPU 88A

Technology:

Powder Bed Fusion

Color:

White

Machine Compatibility:

All SLS machines

Farsoon - EOS - 3D Systems - XYZprinting

High Reusability

Up to 80% of powder reusability

Excellent Surface Quality and High Level of Detail

Highly flexible

Shore A 88 hardness

Ultrasint® TPU 88A

Suited for:

Footwear

Industrial

Sports

Automotive

Medical Applications

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Technical Specifications

Mechanical properties	Standard	X / Z
Charpy Impact Strength Notched -10°C (kJ/m²)	DIN EN ISO 179-1	60 / 58
E-Modulus (MPa)	ISO 527-2, 1A	75 / 75
Tensile Strength (MPa)	DIN 53504, S2	8 / 7
Elongation at Break (%)	DIN 53504, S2	270 / 130

Complete TDS

Tests & Certifications

Skin Contact	UV Stability
ISO 10993-10 & ISO 10993-5	ISO 4892-2B Cycle 3 ISO 4892-2A Cycle 1

Post-Processing and Related Services

Chemical Smoothing

Both mechanical and chemical smoothing will improve material performance while enhancing the appeal, durability, surface roughness and overall quality.

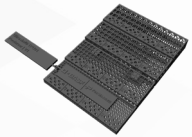
Ultracur3D® Coat F+

The Forward AM Ultracur3D® Coat F+ is a flexible waterborn 2k-basecoat designed to offer exceptional flexibility for 3D Printing Materials and enables new possibilities for advanced applications.

Dyeing

Liquid dyeing ensures that color evenly reaches all surfaces of the parts including small cavities, lattices, and hollowed parts.

Ultrasim® 3D Lattice Design



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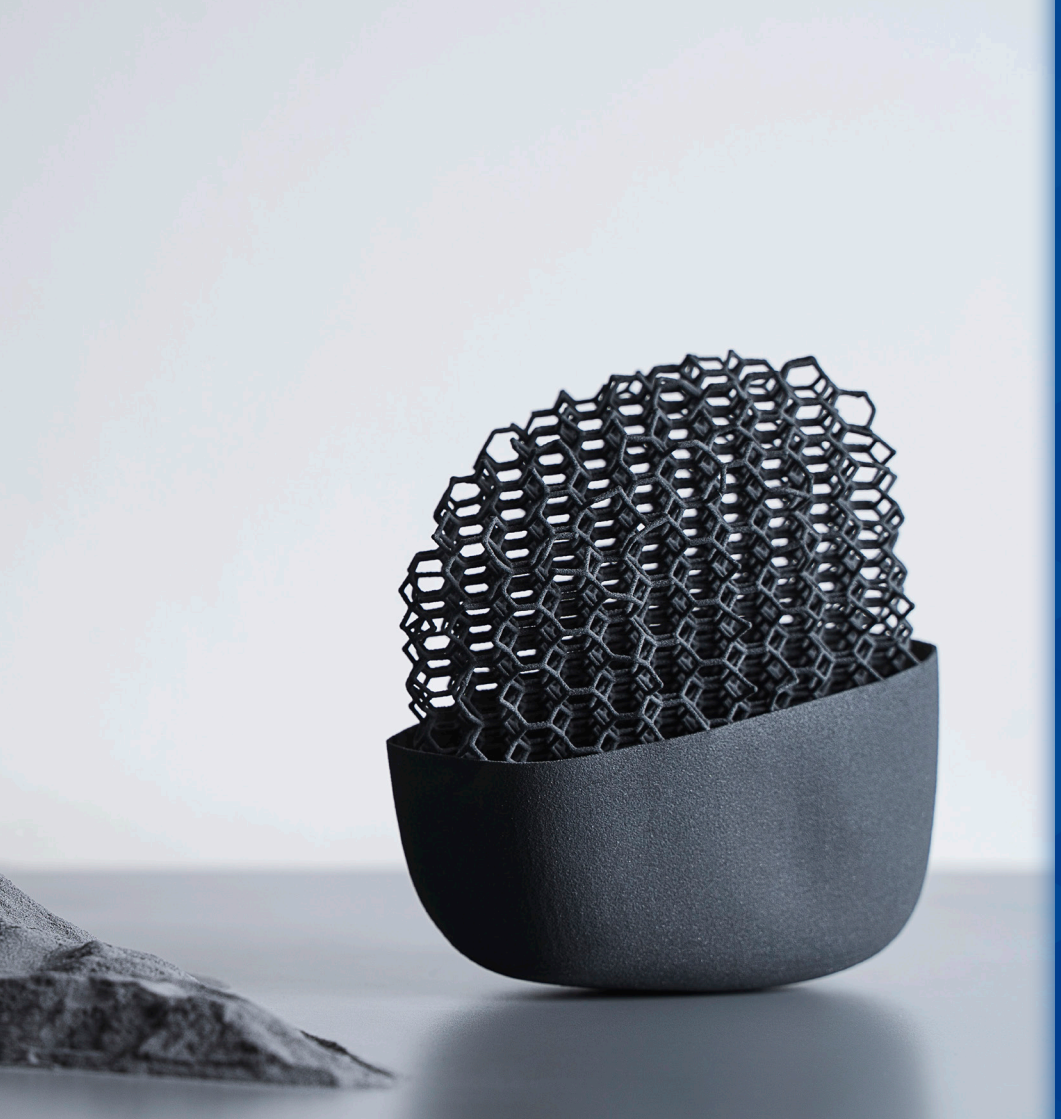

Ultrasint® TPU 88A Black

Technology:

Powder Bed Fusion

Color:

Black

Machine Compatibility:

SLS machines including Desktop Machines

EOS - Farsoon - XYZprinting - 3D Systems

Suitable for Desktop Machines

High Reusability

Up to 80% of powder reusability

High Elasticity and Rebound

Elongation at Break

- up to 360%

Ultrasint® TPU 88A Black

Suited for:

Footwear

Industrial

Sports

Automotive

Medical Applications

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	X / Z
Charpy Impact Strength Notched -30°C (kJ/m²)	DIN EN ISO 179-1	No break / No break
E-Modulus (MPa)	ISO 527-2, 1A	85/85
Tensile Strength (MPa)	DIN 53504, S2	8/5
Elongation at Break (%)	DIN 53504, S2	360/100

Complete TDS

Tests & Certifications

UV Stability	Skin Contact
ISO 4892-2A Cycle 1	ISO 10993-10 & ISO 10993-5

Post-Processing

Chemical Smoothing

Read the whitepaper to learn in detail how to surface treat thermoplastic polymer 3D-printed parts and obtain parts with improved airtightness.

Whitepaper available.

Ultracur3D® Coat F+

Flexible waterborn 2k-basecoat designed to offer exceptional flexibility for elastic 3D Printing Materials and enables new possibilities for advanced applications.

Ultrasint® TPU 90A LT

Technology:

Powder Bed Fusion

Color:

White

Machine Compatibility:

All SLS machines

Farsoon - EOS - 3D Systems - XYZprinting

Lightweight

High Rebound

Highly flexible

Ultrasint® TPU 90A LT

Suited for:

Footwear

Industrial

Sports

Automotive

Medical Applications

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Technical Specifications

Mechanical properties	Standard	X / Z
Tensile Modulus (MPa)	ISO 527-2, 1A	110
Energy Return (%)	DIN 53512	66
Density (g/kg)	DIN EN ISO 1183-1	1.05
Elongation at Break (%)	DIN 53504, S2	280

Complete TDS

Tests & Certifications

Cytotoxicity

Passed

Post-Processing and Related Services

Chemical Smoothing

Both mechanical and chemical smoothing will improve material performance while enhancing the appeal, durability, surface roughness and overall quality.

Ultracur3D® Coat F+

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Dyeing

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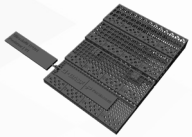
Ultrasim® 3D Lattice Design



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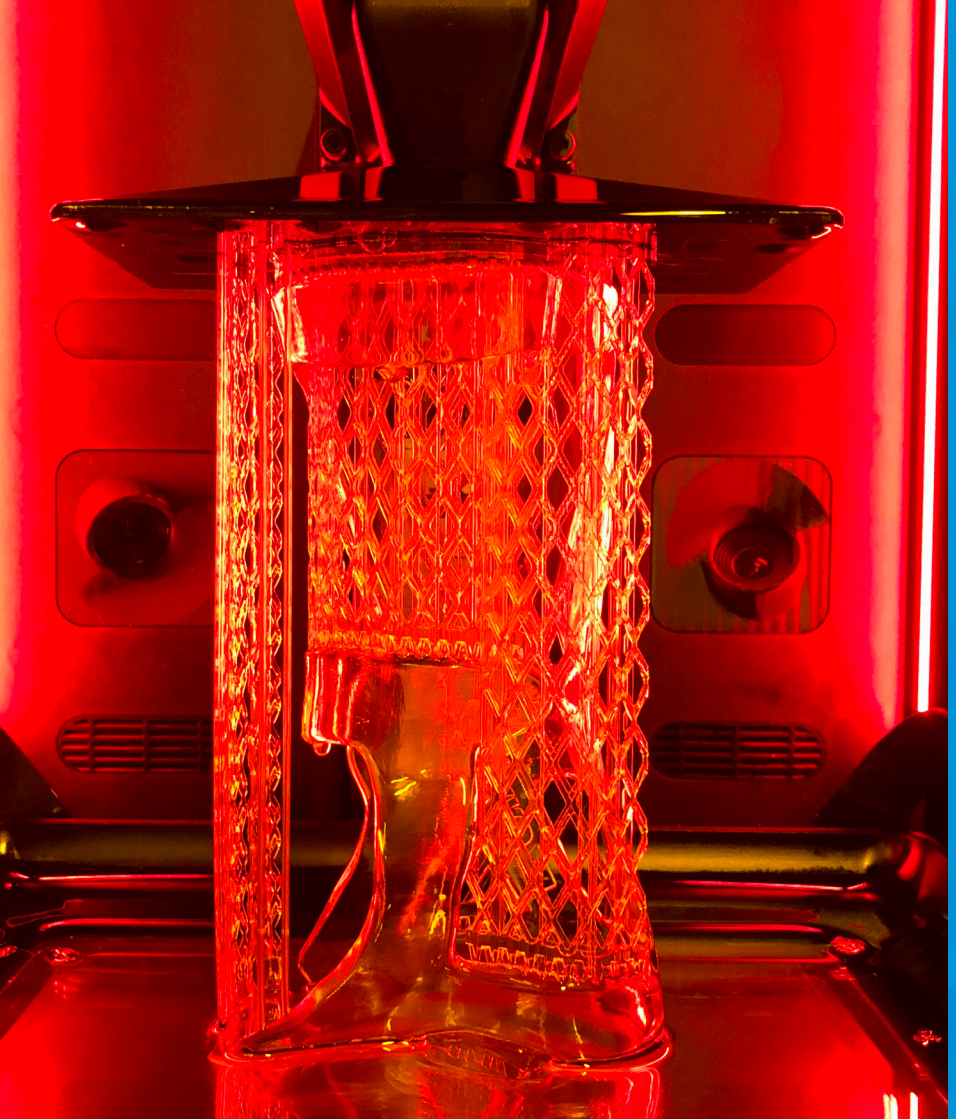


PHOTOPOLYMERS

Discover the wide range of Ultracur3D® reactive urethane photopolymers delivering class-leading performance and consistency to meet your specific application needs.

Mechanical Properties Comparison

	Tough Line				Rigid Line				Dental Line		
	ST 45	ST 80	ST 1400	ST 7500 G	RG 35	RG 1100	RG 3280*	RG 9400 B FR*	DM 2505	DM 2304	DMD 1005
E Modulus [MPa] ASTM D638 type IV	2300	1500	1900	2300	2600	3080	10 600	3900	2200	-	2710
Tensile Strength [MPa] ASTM D638 type IV	60	35	45	54	80	70	87	78	48	4 (1)	60
Elongation at Break [%] ASTM D638 type IV	25	20	43	13	6	5	1.3	3	4	160	4
Flexural Modulus [MPa] ASTM D790	2400	1700	1540	2150	2400	2880	8780	3400	2150	-	2400
Flexural Strength [MPa] ASTM D790	110	60	80	95	110	119	73	115	83	-	85
Impact Strength Izod Notched [J/m] ASTM D256	30	24	43	25	23	16	24	20	15	-	1.6
Hardness ASTM D2240	80 D	80 D	78 D	82 D	85 D	85 D	96 D	88 D	73 D	50 A	80 D
HDT (0.45 MPa) [°C] ASTM D648	73	46	57	64	83	116	284	255	69	-	93
HDT (1.82 MPa) [°C] ASTM D648	61	42	48	54	64	84	132	86	55	-	73
Flammability UL 94 1.5 mm	HB	-	-	-	HB	HB	HB (1,8)	V-0 (2&3)	-	-	-
Viscosity - 25 °C [mPas] Cone/Plate Rheometer	320	600	390	180	900	275	300	830	100	200	150
Tear Strength - Graves [N/mm] ASTM D624 type C	-	-	-	-	-	-	-	-	-	-	-
Rebound Resilience [%] ASTM D7121	-	-	-	-	-	-	-	-	-	-	-

* Mechanical properties with regular UV post-curing and additional thermal post-curing available

Flexible / Elastomeric Line					Engineering Plastic Daylight Line				
FL 300	FL 60	EL 60	EL 150	EL 4000	EPD 1006	EPD 1086	EPD 2006	EPD 3500	EPD 4006
-	-	-	-	-	1500	1810	2370	2500	1800
5 (1)	4 (1)	9 (1)	7 (1)	11 (1)	40	42	50	60	45
245 (1)	90 (1)	95 (1)	182 (1)	170 (1)	25	26	10	18	45
-	-	-	-	-	1460	1620	2210	2400	1600
-	-	-	-	-	52	67	90	110	70
-	-	-	-	-	35	28	11	25	46
40 A	60 A	75 A	80 A	90 A	79 D	81 D	80 D	79 D	78 D
-	-	-	-	-	44	53	81	70	54
-	-	-	-	-	40	46	61	57	43
-	-	-	-	-	HB	HB	HB	-	HB (3)
200	500	4900	120	470	1500	580	460	900	430
9	9	18	14	37	-	-	-	-	-
16	11	21	28	30	-	-	-	-	-

(1) ASTM D412 C

(3) UL 94 3 mm

Tests & Certification Summary

■ Test Completed

	Tough Line				Rigid Line				Dental Line			Flexible / Elastomeric Line					Engineering Plastic Daylight Line				
	ST 45	ST 80	ST 1400	ST 7500 G	RG 35	RG 1100	RG 9400 B FR	RG 3280	DM 2505	DM 2304	DMD 1005	FL 300	FL 60	EL 60	EL 150	EL 4000	EPD 1006	EPD 1086	EPD 2006	EPD 3500	EPD 4006
Temperature Resistance	□□	□	□	□□	□□	□□□	□□□	□□□	□□		□□						□	□	□□	□□	□
Water Absorption	□	□□□	□□□	□□□	□□□	□□□	□□□	□□□	□□	□□	□□□	□□	□□	□□□	□	□	□□□	□□□	□□□	□□□	□□□
Chemical Resistance	□□	□□□		□□□	□□□	□□□	□□□	□□□				□□		□□	□□	□□		□□□	□□□	□□	□□
UV Resistance	□□	□□□	□□	□□□	□□	□□	□□□	□□				□	□□□		□□	□□□		□□	□□	□□	□□
Flammability	■				■	■	■	■									■	■	■		■
Biocompatibility	■	■	■	■	■	■		■				■		■	■	■	■		■		■
Sterilization	■	■	■		■	■		■					■	■							

Printer Compatibility

LEGEND

- ● Validated, available via Forward AM
- ● Validated, available via machine manufacturer
- ○ ○ Preliminary

	DM 2304	DM 2505	EL 60	EL 150	EL 4000	EL 4000 B	FL 60	FL 300	RG 35	RG 35 B	RG 1100	RG 1100 B	RG 3280	RG 9400 B FR	ST 45	ST 45 B	ST 45 M	ST 80	ST 80 B	ST 80 G	ST 80 W	ST 1400	ST 7500 G
Asiga® - MAX X27, MAX X35, MAX X43, MAX UV, PRO 4K 45, PRO 4K 65, PRO 4K 80	●	●		●		●		●	●	●	●	●	●	●		●	●	●			●		○
atum3D® - DLP STATION 5, DLP STATION EXZ (405 nm)			●	●	●	●	●	●		●	●		●	●	●	●		●	●	●	●	●	●
atum3D® - DLP STATION 5 EXZ (365 nm)			●	●		●		●	●	●	●	●		●	●	●		●					
Axtra3D® - Lumia X1			○										●										
Creality3D® - LD-002R							●		●						●	●	●	●			●		
Creality3D® - Halot One CL-60							○		○							○				○			
Creality3D® - Halot Sky-CL-89	●	●			●		●	●	●		●	●	●			●			●	○		●	●
ELEGOO® - Mars 2				○					○							○		○					
ELEGOO® - Mars 2 Pro							○		○						○	○	○						
ELEGOO® - Saturn 2 8K												●			●		●						●
ETEC - Pro XL													●	○									
GENERA® - G1										○		●	○	○		○							○
GENERA® - G2, G3		○		●	●	●			●	●	●	●	●	●	●	●		●			●	●	●
Intrepid® - EPIC													●										

Printer Compatibility

LEGEND

- ● Validated, available via Forward AM
- ● Validated, available via machine manufacturer
- ○ ○ Preliminary

	DM 2304	DM 2505	EL 60	EL 150	EL 4000	EL 4000 B	FL 60	FL 300	RG 35	RG 35 B	RG 1100	RG 1100 B	RG 3280	RG 9400 B FR	ST 45	ST 45 B	ST 45 M	ST 80	ST 80 B	ST 80 G	ST 80 W	ST 1400	ST 7500 G
MiiCraft - Ultra 125 Y (385 nm)	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
MiiCraft - Ultra 125 Y (405 nm)	●	●	●	●	●		●		●	●	●	●	●	●	●	●	●	●		●	●		●
MiiCraft - Prime 150 (405 nm)										●					●	●						●	●
Nexa3D® - NXE 200, NXE 400		●							●	●	○	●	●		●	●	●						
Nexa3D® - XiP										●		●	●	●	●		●						
Nexa3D® - XiP Pro												●	●	●									
Photocentric® - LC Opus		●			●		●		●		●		○			●	●	●				●	
Phrozen® - Sonic Mini 4K, Sonic Mini 8K		●				●	●					●	●	●									●
Phrozen® - Sonic 2022 XL									●	●						●	●		●	●	●		●
Phrozen® - Sonic Mega 8K	●	●			●							●	○										
Prusa® - Original Prusa SL1									●						●	●	●	●		●	●		
Prusa® - Original Prusa SL1S				○				○	○						○		○	○	○		○		

Printer Compatibility

LEGEND

- ● Validated, available via Forward AM
- ● Validated, available via machine manufacturer
- ○ ○ Preliminary

	DM 2304	DM 2505	EL 60	EL 150	EL 4000	EL 4000 B	FL 60	FL 300	RG 35	RG 35 B	RG 1100	RG 1100 B	RG 3280	RG 9400 B FR	ST 45	ST 45 B	ST 45 M	ST 80	ST 80 B	ST 80 G	ST 80 W	ST 1400	ST 7500 G
Raise3D® - DF2												●	●										
RapidShape® - i30+		●	●	●	●		●		●		●	●	●		●			●			●	●	●
RapidShape® - i50+			●	●			○		●	●	●	●	●	●	●	●		●					●
RapidShape® - i100+				○							●	●	●	○	●	●							●
Rayshape® - Shape 1+													●	●									
Shining 3D® - AccuFab-L4K	●	●		●	●	●	●		●	●	●	●			●	●		●	●	●	●	●	●
Stratasys® - Origin® One		●	●	●	●		●	●	●	●	●	●	●	●	●	●		●				●	○
Tangible Engineering® - Solidator 8K V4				●		●		●			○	●	●	○		●							
UnionTech® - Cute 300	○	○	○	●	○		●	○		●		●	●		○	●		○				○	
UnionTech® - Pi 200		○																					
UnionTech® - Martrix 190						●						○											●
Zortrax® - Inkspire 2			●	●	●	○	●		●	●	●	●	●	○	●	●		●	●	●	○	●	●

Ultracur3D® RG 35

Rigid Line

Technology:

LCD (incl. MSLA) & DLP

Color:

Clear & Black

Very high stiffness & high temperature resistance

High accuracy and low shrinkage

Low water uptake

Easy to polish

Ultracur3D® RG 35

Suited for:

- Automotive housings
- Jigs and fixtures
- Molds and inserts
- Electrical castings

Access all resources by scanning the QR code

This information and values are presented as guidance only and based on Forward AM's knowledge and experience. It is believed to be accurate, however all guarantees are explicitly denied. This document was updated June 2024.

Technical Specifications

Mechanical properties	Standard	Value
Young's Modulus (MPa)	ASTM D638 type IV	2600
Tensile Strength (MPa)	ASTM D638 type IV	80
Heat Deflection Temperature (°C)	ASTM D648	83
Hardness (Shore D)	ASTM D2240	85

Complete TDS

Tests & Certifications

Flammability	Skin Contact	UV Stability	Sterilization	Chemical Resistance
UL 94 1.5mm	ISO 10993-5; ISO 10993-10; ISO 10993-11	ISO 4892-2A Cycle 1	Dataset available	Dataset available

Complementary Products

Ultracur3D® Cleaner

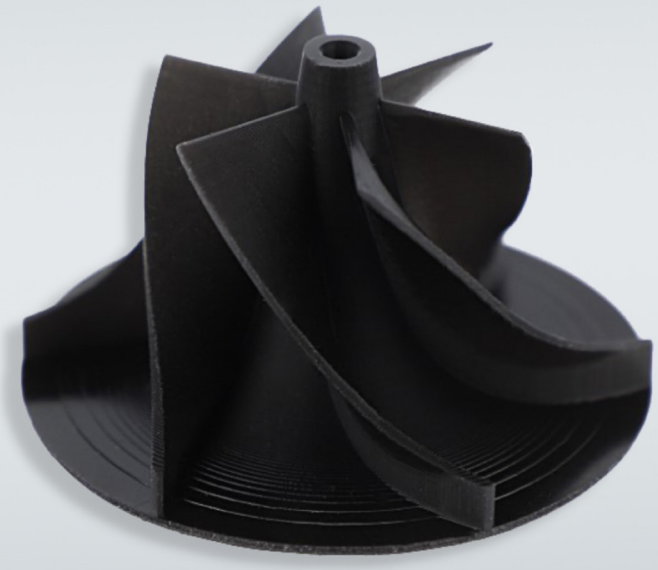
Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® Color Kit

Color kit solution enabling parts in a wide range of colors without the need for post-processing

Ultracur3D® Coat F+

Flexible coating solution to improve part properties and appearance



Ultracur3D® RG 1100

Rigid Line

Technology:

LCD (incl. MSLA) & DLP

Color:

Clear & Black

Very high stiffness

Impressive all-round temperature resistance

Very high chemical resistance and low water uptake

Ultracur3D® RG 1100

Suited for:

Automotive connectors

Engineering parts

Brackets and housings

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Young's Modulus (MPa)	ASTM D638 type IV	3080
Tensile Strength (MPa)	ASTM D638 type IV	70
Heat Deflection Temperature (°C)	ASTM D648	116
Water Absorption, 24h (%)	ASTM D570	0.32

Complete TDS

Tests & Certifications

Flammability	UV Stability	Sterilization	Chemical Resistance	Skin Contact
UL 94 1.5 mm	ISO 4892-2A Cycle 1	Dataset available	Dataset available	ISO 10993-5

Pressure & Temperature Resistance
Dataset available

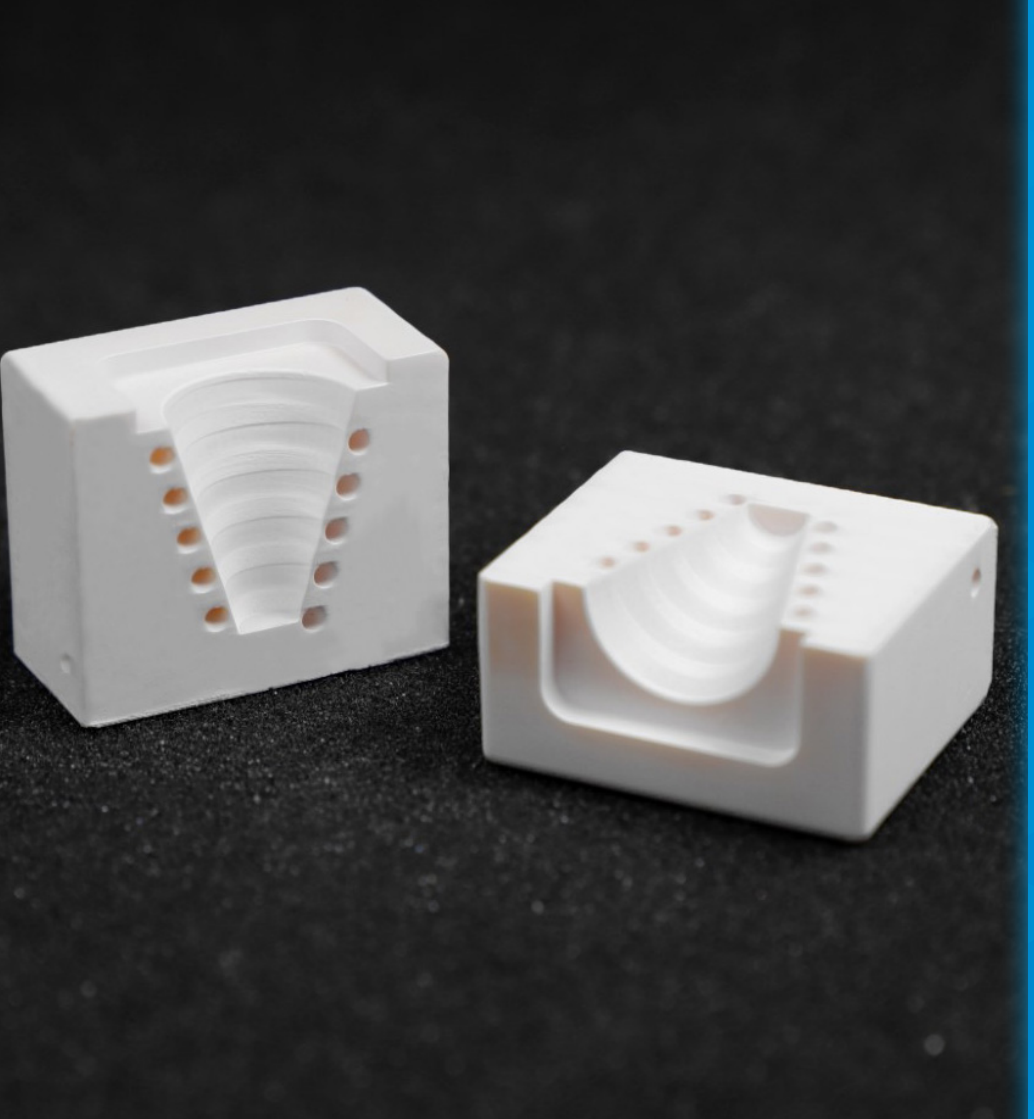
Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® Color Kit

Color kit solution enabling parts in a wide range of colors without the need for post-processing



Ultracur3D® RG 3280

Rigid Line

Technology:

LCD (incl. MSLA) & DLP

Color:

White, ceramic-like

Superior stiffness

Superior temperature performance

Fast and easy to print

High suspension stability

Ultracur3D® RG 3280

Suited for:

Tooling

Molding

Access all resources by scanning the QR code

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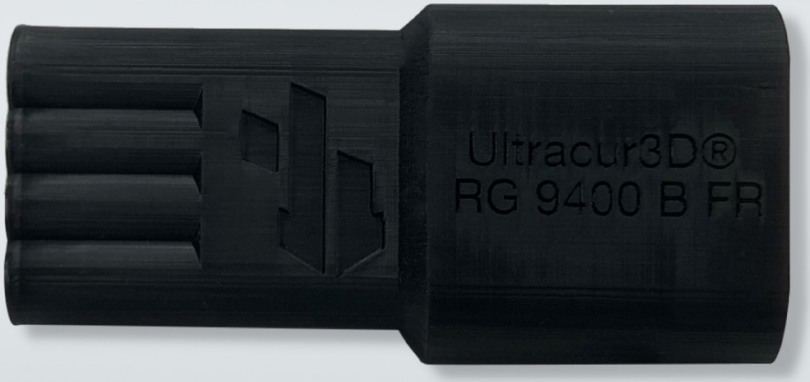
Technical Specifications

Mechanical properties	Standard	Value
Young's Modulus (MPa)	ASTM D638 type IV	10 600
Tensile Strength (MPa)	ASTM D638 type IV	87
Heat Deflection Temperature (°C)	ASTM D648	284
Viscosity, 25°C (mPas)	Cone/Plate Rheometer	300

Complete TDS

Tests & Certifications

Chemical Resistance	Skin Contact	Sterilization
Dataset available	ISO 10993-5	Dataset available



Ultracur3D®
RG 9400 B FR

Rigid Line

Technology:

LCD (incl. MSLA) & DLP

Color:

Black

UL 94 V0 flame retardancy

Superior temperature performance

Easy to print and process

Halogen Free

Ultracur3D®
RG 9400 B FR

Suited for:

Electronics

Housings

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Flammability	UL 94 (2mm)	V-0
Heat Deflection Temperature (°C)	ASTM D648 type IV	255
Young's Modulus (MPa)	ASTM D638	3940
Viscosity, 25°C (mPas)	Cone/Plate Rheometer	830

Complete TDS

Tests & Certifications

Flammability	Chemical Resistance	Skin Contact
UL 94 (V0 at 2mm)	Dataset available	ISO 10993-5

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® ST 45

Tough Line

Technology:

LCD (incl. MSLA) & DLP

Color:

Clear & Black

High strength, toughness and impact resistance

Very fast printing and great surface finishing

Lower curing depth for higher z-resolution (for ST 45 M)

Ultracur3D® ST 45

Suited for:

- Housings
- Prototyping
- High detail & textured parts
- Customized gadgets and tools

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Young's Modulus (MPa)	ASTM D638 type IV	2300
Tensile Strength (MPa)	ASTM D638 type IV	60
Heat Deflection Temperature (°C)	ASTM D648	73
Hardness (Shore D)	ASTM D2240	80

Complete TDS

Tests & Certifications

Flammability	Skin Contact	UV Stability	Sterilization	Chemical Resistance
UL 94 1.5 mm	ISO 10993-5; ISO 10993-10	ISO 4892-2B Cycle 1	Dataset available	Dataset available

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® Color Kit

Color kit solution enabling parts in a wide range of colors without the need for post-processing

Ultracur3D® Coat F+

Flexible coating solution to improve part properties and appearance

Ultracur3D® ST 80

Tough Line

Technology:

LCD (incl. MSLA) & DLP

Color:

Clear, Black, White, & Grey

Well-balanced multi-purpose material

High toughness and impact resistance

Most cost-effective solution

UV stability

Ultracur3D® ST 80

Suited for:

- Electrical castings
- Orthopedics
- High detail & textured parts
- Consumer goods and tools

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Young's Modulus (MPa)	ASTM D638 type IV	1500
Impact Strength, Notched Izod, 23°C (J/m)	ASTM D256	24
Elongation at Break (%)	ASTM D638 type IV	20
Hardness (Shore D)	ASTM D2240	80

Complete TDS

Tests & Certifications

Skin Contact	UV Stability	Sterilization	Chemical Resistance
ISO 10993-5; ISO 10993-10	ISO 4892-2A Cycle 1	Dataset available	Dataset available

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® Color Kit

Color kit solution enabling parts in a wide range of colors without the need for post-processing

Ultracur3D® ST 1400

Tough Line

Technology:

LCD (incl. MSLA) & DLP

Color:

Clear

Outstanding toughness and impact resistance

Bridge between flexible and rigid materials

Low viscosity and fast printing

Ultracur3D® ST 1400

Suited for:

Housings

Prototyping

Orthopedics

Medical applications

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Water Absorption, 24h (%)	ASTM D570	0.33
Impact Strength, Notched Izod, 23°C (J/m)	ASTM D256	43
Elongation at Break (%)	ASTM D638 type IV	43
Young's modulus (MPa)	ASTM D638 type IV	1900

Complete TDS

Tests & Certifications

Skin Contact	UV Stability	Sterilization
ISO 10993-5 ISO 10993-10	ISO 4892-2A Cycle 1	Dataset available

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® Color Kit

Color kit solution enabling parts in a wide range of colors without the need for post-processing

Ultracur3D® ST 7500 G

Tough Line

Technology:

LCD (incl. MSLA) & DLP

Color:

Grey

Surface quality and details

Durability and toughness

Fast and easy printing

Ultracur3D® ST 7500 G

Suited for:

Figurines

Functional Prototypes

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Young's Modulus (MPa)	ASTM D638 type IV	2300
Elongation at Break (%)	ASTM D638 type IV	13
Water Absorption, 24h (%)	ASTM D570	0.9
Viscosity, 25°C (mPas)	Cone/Plate Rheometer	180

Complete TDS

Tests & Certifications

UV Stability	Skin Contact	Chemical Resistance	Pressure & Temperature Resistance
ISO 4892-2A Cycle 1	ISO 10993-5 ISO 10993-10	Dataset available	Dataset available

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® FL 300

Flexible / Elastomeric Line

Technology:

LCD (incl. MSLA) & DLP

Color:

Clear

Very low hardness
(Shore 40 A)

Superior elongation at break

Ultracur3D® FL 300

Suited for:

Footwear

Prototyping

Energy damping

Cushioning pads

Flexible grips

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Rebound Resilience (%)	ASTM D7121	16
Tear Strength, Graves (N/mm)	ASTM D624 type C	9
Elongation at Break (%)	ASTM D412 C	245
Hardness (Shore A)	ASTM D2240	40

Complete TDS

Tests & Certifications

Rosslfex	Skin Contact	Chemical Resistance	UV Stability
ASTM D1052	ISO 10993-10	Dataset available	ISO 4892-2A Cycle 1

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® Color Kit

Color kit solution enabling parts in a wide range of colors without the need for post-processing

Ultracur3D® Coat F+

Flexible coating solution to improve part properties and appearance

Ultracur3D® FL 60

Flexible / Elastomeric Line

Technology:

LCD (incl. MSLA) & DLP

Color:

Clear

Very low hardness
(Shore 60 A)

Very good haptics

Very stable clear-white color

Ultracur3D® FL 60

Suited for:

- Footwear
- Functional prototyping
- Flexible grips
- Cushioning pads

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Rebound Resilience (%)	ASTM D7121	11
Tear Strength, Graves (N/mm)	ASTM D624 type C	9
Elongation at Break (%)	ASTM D412 C	90
Hardness (Shore A)	ASTM D2240	60

Complete TDS

Tests & Certifications

Sterilization	UV Stability
Dataset available	ISO 4892-2A Cycle 1

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® Color Kit

Color kit solution enabling parts in a wide range of colors without the need for post-processing

Ultracur3D® Coat F+

Flexible coating solution to improve part properties and appearance

Ultracur3D® EL 60

Flexible / Elastomeric Line

Technology:

LCD (incl. MSLA) & DLP

Color:

Clear

Low hardness
(Shore 75 A)

Quick elastic response

Easy to print

Ultracur3D® EL 60

Suited for:

Footwear

Functional prototyping

Flexible grips

Cushioning pads

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Rebound Resilience (%)	ASTM D7121	21
Elongation at Break (%)	ASTM D412 C	95
Water Absorption, 24h (%)	ASTM D570	1.12%
Hardness (Shore A)	ASTM D2240	75

Complete TDS

Tests & Certifications

Sterilization	Skin Contact	Rossflex	Chemical Resistance
Dataset available	ISO 10993-5 ISO 10993-10	ASTM D1052	Dataset available

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® Color Kit

Color kit solution enabling parts in a wide range of colors without the need for post-processing

Ultracur3D® Coat F+

Flexible coating solution to improve part properties and appearance

Ultracur3D® EL 150

Flexible / Elastomeric Line

Technology:

LCD (incl. MSLA) & DLP

Color:

Clear

Medium Hardness
(Shore 80 A)

Optimum combination of high strength, elongation at break and rebound

Ultracur3D® EL 150

Suited for:

Footwear

Prototyping

Flexible grips

Cushioning pads

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Rebound Resilience (%)	ASTM D7121	28
Tear Strength, Graves (N/mm)	ASTM D624 type C	14
Elongation at Break (%)	ASTM D412 C	182
Hardness (Shore A)	ASTM D2240	80

Complete TDS

Tests & Certifications

Rosflex	Skin Contact	UV Stability	Chemical Resistance
ASTM D1052	ISO 10993-10	ISO 4892-2A Cycle 1	Dataset available

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® Color Kit

Color kit solution enabling parts in a wide range of colors without the need for post-processing

Ultracur3D® Coat F+

Flexible coating solution to improve part properties and appearance

Ultracur3D® EL 4000

Flexible / Elastomeric Line

Technology:

LCD (incl. MSLA) & DLP

Color:

Clear & Black

High hardness
(Shore 90 A)

Ideal for printing intricate flexible parts

Superior strength, rebound and tear resistance

Ultracur3D® EL 4000

Suited for:

Footwear

Bike saddle

Cushioning pads

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Elongation at Break (%)	ASTM D412 C	170
Hardness (Shore A)	ASTM D2240	90
Rebound Resilience (%)	ASTM D7121	30
Tear Strength, Graves (N/mm)	ASTM D624 type C	37

Complete TDS

Tests & Certifications

Rossflex	UV Stability	Chemical Resistance	Skin Contact
ASTM D1052	ISO 4892-2A Cycle 1	Dataset available	ISO 10993-5

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® Color Kit

Color kit solution enabling parts in a wide range of colors without the need for post-processing

Ultracur3D® DM 2505

Dental Line

Technology:

LCD (incl. MSLA) & DLP

Color:

Beige

Precise manufacturing of dental models and molds

Ideal for thermoforming

Parts can be washed with water

Ultracur3D® DM 2505

Suited for:

Dental models and molds

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Young's Modulus (MPa)	ASTM D638 type IV	2200
Tensile Strength (MPa)	ASTM D638 type IV	48
Viscosity, 25°C (mPas)	Cone/Plate Rheometer	100
Hardness (Shore D)	ASTM D2240	73

Complete TDS

Tests & Certifications

Accuracy	Pressure & Temperature Resistance
High printing and thermoforming accuracy	Dataset available

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® DM 2304

Dental Line

Technology:

LCD (incl. MSLA) & DLP

Color:

Pink

Optimized for producing gingiva masks

Highly flexible and very soft

Ultracur3D® DM 2304

Suited for:

Non-Medical
Gingiva Mask

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Elongation at Break (%)	ASTM D412 C	160
Tensile Strength (MPa)	ASTM D412 C	4
Viscosity, 25°C (mPas)	Cone/Plate Rheometer	200
Hardness (Shore A)	ASTM D2240	50

Complete TDS

Tests & Certifications

Accuracy

High printing and thermoforming accuracy

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® DMD 1005

Dental Line

Technology:

LCD Photocentric

Color:

Beige

Ideal for economic and large-scale production

Suitable for thermoforming

Good printing accuracy

Ultracur3D® DMD 1005

Suited for:

Dental models and molds

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Young's Modulus (MPa)	ASTM D638 type IV	2710
Tensile Strength (MPa)	ASTM D638 type IV	60
Heat Deflection Temperature (°C)	ASTM D648	93
Hardness (Shore D)	ASTM D2240	80

Complete TDS

Tests & Certifications

Accuracy

High printing and thermoforming accuracy

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® EPD 1006

Daylight Line

Technology:

LCD Photocentric

Color:

Black

Good toughness and impact resistance

Easy to print, nice surface finish & intricate geometries

Ideal for prototyping, jigs and fixtures

Ultracur3D® EPD 1006

Suited for:

- Prototyping
- Jigs and fixtures
- Customized gadgets and tools
- High detail and textured parts

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Young's Modulus (MPa)	ASTM D638 type IV	1500
Tensile Strength (MPa)	ASTM D638 type IV	40
Elongation at Break (%)	ASTM D638 type IV	25
Impact Strength, Notched Izod, 23°C (J/m)	ASTM D256	35

Complete TDS

Tests & Certifications

Flammability	Skin Contact
UL 94 1.5 mm	ISO 10993-5

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® EPD 1086

Daylight Line

Technology:

LCD Photocentric

Color:

Black

Well-balanced mechanical properties

Cost-effective solution for a wide range of applications

Ultracur3D® EPD 1086

Suited for:

High detail and textured parts

Customized gadgets and tools

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Young's Modulus (MPa)	ASTM D638 type IV	1810
Tensile Strength (MPa)	ASTM D638 type IV	42
Elongation at Break (%)	ASTM D638 type IV	26
Hardness (Shore D)	ASTM D2240	81

Complete TDS

Tests & Certifications

Flammability	UV Stability	Chemical Resistance
UL 94 1.5 mm	ISO 4892-2A Cycle 1	Dataset available

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® EPD 2006

Daylight Line

Technology:

LCD PhotoCentric

Color:

Black

Very high stiffness and temperature resistance

Ideal for large-scale objects

Printed parts exhibit intricate detail

Ultracur3D® EPD 2006

Suited for:

High detail and textured parts

Customized gadgets and tools

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Young's Modulus (MPa)	ASTM D638 type IV	2370
Tensile Strength (MPa)	ASTM D638 type IV	50
Elongation at Break (%)	ASTM D638 type IV	10.3
Heat Deflection Temperature (°C)	ASTM D648	81

Complete TDS

Tests & Certifications

Flammability	Skin Contact	UV Stability	Chemical Resistance
UL 94 1.5 mm	ISO 10993-5; ISO 10993-10	ISO 4892-2A Cycle 1	Dataset available

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

Ultracur3D® EPD 3500

Daylight Line

Technology:

LCD Photocentric

Color:

Amber

High strength, high stiffness & good impact resistance

Low water uptake

Ideal for engineering prototypes

Ultracur3D® EPD 3500

Suited for:

High detail and textured parts

Customized gadgets and tools

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value
Young's Modulus (MPa)	ASTM D638 type IV	2500
Tensile Strength (MPa)	ASTM D638 type IV	60
Elongation at Break (%)	ASTM D638 type IV	18
Impact Strength, Notched Izod, 23°C (J/m)	ASTM D256	25

Complete TDS

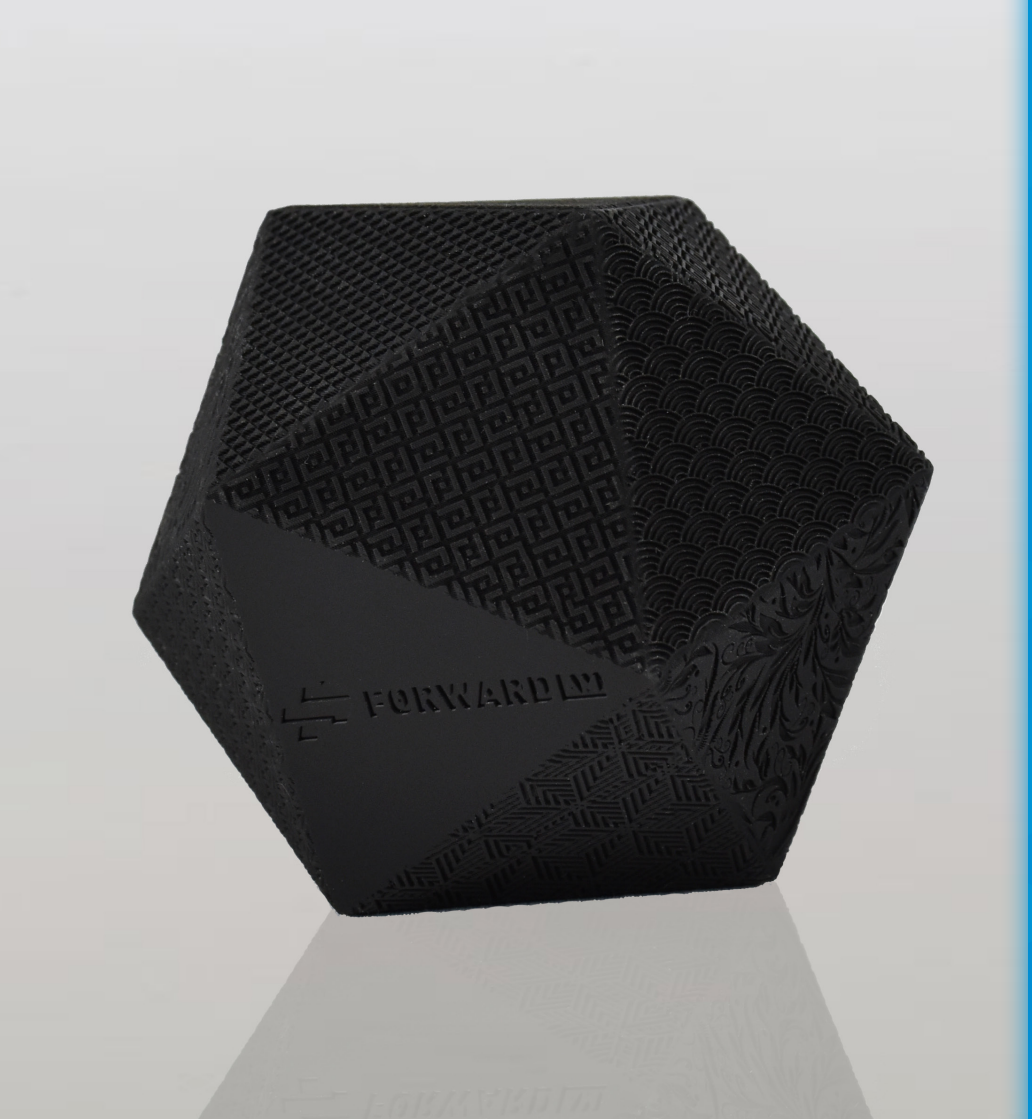
Tests & Certifications

UV Stability	Chemical Resistance
ISO 4892-2A Cycle 1	Dataset available

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts



Ultracur3D® EPD 4006

Daylight Line

Technology:

LCD Photocentric

Color:

Black

Extremely tough & durable material

Superior impact resistance

Easy to print and smooth surface finish

Ultracur3D® EPD 4006

Suited for:

High detail and textured parts

Customized gadgets and tools

Access all resources by scanning the QR code

Technical Specifications

Mechanical properties	Standard	Value
Young's Modulus (MPa)	ASTM D638 type IV	1800
Tensile Strength (MPa)	ASTM D638 type IV	45
Elongation at Break (%)	ASTM D638 type IV	45
Impact Strength, Notched Izod, 23°C (J/m)	ASTM D256	46

Complete TDS

Tests & Certifications

Flammabilty	Skin Contact	UV Stability	Chemical Resistance
UL 94 3 mm	ISO 10993-5	ISO 4892-2A Cycle 1	Dataset available

Complementary Products

Ultracur3D® Cleaner

Cleaning solution for removal of any uncured photopolymer resin from printed parts

FUSED FILAMENT FABRICATION

Explore one of the broadest portfolios for Fused Filament Fabrication. Our Ultrafuse® line comprises filaments ranging from engineering-grade materials, through reinforced and support materials, to advanced metal filaments for a variety of industrial applications.

Mechanical Properties Comparison

Full Comparison Table

		Ultrafuse® Standard Filaments					Ultrafuse® Support Filaments	
		PLA	PET	ABS	PP	rPET	BVOH	HIPS
HDT (0.45 Mpa) [°C] ISO 75-2		65,0	63,0	96,0	54,0	71,0	-	91,0
Tensile Strength [MPa] ISO 527	XY	34,7	33,4	36,3	15,5	38,6	33,7	18,4
	ZX	21,2	17,2	21,3	9,0	14,7	8,7	13,7
Elongation at Break [%] ISO 527	XY	4,2	2,7	7,4	118,6	4,3	14,8	1,4
	ZX	1,2	1,1	1,8	5,4	1,2	0,6	1,3
Young's Modulus [MPa] ISO 527	XY	2308,0	1933,0	1958,0	541,0	1640,0	2339,0	1588,0
	XZ	2131,0	1665,0	1608,0	435,0	1334,0	1426,0	1603,0
Impact Strength Charpy (unnotched) [kJ/m^2] ISO 179-2	XY	13,2	18,4	36,4	41,8	55,5	-	36,0
	XZ	14,3	9,7	42,2	62,3	33,7	-	57,6
	ZX	4,3	4,6	6,8	13,6	3,3	-	8,6
Impact Strength Izod (unnotched) [kJ/m^2] ISO 180	XY	11,0	12,3	40,0	37,7	48,2	-	35,0
	XZ	9,6	7,7	35,7	37,6	21,9	-	57,1
	ZX	4,7	4,1	7,2	11,6	4,4	-	9,1

Ultrafuse® High Temp Filaments	Ultrafuse® Engineering Filaments					Ultrafuse® Reinforced Filaments				
PPSU	PLA Tough	ABS Fusion+	ASA	PA (Conditioned)	PC/ABS FR	PP GF30	PET CF15	PAHT CF15 (Conditioned)	PA6 GF30 (Conditioned)	PC GF30
215,0	55	91,0	101,0	135,0	86,0	127,0	108,0	128,0	114,0	134,0
74.5	40	29,5	34,6	33,2	50,1	41,7	63,2	62,9	46,4	36,1
49,0	28	17,9	12,0	17,6	17,3	15,9	12,5	19.1	12.2	11.2
7.3	7,4	10,9	4,5	143,3	10,7	4,4	3,7	2,9	3,2	2,4
2.9	2,2	2,1	1,0	12,8	0,8	0,8	0,5	0.8	1,9	1,1
2221,0	2672	1379,0	1828,0	395,0	2545,0	2628,0	6178,0	5052,0	2469,0	2664,0
2150,0	2576	1106,0	1400,0	334,0	2188,0	2242,0	2822,0	2455,0	1156,0	1231,0
224.8	33	71,9	42,7	No break	49,8	23,1	27,8	21,9	41,8	17,1
270.5	34	118,7	41,2	No break	65,4	25,8	32,0	20,4	48,8	18,9
16.3	10	6,9	5,1	13,4	2,9	2,5	1,3	2,8	3,1	3,7
No break	28	73,1	36,8	No break	57,0	20,5	25,1	16,3	36,9	13,9
No break	27	131,1	39,3	No break	87,9	2,4	22,6	15,1	41,4	17,8
21,0	10	6,6	6,8	17,4	3,0	2,6	2,4	4,1	3,8	3,4

		Ultrafuse® Flexible Filaments			
		TPU 85A	TPU 64D	TPU 95A	TPS 90A
Shore A Hardness (3 s) ISO 7619-1		85,0	58 (Shore D)	92,0	89,0
Abrasion Resistance [mm^3] ISO 4649		82,0	43,0	64,0	111,0
Compression Set at 23 °C, 72 h [%] ISO 815		26,0	25,0	38,0	75,0
Elongation at Break TPE [%] ISO 527	XY	600,0	399,0	611,0	-
	ZX	320,0	115,0	192,0	-
Stress at Break TPE [MPa] ISO 527	XY	34,0	37,0	44.2	7,0
	ZX	10,0	19,0	12.2	2,0
Tear Strength [kN/m] ISO 34-1	XY	80,0	66,0	90,0	10,0
	XZ	18,0	37,0	8,0	5,0
	ZX	30,0	79,0	14,0	4,0

		Ultrafuse® Metal Filaments	
		316L	17-4 PH
Sintered Part Density [kg/m^3] ISO 1183-1		7850,0	7600,0
Elongation at Break [%] ISO 6892-1[1]	XY	53,0	4,0
	ZX	36,0	4,0
Yield Strength, $R_{p\,0.2}$ [MPa] ISO 6892-1[1]	XY	251,0	756
	ZX	234,0	764
Vickers Hardness HV10 ISO 6507-1	XY	128	291
	ZX	128	309

Print Profile Availability

- ■ Available from Forward AM
- ■ Available from machine manufacturer
- □ To be validated
- X Not compatible

See complete print profile availability

	Bambu Lab			Prusa		BCN3D				Ultimaker					Raise3D				Zortrax	
	P1P	P1S	X1-Carbon	Mk3	Mk3s	Sigma R19	Sigmax R19	Epsilon W27	Epsilon W50	2+ Connect	3	S3	S5	S7	E2	Pro2	Pro3	Pro3 hyper speed	M300 Dual	Endureal
rPET	■ HS	■ HS	■ HS	■	■	■	■	■	■	■	□	■	■	■	■	■	■	□	□	□
PLA Tough	■ HS	■ HS	■ HS	■	■	■	■	■	■	■	□	■	■	□	■	■	■	■ HS	□	□
PC/ABS FR	X	X	■ HS	■	■	■	■	■	■	■	□	■	■	■	■	■	■	■ HS	□	■
TPU 64D	□	□	□	■	■	■	■	■	■	■	■	□	■	■	■	■	■	□	□	□
17-4 PH	□	□	□	■	■	□	■	■	■	X	■	■	■	■	X	■	■	X	■	■

Support Material Compatibility

■ Compatible
□ To be validated

	Standard					High Temp	Engineering					Reinforced					Flexible				Metal	
	PLA	PET	ABS	PP	rPET	PPSU	PLA Tough	ABS Fusion+	ASA	PA	PC/ABS FR	PP GF30	PET CF15	PAHT CF15	PA6 GF30	PC GF30	TPU 85A	TPU 64D	TPU 95A	TPS 90A	316L	17-4PH
Single Material Breakaway	■	■	■	□	■		■	□	□	□	□	□	■	□	□	□	■	□	□	□		
Ultrafuse® BVOH	■	■		□	■		■	□		■			■	■	■		■	■	■			
Ultrafuse® HiPS	□	□	■	□	□			□	■	□	■	□	■	□	□		■	□	□			
Ultrafuse® Support Layer																					■	■

Ultrafuse® PLA

Standard Filaments

Technology:

Fused Filament Fabrication

Color:

Natural, Black, White
+ 22 others

High success rate

Repeatability

Relatively low printing temperatures

Non/extremely low warpage/ shrinkage

Ultrafuse® PLA

Suited for:

Prototyping

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	65,0
Tensile Strength (MPa)	ISO 527	80
Elongation at Break (%)	ISO 527	4,2 / - / 1,2
Young's Modulus (MPa)	ISO 527	2308 / - / 2131
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	3,3 / 2,1 / 1,6
Impact Strength Izod (unnotched) (kJ/m^2)	ISO 180	11 / 9,6 / 4,7

Complete TDS

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
210-230	-	50-70	glass	≥0,4	40-80

Ultrafuse® PET

Standard Filaments

Technology:

Fused Filament Fabrication

Color:

Black, White, Red, Blue
+ 4 others

Watertight prints possible

Easy to print like PLA

High resolution prints

Ultrafuse® PET

Suited for:

Food applications

Parts where watertightness is required

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	63,0
Tensile Strength (MPa)	ISO 527	33,4 / - / 17,2
Elongation at Break (%)	ISO 527	2,7 / - / 1,1
Young's Modulus (MPa)	ISO 527	1933 / - / 1665
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	2,1 / 1,9 / 1,8
Impact Strength Izod (unnotched) (kJ/m^2)	ISO 180	12,3 / 7,7 / 4,1

Complete TDS

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
210-230	-	60-80	glass	≥0,4	40-80

Ultrafuse® ABS

Standard Filaments

Technology:

Fused Filament Fabrication

Color:

White, Blue, Yellow
+6 others

Chemical Resistance

Very tough

High wear and tear

Can be used for working parts

Ultrafuse® ABS

Suited for:

- Functional prototypes
- Chemical environment
- Reasonable heat resistance

Access all resources by scanning the QR code

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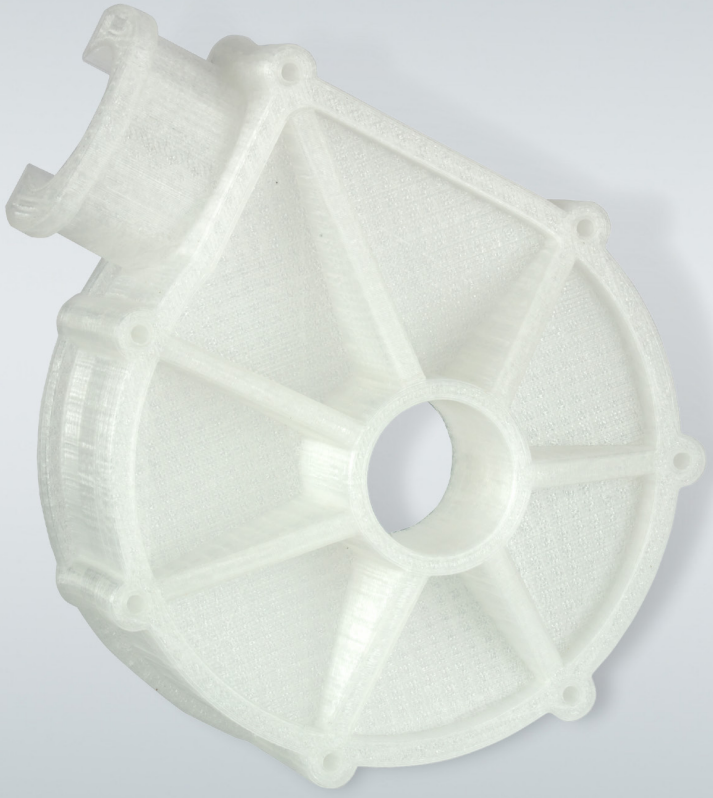
Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	96,0
Tensile Strength (MPa)	ISO 527	36,3 / - / 21,3
Elongation at Break (%)	ISO 527	7,4 / - / 1,8
Young's Modulus (MPa)	ISO 527	1958 / - / 1608
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	18,8 / 18,9 / 3,5
Impact Strength Izod (unnotched) (kJ/m^2)	ISO 180	40 / 35,7 / 7,2

Complete TDS

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
240-260	-	90-110	Tape, spray or glue	≥0,4	40-80



Ultrafuse® PP

Standard Filaments

Technology:

Fused Filament Fabrication

Color:

White

Tough and Strong

Fatigue Resistant

Chemical Resistant

Light weight (low density)

Ultrafuse® PP

Suited for:

Chemical contact

Prototyping

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	54,0
Tensile Strength (MPa)	ISO 527	15,5 / - / 9
Elongation at Break (%)	ISO 527	118,6 / - / 5,4
Young's Modulus (MPa)	ISO 527	541 / - / 435
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	5,3 / 10,6 / 2,3
Impact Strength Izod (unnotched) (kJ/m^2)	ISO 180	37,7 / 37,6 / 11,6

Complete TDS

Advanced Testing

Skin Contact / Biocompatibility
ISO 10993-5; ISO 10993-10
Passed

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
220-240	-	60-80	PP tape or PP adhesive	≥0,4	20-50

Ultrafuse® rPET

Standard Filaments

Technology:

Fused Filament Fabrication

Color:

Blue Transparent

> 99% recycled PETG

Easy to print

Great end results

Ultrafuse® rPET

Suited for:

Prototyping

Decorative parts

Automotive parts

Consumer Goods

Access all resources by scanning the QR code

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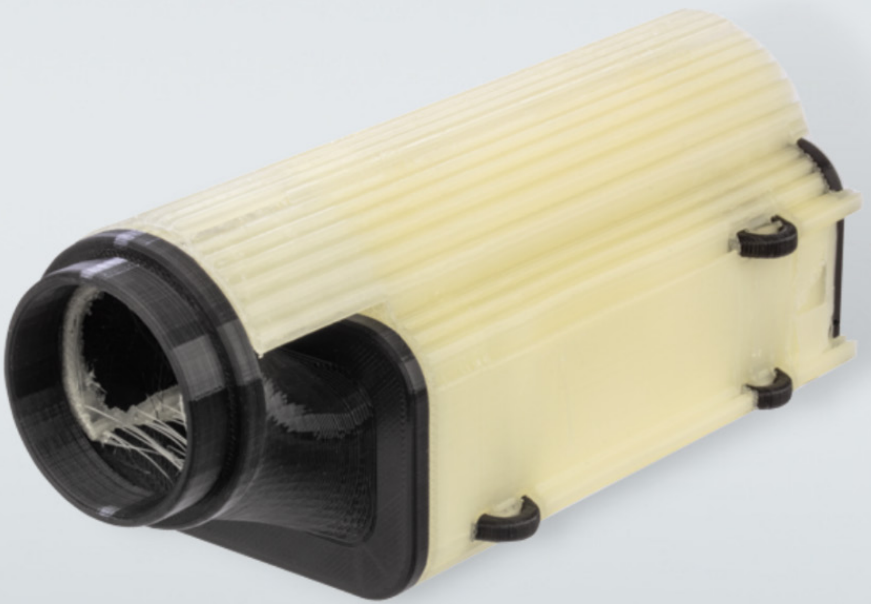
Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	71
Tensile Strength (MPa)	ISO 527	38,6 / - / 14,7
Elongation at Break (%)	ISO 527	4,3 / - / 1,2
Young's Modulus (MPa)	ISO 527	1640 / - /1334
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	4,4 / 3,3 /1,5
Impact Strength Izod (unnotched) (kJ/m^2)	ISO 180	48,2 / 21,9 /4,4

Complete TDS

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
225-245	-	65-85	glass + adheasive spray	≥0,4	30-60



Ultrafuse® BVOH

Support Filaments

Technology:

Fused Filament Fabrication

Color:

Natural Yellow

Water soluble

Dissolves 2 times faster than other PVA

Support compatible with multiple materials

Ultrafuse® BVOH

Suited for:

Parts with overhang

Complex parts

Hollow parts

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	-
Tensile Strength (MPa)	ISO 527	33,7 / - / 8,7
Elongation at Break (%)	ISO 527	14,8 / - / 0,6
Young's Modulus (MPa)	ISO 527	2339 / - / 1426

Complete TDS

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
190-210	-	60-100	glass	≥0,4	30-60

Ultrafuse® HiPS

Support Filaments

Technology:

Fused Filament Fabrication

Color:

White

Easy post processing
(Glue and painting)

Good aesthetics

Compatible with many materials

Ultrafuse® HiPS

Suited for:

Support material for printing applications with ABS

Access all resources by scanning the QR code

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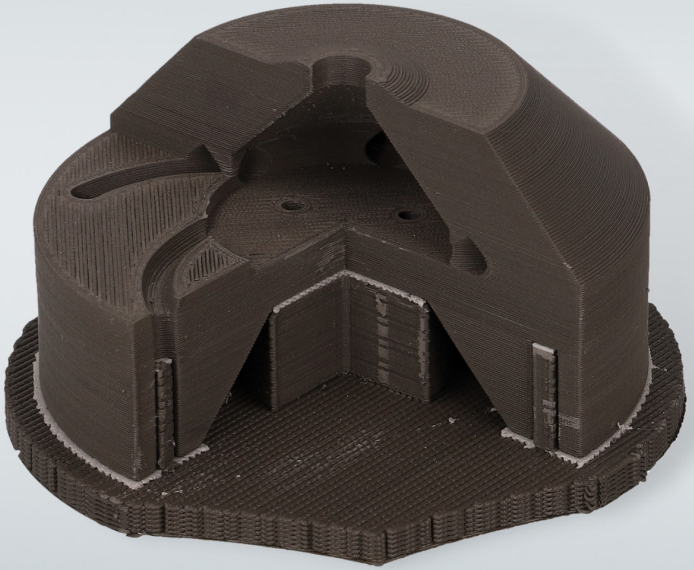
Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	91,0
Tensile Strength (MPa)	ISO 527	18,4 / - / 13,7
Elongation at Break (%)	ISO 527	1,4 / - / 1,3
Young's Modulus (MPa)	ISO 527	1588 / - / 1603
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	6,9 / 7,1 / 4,8
Impact Strength Izod (unnotched) (kJ/m^2)	ISO 180	35 / 57,1 / 9,1

Complete TDS

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
240-260	-	100-120	spray	≥0,4	40-80



Ultrafuse® Support Layer

Support Filaments

Technology:

Fused Filament Fabrication

Color:

Natural

Suitable for Ultrafuse® metal filaments

Allows a wider range of designs

Excellent surface quality of supported areas of the part

Minimizes distortion during debinding and sintering

Ultrafuse® Support Layer

Suited for:

- Series production
- Functional parts and prototypes
- Tooling
- Jigs and fixtures

Access all resources by scanning the QR code

This information and values are presented as guidance only and based on Forward AM's knowledge and experience. It is believed to be accurate, however all guarantees are explicitly denied. This document was updated June 2024.

Additional Information

Ultrafuse® Support Layer is not developed to print stand-alone parts and should only be printed as a layer attached to the support structures in dual extrusion prints for Ultrafuse® metal filaments.

**This product is not intended for sale, distribution or use in the US and Canada and is not available to our customers in those countries.

Complete TDS

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
245-260	passively heated, closed chamber	-	-	≥0,4	15-20

Ultrafuse® PPSU

High Temperature Filaments

Technology:

Fused Filament Fabrication

Color:

Natural

High dimensional stability

Resistant to hot water and coolants

Resistant to long-term service temperatures up to 180°C

Inherently flame retardant

Ultrafuse® PPSU

Suited for:

Suitable for autoclaving processes

Aerospace

High-temperature applications

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	215,0
Tensile Strength (MPa)	ISO 527	74.5 / - / 49
Elongation at Break (%)	ISO 527	7.3 / - / 2.9
Young's Modulus (MPa)	ISO 527	2221 / - / 2150
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	13,7 / 15,8 / 5,3
Impact Strength Charpy (notched) (kJ/m^2)	ISO 179-2	21,8 / 15,0 / 5,7

Complete TDS

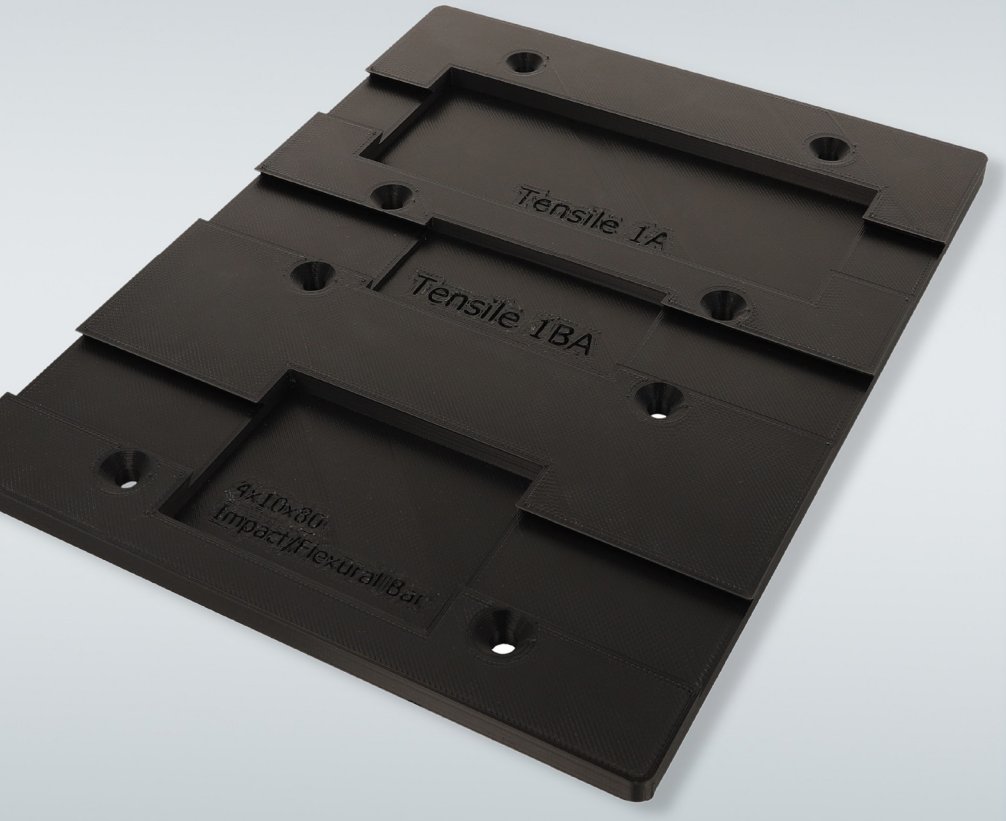
Advanced Testing

Volume resistivity [Ωcm]	Surface resistivity [Ωcm]	Dielectric strength (ortho) [kV/mm]	Vicat softening point (50 N) [°C]	Flame class rating	Glow wire test (GWEPT)	Coefficient of Thermal Expansion
IEC 62631-3-1	IEC 62631- 3-2	IEC 62631-3-1	ISO 306	UL94	IEC 60695-2-11	ISO 11359-2
2,60E+15 / - / -	2,60E+15	18,5	217,0	V0 @ 1.5 mm and 3.0 mm thickness	960 °C @ 1.5 mm and 3.0 mm thickness	55 E-6/K

Flammability F1 60 sec. vertical	Flammability F2 12 sec. vertical	HR Total Heat Release [KW*min/m2]	HRRmax [KW/m2]	Optical Smoke Density	Smoke Toxicity	Railway
FAR 25.853 (a) (thickness 1.6 and 6.35 mm)	FAR 25.853 (a) (thickness 1.6 and 6.35 mm)	FAR 25.853 (d) (thickness 1.0 and 4.0 mm)	FAR 25.853 (d) (thickness 1.0mm)	FAR 25.853 (d) (thickness 1.0 and 4.5 mm)	AITM 3.0005 (thickness 1.5 and 4.5 mm)	EN 45545-2 (thickness 1.5 and 3.0 mm)
Passed	Passed	Passed	Passed	Passed	Passed	Classified HL1-3 R7*, R23, R24, R26 * HL1-2 1.5mm

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
390-410	170-210	190-220	glass	≥0,4	25-80



Ultrafuse® PLA Tough

Engineering Filaments

Technology:

Fused Filament Fabrication

Color:

Natural, Black

Speed of printing

Strength

Consistency

Ultrafuse® PLA Tough

Suited for:

Jigs & fixtures

Prototyping

Orthotics and Prostheses

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
Tensile Strength (MPa)	ISO 527	40 / - / 28
Elongation at Break (%)	ISO 527	7.4 / - / 2.2
Young's Modulus (MPa)	ISO 527	2672 / - / 2576
Impact Strength	ISO 179-2	33 / 34 / 10
Flexural Strength	ISO 178	73 / 75 / 51

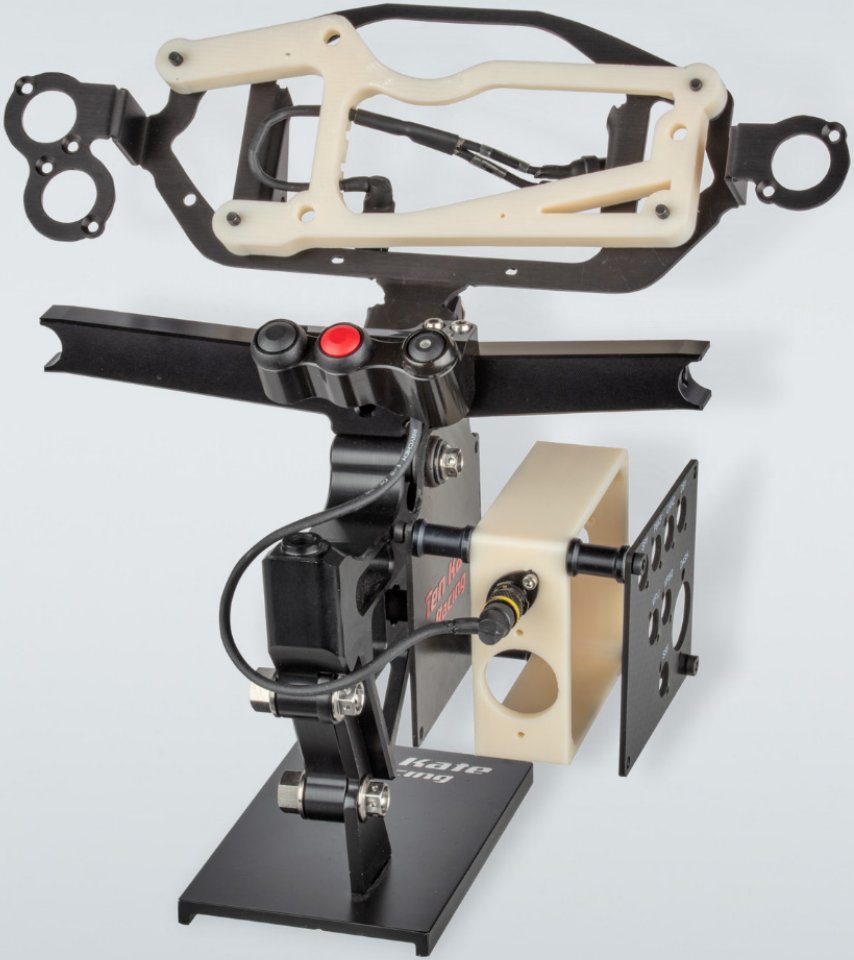
Complete TDS

Advanced Testing

Skin Contact / Biocompatibility
ISO 10993-5; ISO 10993-10
Passed

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
200-220	-	50-70	glass	≥0,4	40-300



Ultrafuse®
ABS Fusion+

Engineering Filaments

Technology:

Fused Filament Fabrication

Color:

Natural, Black, Grey

- Easy to print
- Direct printing on heated glass or print bed surfaces
- High heat resistance
- Adheres to water soluble support

Ultrafuse® ABS Fusion+

Suited for:

Jigs & fixtures

Automotive parts

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	91,0
Tensile Strength (MPa)	ISO 527	29,5 / - / 17,9
Elongation at Break (%)	ISO 527	10,9 / - / 2,1
Young's Modulus (MPa)	ISO 527	1379 / - / 1106
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	26,4 / 38,4 / 2,2
Impact Strength Izod (unnotched) (kJ/m^2)	ISO 180	73,1 / 131,1 / 6,6

Complete TDS

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
240-260	-	100-120	glass + spray glue	≥0,4	40-80

Ultrafuse® ASA

Engineering Filaments

Technology:

Fused Filament Fabrication

Color:

Natural, Black

UV Stabilized

Weather resistance

Chemical resistance

Resistant to wear and tear

Ultrafuse® ASA

Suited for:

- Outdoor use
- Functional prototypes
- Chemical environment
- Reasonable heat resistance

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	101,0
Tensile Strength (MPa)	ISO 527	34,6 / - / 12
Elongation at Break (%)	ISO 527	4,5 / - / 1
Young's Modulus (MPa)	ISO 527	1828 / - / 1400
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	8,7 / 11,4 / 1,9
Impact Strength Izod (unnotched) (kJ/m^2)	ISO 180	36,8 / 39,3 / 6,8

Complete TDS

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
260-280	passively heated, closed chamber	100-120	spray or PC adhesive	≥0,4	30-60

Ultrafuse® PA

Engineering Filaments

Technology:

Fused Filament Fabrication

Color:

Natrual & Black

Good fatigue resistance

Good wear resistance/ lubricity

Good impact resistance at low temperatures

Low melting point makes it printable for many FFF printers

Ultrafuse® PA

Suited for:

Suitable for a wide range of different components and machine elements

Most engineering sectors

Access all resources by scanning the QR code

Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	135,0
Tensile Strength (MPa)	ISO 527	33,2 / - / 17,6
Elongation at Break (%)	ISO 527	143,3 / - / 12,8
Young's Modulus (MPa)	ISO 527	395,0 / - / 334,0
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	85,4 /106,0 / 10,1
Impact Strength Charpy (notched) (kJ/m^2)	ISO 179-2	- / 136,0 / 9,4

Complete TDS

Advanced Testing

Vicat softening point (50 N) [°C]
ISO 306
172,0

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
220-250	-	90-120	glass with PVA	≥0,4	30-60

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Ultrafuse® PC/ABS FR

Engineering Filaments

Technology:
Fused Filament Fabrication

Color:
Black

- Outstanding aesthetics
- Strong layer adhesion
- High print speeds possible
- UL94 V0 flame retardancy

Ultrafuse® PC/ABS FR

Suited for:

- Housing for Raspberry pi
- Sockets and plugs
- Housing for handheld devices or powertools
- Automotive components

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	86,0
Tensile Strength (MPa)	ISO 527	50,1 / - / 17,3
Elongation at Break (%)	ISO 527	10,7 / - / 0,8
Young's Modulus (MPa)	ISO 527	2545 / - / 2188
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	16,8 / 30,3 / 1,8
Impact Strength Izod (unnotched) (kJ/m^2)	ISO 180	16,8 / 30,3 / 1,8

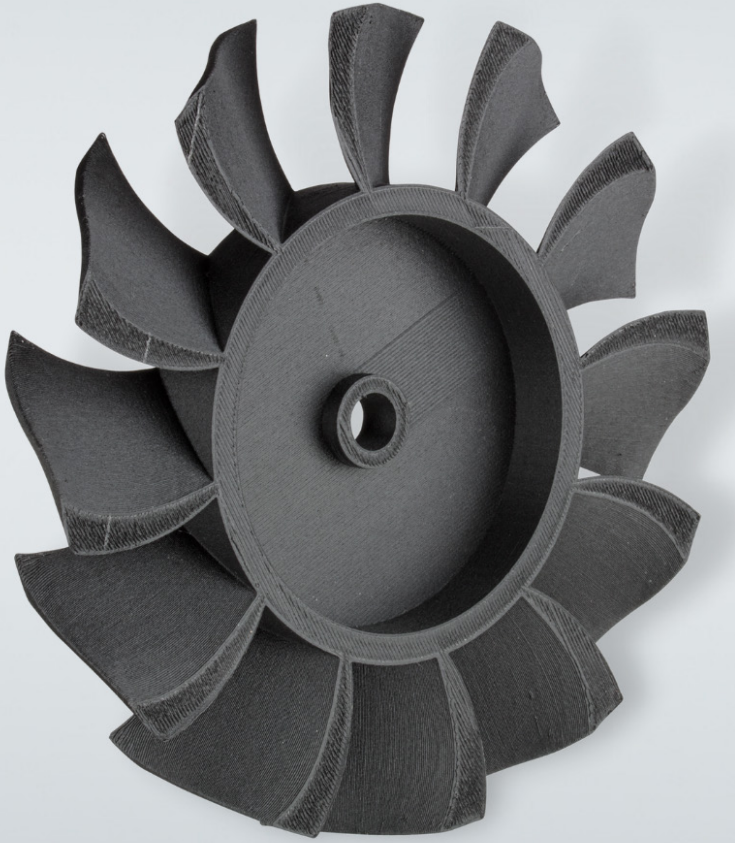
Complete TDS

Advanced Testing

Flame class rating	Glow wire test (GWEPT)	Railway
UL94	IEC 60695-2-11	EN 45545-2 (thickness 1.5 and 3.0 mm)
V0 @ 1.5 mm and 3.0 mm thickness	725 °C @ 1.5 mm thickness 960 °C @ 3.0 mm thickness	Classified HL1-3 R26

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
260-280	passively heated, closed chamber	90-110	glass	≥0,4	30-50



Ultrafuse® PP GF30

Reinforced Filaments

Technology:

Fused Filament Fabrication

Color:

Black

Excellent chemical resistance

High heat resistance

Improved UV resistance

Low moisture uptake

Ultrafuse® PP GF30

Suited for:

Functional prototyping

Automotive/ transportation

Jigs and fixtures

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	127,0
Tensile Strength (MPa)	ISO 527	41,7 / - / 15,9
Elongation at Break (%)	ISO 527	4,4 / - / 0,8
Young's Modulus (MPa)	ISO 527	2628 / - / 2242
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	5,6 / 6,2 / 1,4
Impact Strength Izod (unnotched) (kJ/m^2)	ISO 180	20,5 / 2,4 / 2,6

Complete TDS

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
240-260	-	20-40 / 70-90	PP strapping tape / PPGF adhesive	≥0,6	30-80

Ultrafuse® PET CF15

Reinforced Filaments

Technology:

Fused Filament Fabrication

Color:

Black

Strong, rigid components

Very low moisture absorption

High dimensional stability

Heat resistant up to 108

Ultrafuse® PET CF15

Suited for:

Automotive

Jigs & fixtures

Applications for humid operating environments

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	108,0
Tensile Strength (MPa)	ISO 527	63,2 / - / 12,5
Elongation at Break (%)	ISO 527	3,7 / - / 0,5
Young's Modulus (MPa)	ISO 527	6178 / - / 2822
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	5,7 / 5 / 2
Impact Strength Izod (unnotched) (kJ/m^2)	ISO 180	25,1 / 22,6 / 2,4

Complete TDS

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
250-270	-	65-85	PEI or glass	≥0,6	30-80

Ultrafuse® PAHT CF15

Reinforced Filaments

Technology:

Fused Filament Fabrication

Color:

Black

Higher chemical resistance than most PA grades

Strong, rigid components

High dimensional stability

Low moisture absorption

Ultrafuse® PAHT CF15

Suited for:

Automotive

Complex geometries in challenging environments

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	128,0
Tensile Strength (MPa)	ISO 527	62,9 / - / 19,1
Elongation at Break (%)	ISO 527	2,9 / - / 0,8
Young's Modulus (MPa)	ISO 527	5052,0 / - / 2455,0
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	6,5 / 5,8 / -
Impact Strength Izod (unnotched) (kJ/m^2)	ISO 180	16,3 / 15,1 / 4,1

Complete TDS

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
260-280	-	100-120	PEI or glass	≥0,6	30-80

Ultrafuse® PA6 GF30

Reinforced Filaments

Technology:

Fused Filament Fabrication

Color:

Black

Good chemical resistance

Very high stiffness and strength

Resistance to UV light exposure

Excellent layer adhesion

Ultrafuse® PA6 GF30

Suited for:

Industrial tooling

Automotive / transportation

Functional prototyping

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	114,0
Tensile Strength (MPa)	ISO 527	46,4 / - / 12,2
Elongation at Break (%)	ISO 527	3,2 / - / 1,9
Young's Modulus (MPa)	ISO 527	2469,0 / - / 1156,0
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	20,9 / 19,0 / 2,7
Impact Strength Izod (unnotched) (kJ/m^2)	ISO 180	36,9 / 41,4 / 3,8

Complete TDS

Advanced Testing

Vicat softening point (50 N) [°C]
ISO 306
192,0

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
240-280	-	70-100	glass	≥0,6	30-80

Ultrafuse® PC GF30

Reinforced Filaments

Technology:

Fused Filament Fabrication

Color:

Black

UL94 V0 flame retardancy

Very low moisture absorption

Good temperature resistance

Good heat deflection temperature

Ultrafuse® PC GF30

Suited for:

Electronics

Automotive / transportation

Functional prototyping

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
HDT (0.45 MPa) (°C)	ISO 75-2	134,0
Tensile Strength (MPa)	ISO 527	36,1 / - / 11,2
Elongation at Break (%)	ISO 527	2,4 / - / 1,1
Young's Modulus (MPa)	ISO 527	2664,0 / - / 1231,0
Impact Strength Izod (notched) (kJ/m^2)	ISO 180	5,6 / 5,4 / 2,1
Impact Strength Izod (unnotched) (kJ/m^2)	ISO 180	13,9 / 17,8 / 3,4

Complete TDS

Advanced Testing

Flame class rating	Railway
UL94	EN 45545-2 (thickness 1.5 and 3.0 mm)
V0 @ 1.5 mm and 3.0 mm thickness	Classified HL1-3 R22, R23, R24, R26

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
280-330	-	80-100	PC adhesive	≥0,6	30-60

Ultrafuse® TPU 85A

Flexible Filaments

Technology:

Fused Filament Fabrication

Color:

Natural

High tensile strength and outstanding resistance to tear propagation

Excellent damping characteristics

High resistance to oils, greases, oxygen and ozone

Very good low-temperature flexibility

Ultrafuse® TPU 85A

Suited for:

Automotive, industrial manufacturing agriculture and construction

Footwear, sports and leisure

Functional flexible parts

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
Compression Set at 23 °C, 72 h (%)	ISO 815	26,0
Abrasion Resistance (mm^3)	ISO 4649	82,0
Shore A Hardness (3 s)	ISO 7619-1	85,0
Elongation at Break TPE (%)	ISO 527	600 / - / 320
Stress at Break TPE (MPa)	ISO 527	34 / - / 10
Tear Strength (kN/m)	ISO 34-1	80 / 18 / 30

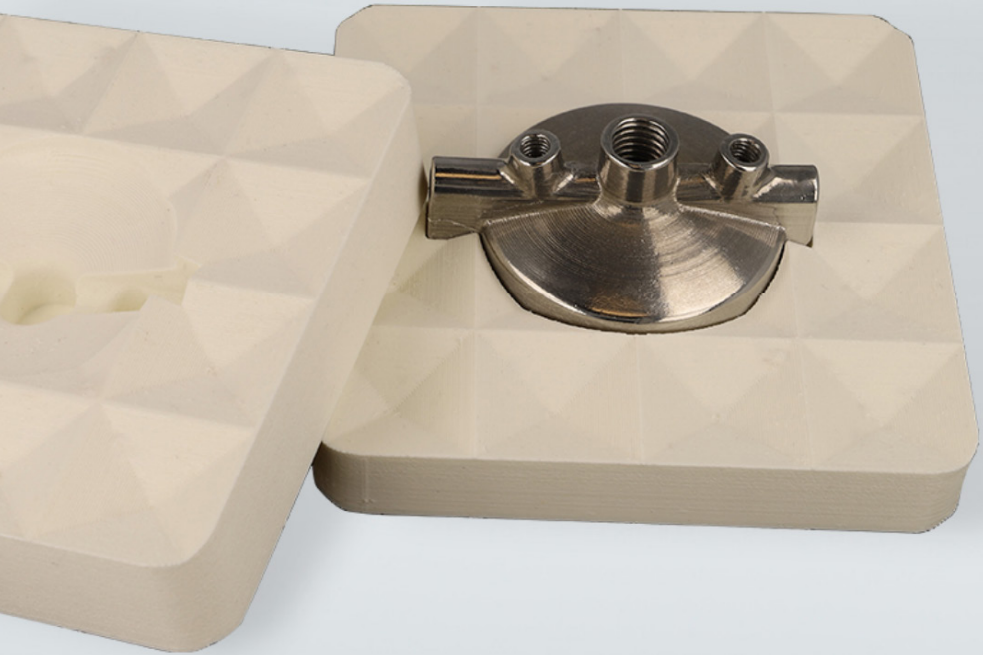
Complete TDS

Advanced Testing

Volume resistivity [Ωcm]	Dielectric strength (orthogonal) [kV/mm]	Skin Contact / Biocompatibility
IEC 62631-3-1	IEC 62631-3-1	ISO 10993-5; ISO 10993-10
2,60E+11 / - / 2,10E+11	21,0	Passed

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
200-220	-	40	glass	≥0,4	15-40



Ultrafuse® TPU 64D

Flexible Filaments

Technology:

Fused Filament Fabrication

Color:

White, Black

High resistance to oils, greases, oxygen and ozone

Compatible with water soluble support

High impact resistance

High wear and abrasion resistance

Ultrafuse® TPU 64D

Suited for:

Tooling, jigs and fixtures

Functional flexible parts

Wear and tear application

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
Compression Set at 23 °C, 72 h (%)	ISO 815	25,0
Abrasion Resistance (mm^3)	ISO 4649	43,0
Elongation at Break TPE (%)	ISO 527	399 / - / 115
Stress at Break TPE (MPa)	ISO 527	37 / - / 19
Tear Strength (kN/m)	ISO 34-1	66 / 37 / 79

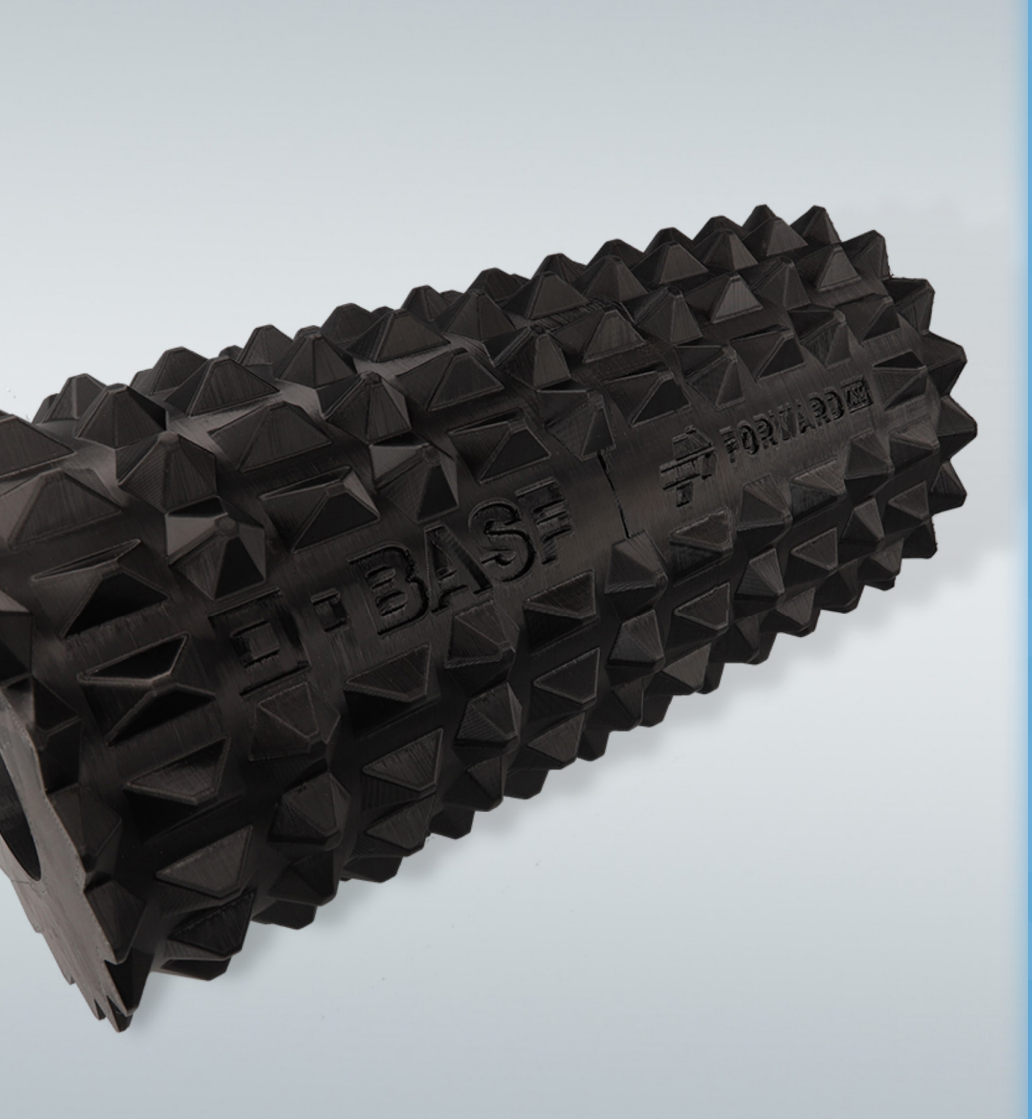
Complete TDS

Advanced Testing

Skin Contact / Biocompatibility
ISO 10993-5; ISO 10993-10
Passed

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
230-255	-	55	glass	≥0,4	30-60



Ultrafuse® TPU 95A

Flexible Filaments

Technology:

Fused Filament Fabrication

Color:

White, Black

Perfect for fast printing

High abrasion resistance

Good resistance to oils and common industrially used chemicals

Printable on direct drive and bowden style printers

Ultrafuse® TPU 95A

Suited for:

Wear and tear application

Functional flexible parts

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
Compression Set at 23 °C, 72 h (%)	ISO 815	38,0
Abrasion Resistance (mm^3)	ISO 4649	64,0
Shore A Hardness (3 s)	ISO 7619-1	92,0
Elongation at Break TPE (%)	ISO 527	611 / - / 192
Stress at Break TPE (MPa)	ISO 527	44,2 / - / 12,2
Tear Strength (kN/m)	ISO 34-1	90 / 8 / 14

Complete TDS

Advanced Testing

Skin Contact / Biocompatibility
ISO 10993-5; ISO 10993-10
Passed

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
210-230	-	40	glass	≥0,4	15-40

Ultrafuse® TPS 90A

Flexible Filaments

Technology:

Fused Filament Fabrication

Color:

Natural White

Non-slip properties

Reduced moisture uptake

Excellent layer adhesion

Very good low-temperature flexibility

Ultrafuse® TPS 90A

Suited for:

- Functional flexible parts
- Handles of appliances
- Seals and gaskets
- Tooling, jigs and fixtures

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / XZ / ZX
Compression Set at 23 °C, 72 h (%)	ISO 815	75,0
Abrasion Resistance (mm^3)	ISO 4649	111,0
Shore A Hardness (3 s)	ISO 7619-1	89,0
Strain at Break TPE (%)	ISO 527	280 / - / 9
Stress at Break TPE (MPa)	ISO 527	7 / - / 2
Tear Strength (kN/m)	ISO 34-1	10 / 5 / 4

Complete TDS

Advanced Testing

Skin Contact / Biocompatibility
ISO 10993-5; ISO 10993-10
Passed

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
260-280	-	70-90	PEI, PI or glue	≥0,4	10-30

Ultrafuse® 316L

Metal Filaments

Technology:

Fused Filament Fabrication

Color:

Steel

Attractive Total Cost of Ownership

Fast material exchange

Easily applicable filament for FFF

Easy and affordable metal 3D printing

Ultrafuse® 316L

Suited for:

Tooling

Jigs & fixtures

Functional prototypes

Suitable for serial production

Access all resources by scanning the QR code

This information and values are presented as guidance only and based on Forward AM's knowledge and experience. It is believed to be accurate, however all guarantees are explicitly denied. This document was updated June 2024.

Technical Specifications

Mechanical properties	Standard	Value XY / ZX
Impact Strength Charpy (notched) (kJ/m2)	ISO 148-12	111,0
Tensile Strength (MPa)	ISO 6892-11	561 / 521
Elongation at Break (%)	ISO 6892-11	53 / 36
Yield Strength, Rp 0.2 (MPa)	ISO 6892-11	251 / 234
Vickers Hardness	ISO 6507-1	128 HV10 / 128HV10

Complete TDS

Print Settings

Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
230-250	-	90-120	glass + tape or glue	≥0,4	15-50

Ultrafuse® 17-4 PH

Metal Filaments

Technology:

Fused Filament Fabrication

Color:

Steel

Easy and affordable way of metal 3D printing

Fully hardened enables highest strength

Wide range of post-processing options for green parts

High mechanical strength and hardness

Ultrafuse® 17-4PH

Suited for:

Tooling

Jigs & fixtures

Functional parts & prototypes

Series production

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Value XY / ZX
Tensile Strength (MPa)	ISO 6892-11	990 / 1004
Elongation at Break (%)	ISO 6892-11	4 / 4
Yield Strength, Rp 0.2 (MPa)	ISO 6892-11	756 / 764
Vickers Hardness HV10	ISO 6507-1	291 / 309

Complete TDS

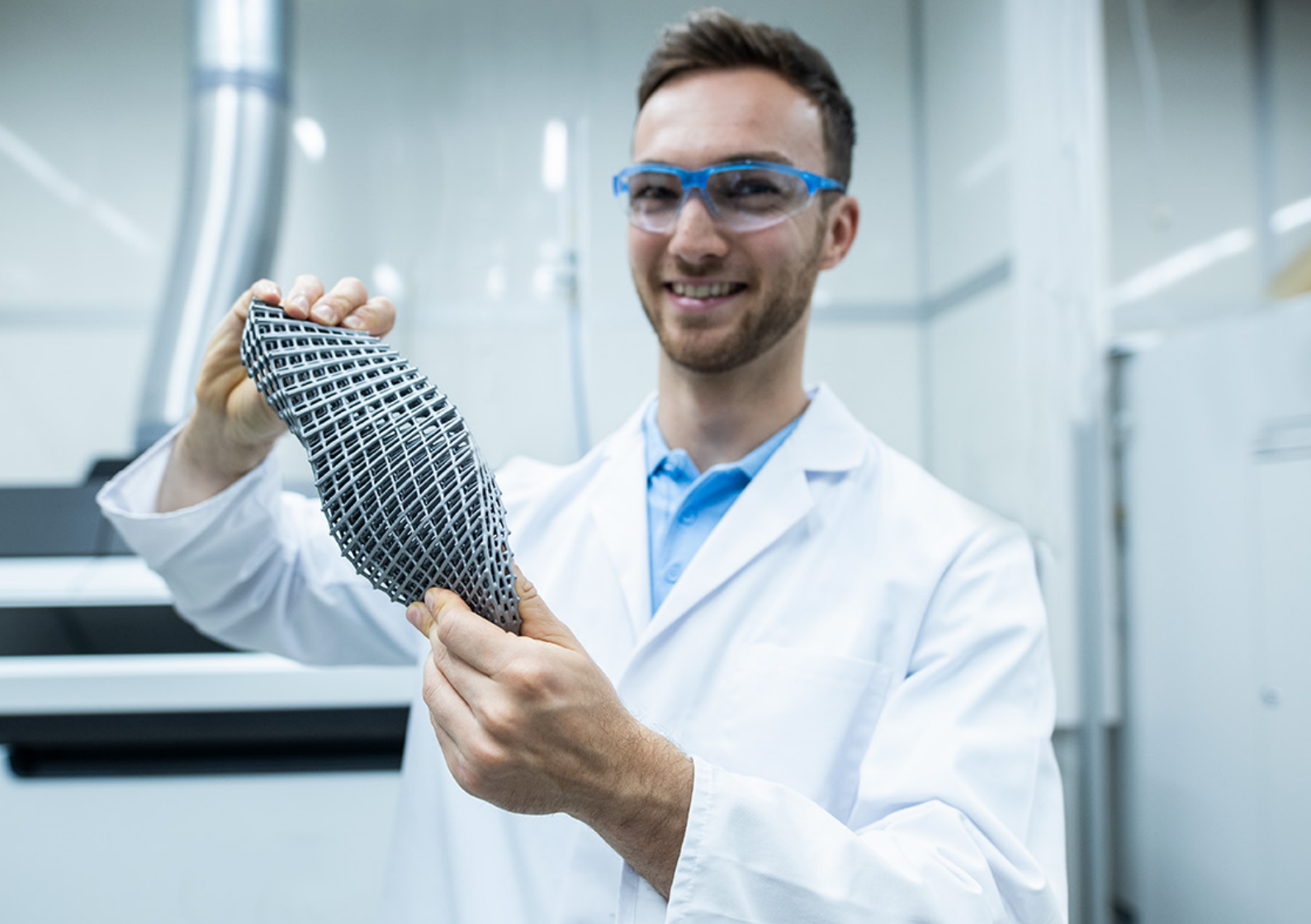
Print Settings

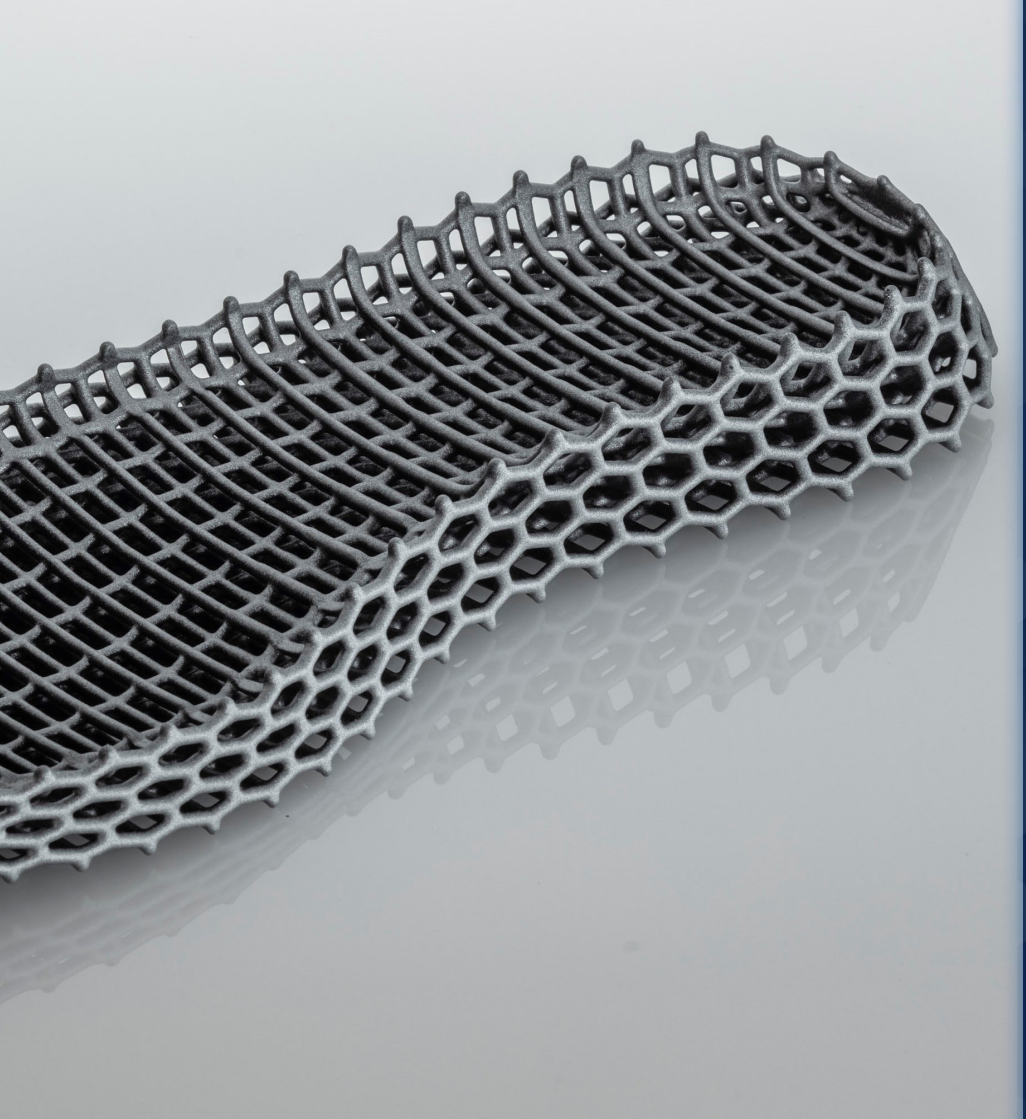
Nozzle Temperature [°C]	Build Chamber Temperture [°C]	Bed Temperture [°C]	Bed Material	Nozzle Diameter [mm]	Print Speed [mm/s]
230-250	-	90-120	glass + tape or glue	≥0,4	15-50

SOLUTIONS & SERVICES

More than just material – From design to the finished product

Discover the full range of Ultrasim® 3D Services to support customers, from design for AM and simulation of part behavior to post-processing the final part.





Ultrasim® 3D Lattice Design

Technologies:

HP MJF Technologies

SLS Technologies

- Increased Comfort
- Aeration
- Weight Reduction
- Optimized Material Performance

Ultrasim® 3D Lattice Design

Suited for:


Footwear


Industrial


Sports


Automotive


Medical Applications


Consumer Goods

Access all resources by scanning the QR code

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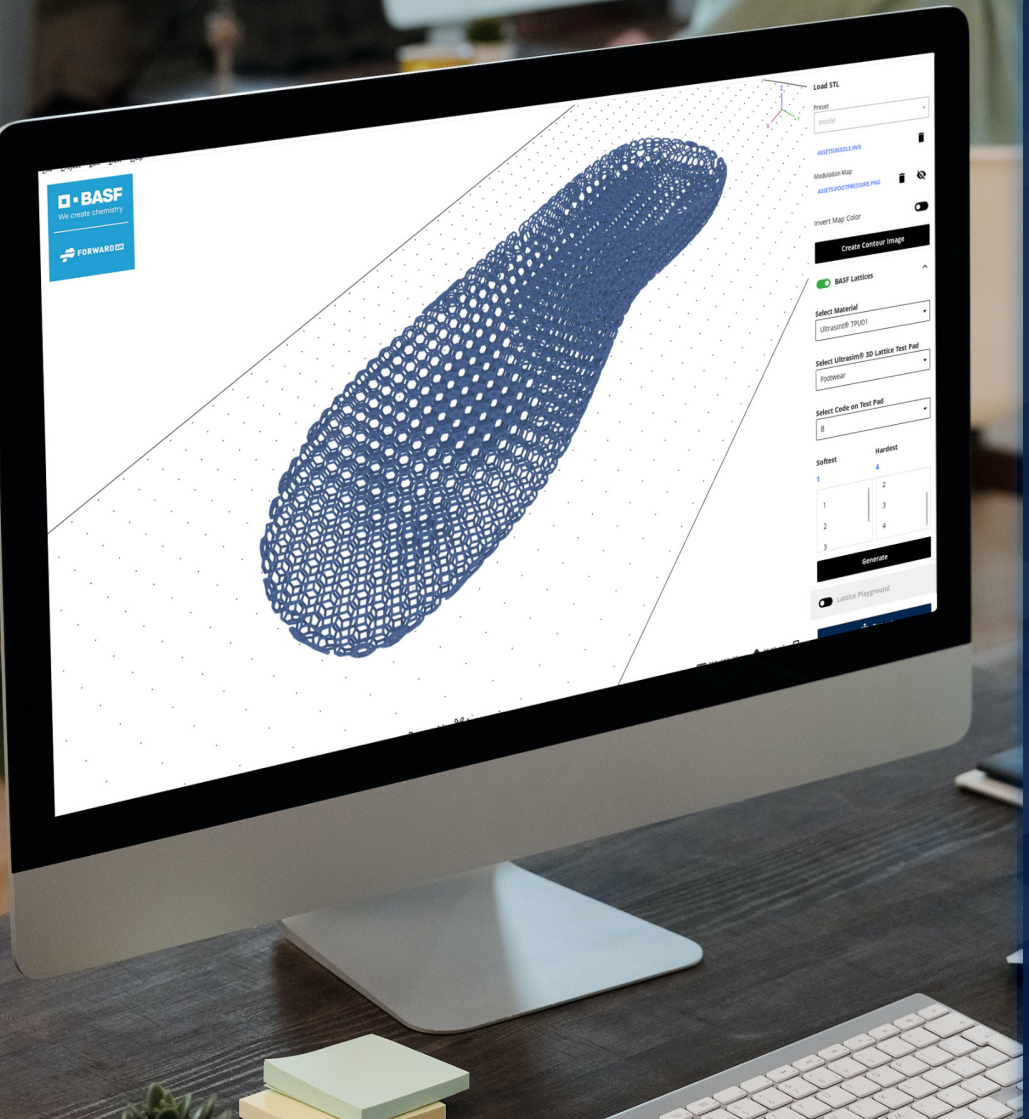
Offers

	Lattice Design Service	Foam Replacement	Full Engineering Support
Description	Custom designed lattice including partial and multi-zone lattices	Custom foam replacement lattice design using proprietary FEA and lattice library	Complete product design development lattice engineering
STL file of digital lattice part	■	■	■
Digital Stress-Strain Curves of all lattices	■	■	■
Customized 3D Printed Lattice sample		■	■
Digital Stress-Strain Curves of tested foam		■	■
Full Engineering			■
Material Compatibility	Full Ultrasint® Powders line	Ultrasint® TPU01	Full Ultrasint® Powders line Full Ultracur3D® Photopolymers line Full Ultrafuse® Filaments line



Ultrasim® 3D Lattice Engine

Material Compatibility:

Ultrasint® Powders

- Pre-selected, validated lattices
- One-click lattice engineering
- On-premise software solution

Ultrasim® 3D Lattice Engine

Suited for:

Footwear

Seating

Protection

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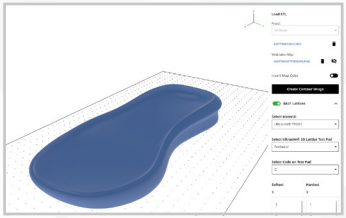
Workflow



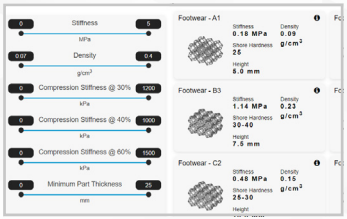
1. Upload STL

Upload your solid STL file and choose the material the part will be produced in.

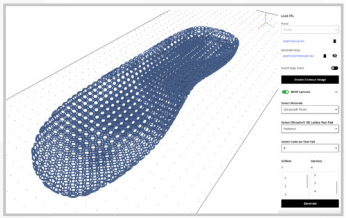
2. Select Lattice

Choose from pre-engineered lattices designed specifically for different applications by using either:

a) The Ultrasim® 3D Lattice Test Pad to select the desired lattice by feel.



b) The Ultrasim® 3D Lattice Library to select by mechanical data of stress-strain curves and specifying different mechanical properties.



3. Generate and Download Lattice File

The selected lattice is automatically generated into the part. You can download the ready-to-print STL and print your part.

Ultrasim® 3D Simulation (FEA)

Material Compatibility:

Ultrasint® Powders

Ultracur3D® Photopolymers

- Ensure your design works
- Material data & modeling
- Quicker development cycles
- 3D design optimization

Ultrasim® 3D Simulation (FEA)

Suited for:


Footwear


Industrial


Sports


Automotive


Medical Applications


Consumer Goods

Access all resources by scanning the QR code

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Offers

	Starter	Premium	Enterprise
Description	Get the curves behind our TDS data to start basic simulation work. Add additional temperatures or strain-rates to the starter solution.	We run the simulation for you. We help you to speed up your engineering process and increases confidence in part performance using a digital twin of your part.	Use our in-house developed material models for 3D-Printing including anisotropy of the process and our experience in virtual Engineering.
Material Data at room temperature	■	■	■
3D Simulation (FEA) support		■	■
Ultrasim 3D material model as a service (incl. installation)			■
Material Compatibility (Preliminary Compatibility)	Ultrasint® TPU01 Ultrasint® PA6 MF Ultracur3D® RG 35 Ultracur3D® RG 1100 Ultracur3D® ST 45 Ultracur3D® ST 80 Ultracur3D® EPD 2006 --- Ultrasint® PA11 Ultrasint® PA11 ESD Ultrasint® PA11 CF	Ultrasint® TPU01 Ultrasint® PA6 MF Ultracur3D® RG 35 Ultracur3D® RG 1100 Ultracur3D® ST 45 Ultracur3D® ST 80 Ultracur3D® EPD 2006 --- Ultrasint® PA11 Ultrasint® PA11 ESD Ultrasint® PA11 CF	Ultrasint® TPU01 Ultrasint® PA6 MF Ultracur3D® RG 35 --- Ultrasint® PA11 Ultrasint® PA11 ESD Ultrasint® PA11 CF

Ultracur3D® Coat F+

Material Compatibility:

Ultrasint® Powders

Ultracur3D® Photopolymers

Ultrafuse® Filaments

Colors:

10+ Standard Colors

Custom Color services available

Application Method:

Spraying

Highly Flexible

Waterbased

Low VOC content

Broad Color Portfolio

Ultracur3D® Coat F+

Suited for:

Footwear

Industrial

Sports

Automotive

Medical Applications

Consumer Goods

Access all resources by scanning the QR code

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Technical Specifications

Mechanical properties	Standard	Typical Value
Ph Value	DIN EN ISO 3251	7.0 – 8.0
Viscosity at 23°C, 1000 1/s	Spindle Viscometer	100 – 300 mPas
Density at 23°C	DIN EN ISO 2811-3	1.0 – 1.3 g/cm³
Solid content	DIN EN ISO 3251	34 – 48%
Flashpoint	ISO 3679	> 95°C

Complete TDS

Tests & Certifications

Skin Contact	UV Stability	Hydrolysis Resistance
ISO 10993-5	ISO 4892-2A ISO 4892-2B Cycle 3	70°C / 95% rH / 168h

User Guidelines

Mixing Ratio	Hardener	Reducer	Potlife at 20°C	Shelf life (5-35°C)
100 : 4 by weight	Ultracur3D® Hardener F+	DI-Water	2 h	6 months

Nozzle pressure	Nozzle size	Spray passes	Flash off at 23°C	Dry film thickness	Drying conditions
2 – 2.5 bar	1.3 mm	1.5 - 2	5 min	25 ± 5 µm	30 minutes at 80°C

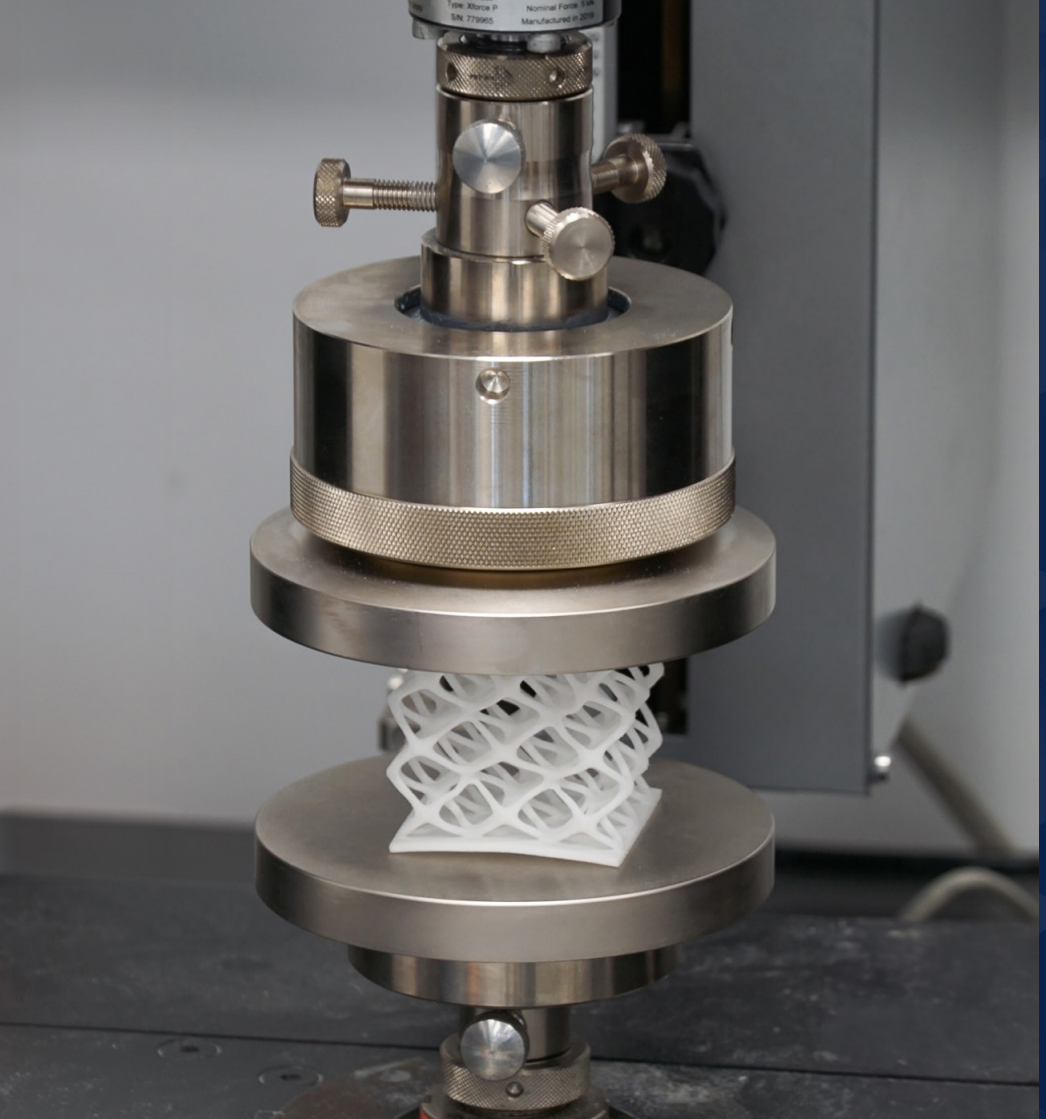
Material Compatibility

Ultrasint® TPU01
Ultrasint® TPU 88A
Ultrasint® PA11
Ultrasint® PA11 Black CF

Ultracur3D® RG 35
Ultracur3D® ST 45
Ultracur3D® FL 300
Ultracur3D® FL 60

Ultracur3D® EL 60
Ultracur3D® EL 4000
Ultracur3D® EPD 1086

Ultrafuse® ASA
Ultrafuse® TPU 85A
Ultrafuse® TPU 90A
Ultrafuse® TPU 64D
Ultrafuse® TPS 90A



Ultrasim® 3D Testing for AM (TfAM)

Material Compatibility:

Ultrasint® Powders

Ultracur3D® Photopolymers

Ultrafuse® Filaments

Third Party Materials

- 150+ Test Methods
- Tests Beyond Standard
- Industry-Specific Tests for +9 Industries
- 150+ Years of Material Excellence

Ultrasim® 3D Testing for AM (TfAM)

Suited for:


Footwear


Industrial


Sports


Automotive


Medical Applications


Consumer Goods

Access all resources by scanning the QR code

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Offers

	Starter Testing On Demand	Premium Monthly Subscription	Enterprise Full-Service Testing
Description	Ideal for customers needing to understand material properties or verify that their 3D printed application meets testing requirements on demand.	Ideal for customers wanting to consistently track their quality in each print job and build up trust in their quality measures.	Ideal for customers wanting or already onboarded to our material with full support from our Product Teams.
Mechanical & Thermal Properties / Industry-Specific Properties / Test report as PDF	■	■	■
Priority Testing		■	■
Testing Consultancy & Print Parameter Optimization			■
Optional Add-on: Customized Parts Testing	■	■	■
Testable AM Materials (MJF/ SLS/ LCD/ DLP/ FFF)	Forward AM materials + 3rd party materials	Forward AM materials + 3rd party materials	Forward AM materials + Testing service to validate customer machines with Forward AM materials