



Business and Technology

Overview of Ultrasint® TPU01

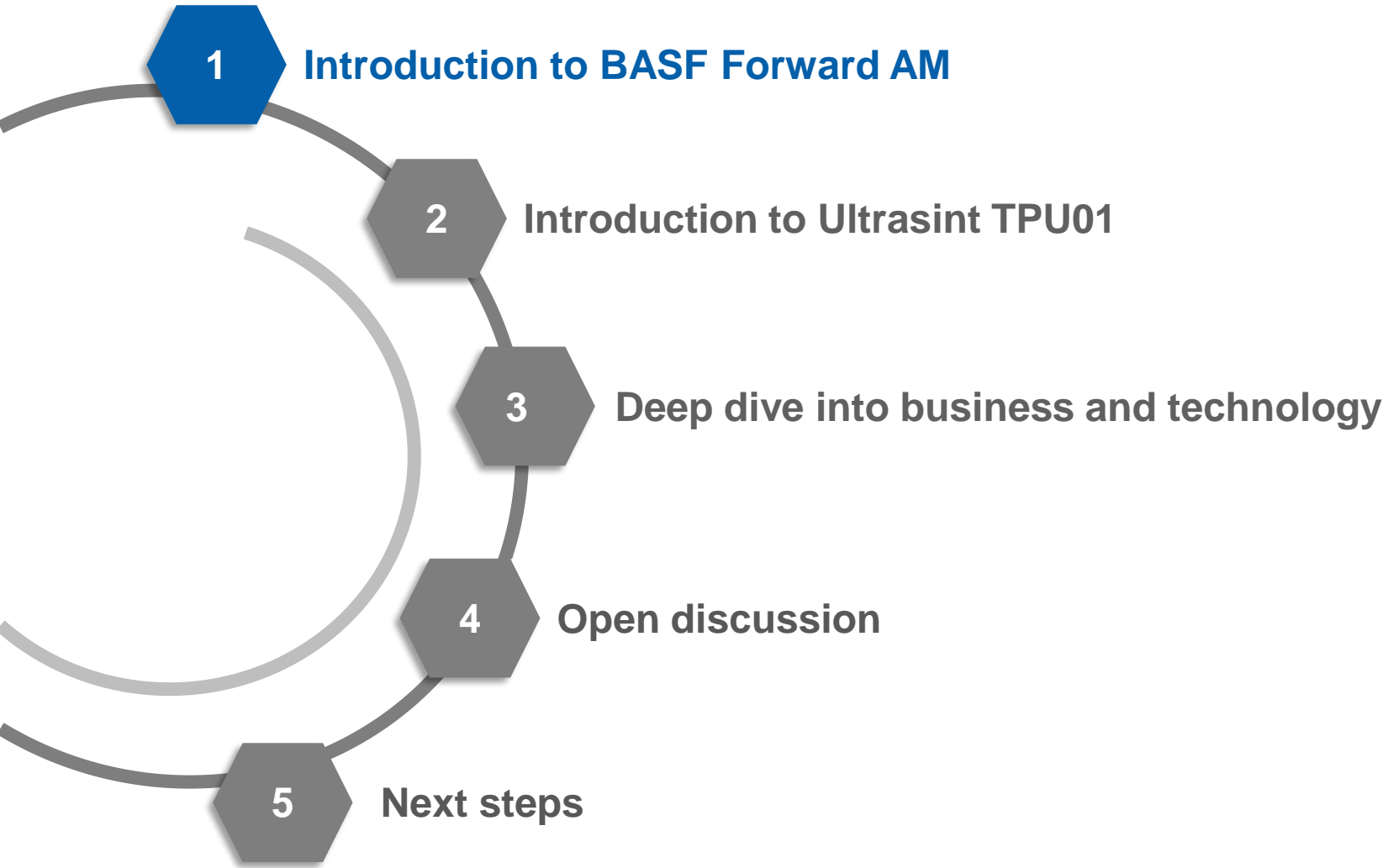
V1, February 2023

HOW TO USE THIS PRESENTATION

This presentation will be updated on a regular basis

- You will find an overview about the most important aspects of Ultrasint TPU01 from slide 7 -12
- On all overview slides (like slide 14) the pictures are links within the presentation to jump to the topic your audience is interested in
- Each topic includes overview slides and deep dives
- Please only share the content of this presentation as a PDF
- In case of any question, we are happy to support you:
- **Valentin Holz**, Key Account Manager PBF, valentin.holz@basf-3dps.com
- **Tobias Haefele**, Product Manager TPU, tobias.haefele@basf-3dps.com

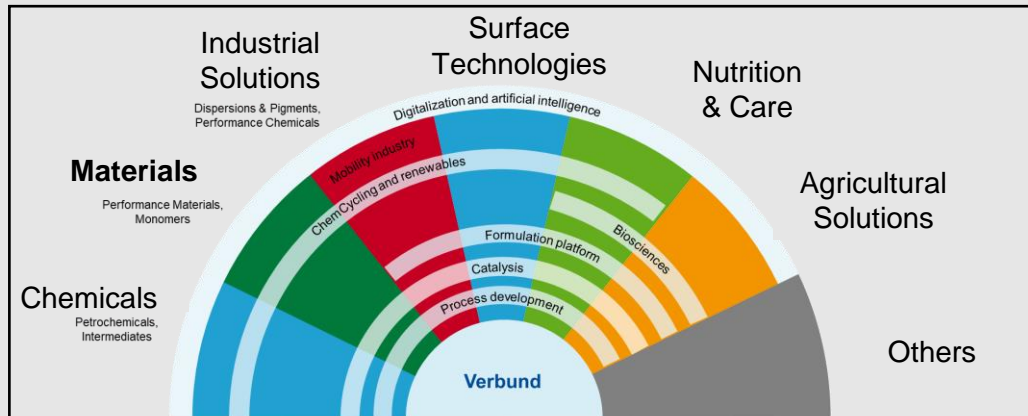
Talking Points



Who is BASF?

Key Facts about BASF

- Sales 2021: € 78.8 billion
- Employees 2020: >110.000
- R&D as major growth driver € 2.2 billion invested
- R&D Employees Worldwide >11.000 employees worldwide



Key Facts about Materials

- ~\$15B Segment
- World-scale plants
 - >1.6B lbs engineered plastic capacity
 - >5B lbs isocyanates capacity
- Polyurethane Systems:
 - Includes PU, MPU, and TPU technologies
 - #1 position in MPU and TPU
- Globally:
 - >\$2.5B into Consumer Goods
 - >\$1.4B into Transportation and Automotive

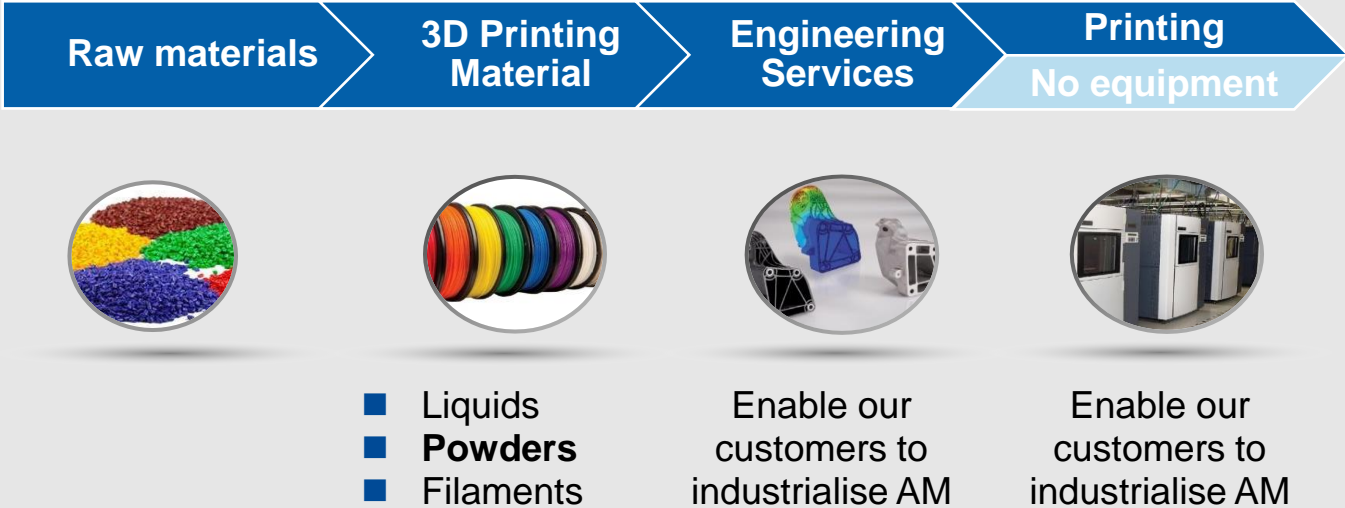
> BASF is our Backbone – the leading chemical company

Who is BASF Forward AM?

Offering along the Full Value Chain

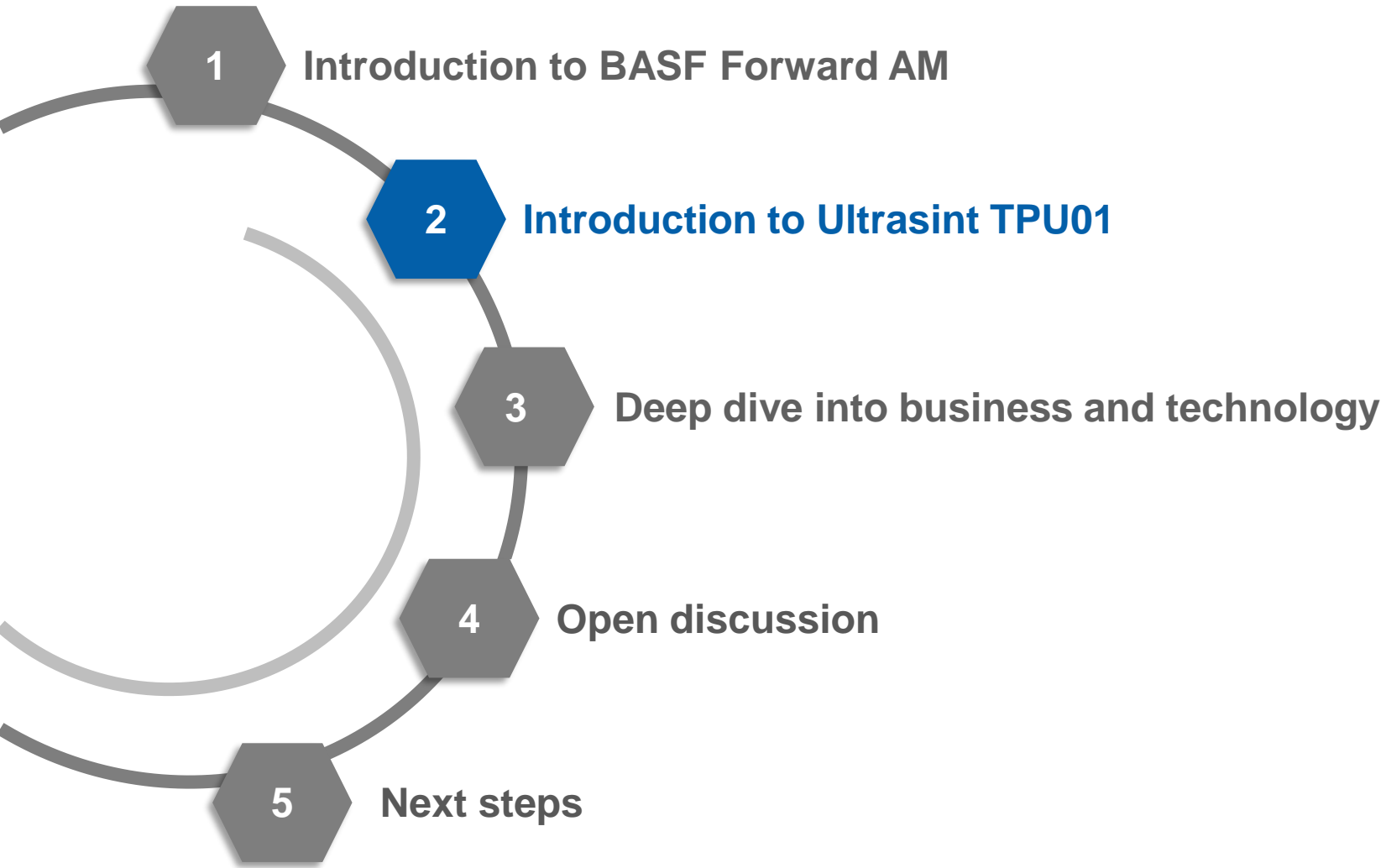
Value Proposition:

- Established in **September 2017** as BASF 3D Printing Solutions operating under the brand Forward AM
- Headquartered in Heidelberg**, Germany
- Global team of **over 200 people** directly dedicated to Additive Manufacturing
- Our Application Technology Centers (ATC) are exclusively focused on supporting the realization of customer applications



Technology agnostic approach to better advice our customers

Talking Points



What is TPU - Thermoplastic Polyurethane

Key Properties

- Rubber like properties
- High wear and abrasion resistance
- High resistance against oils, greases and oxygen
- Very good low-temperature flexibility
- Very good damping capacity

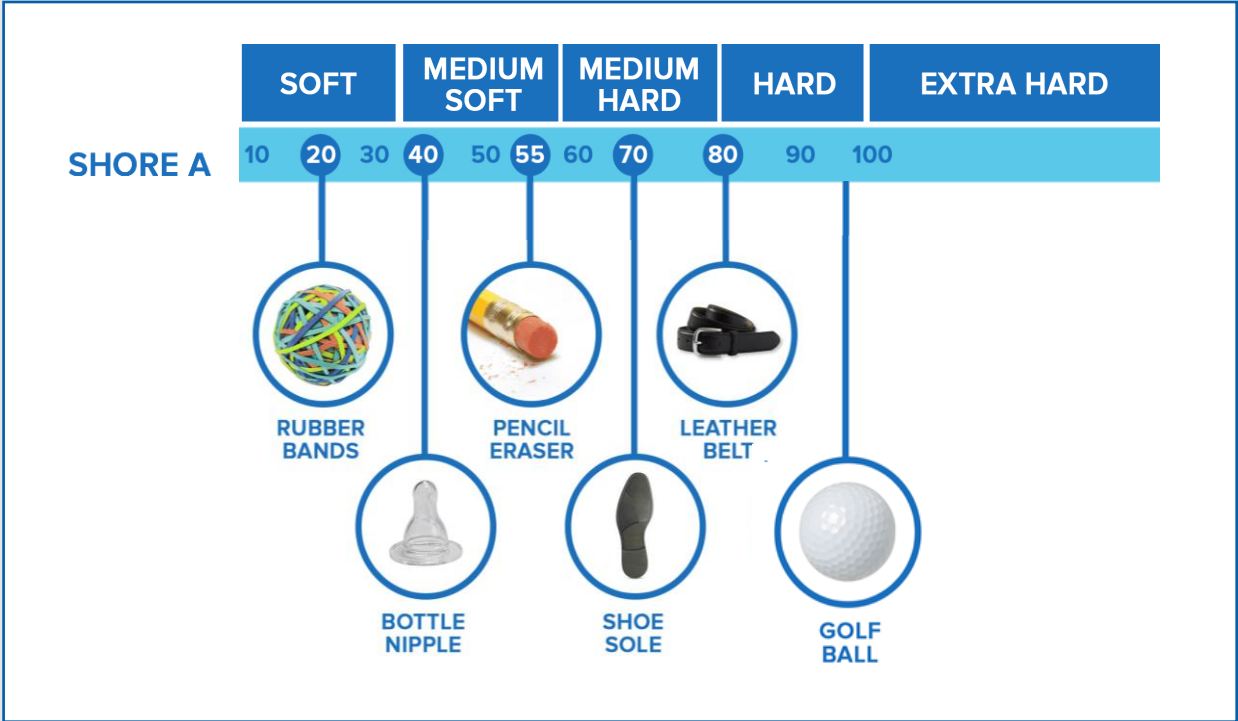
Our Brands



Elastollan® (TPU)



Ultrasint® (TPU)

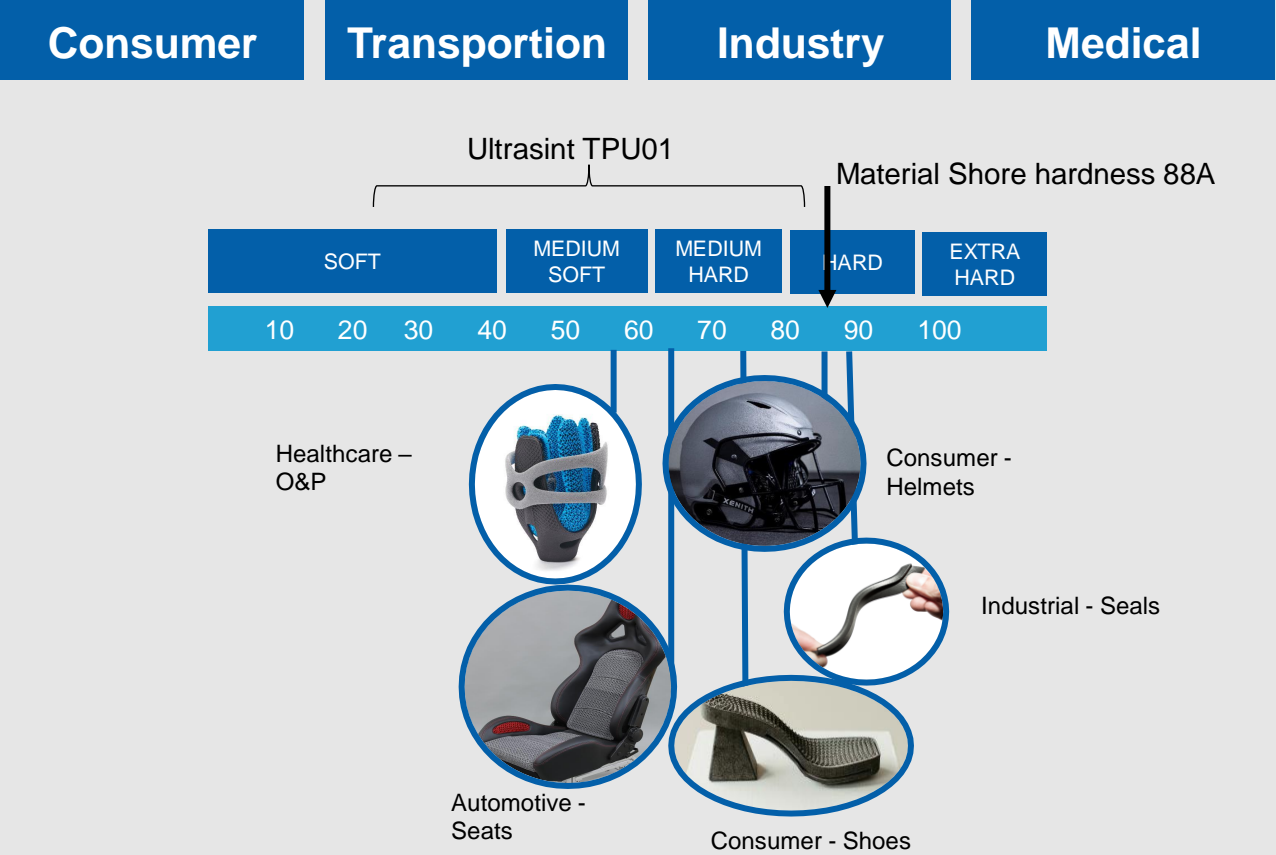


> Rubber like material with wide range of properties

Ultrasint® TPU01

Value Proposition:

- High shock absorption, energy return and resistance to fatigue
- Use in wide range of industries
- Good chemical resistance
- Passed skin contact tests
- 80/20 (old/new) Recyclability ratio
- Ultrasim® 3D Lattice Design for application enablement
- Post-processing like coating and vapour smoothing













Ultrasint® TPU01 used as single material in wide range of industries

Ultrasint® TPU01

Value Proposition:

- High shock absorption, energy return and resistance to fatigue
- Use in wide range of industries
- **Good chemical resistance**
- **Passed skin contact tests**
- **80/20 (old/new) Recyclability ratio**
- Ultrasim® 3D Lattice Design for application enablement
- Post-processing like coating and vapour smoothing

Material Tests and Certification

	Cyclic loading	Available Rossflex for plates at -10°C and 23°C and lattice at 23°C
	UV resistance	Available for ISO 4892-2A Cycle 1 and ISO 4892-2B Cycle 3
	Hydrolysis resistance	Available for 40-60-70-80°C
	Flame Resistance	UL blue card available (HB rating), as well as FMVSS 302
	Low/high temp. resistance	Available for -50 to 100°C: impact, DMA, Vicat, HDT
	Chemical resistance	Available for selected IRM oils and Fuel A.; washability and cleaning through soap, ethanol, isopropanol
	Burst pressure	Available for wall thicknesses 1 – 1.5 – 2 – 3 mm
	Air and water tightness	Water tightness available, air tightness currently being verified
	Emissions	VDA 270, 275, 276, 278
	Skin contact	Statement available (ISO 10993-5, 10993-10);

 **Large test database available**

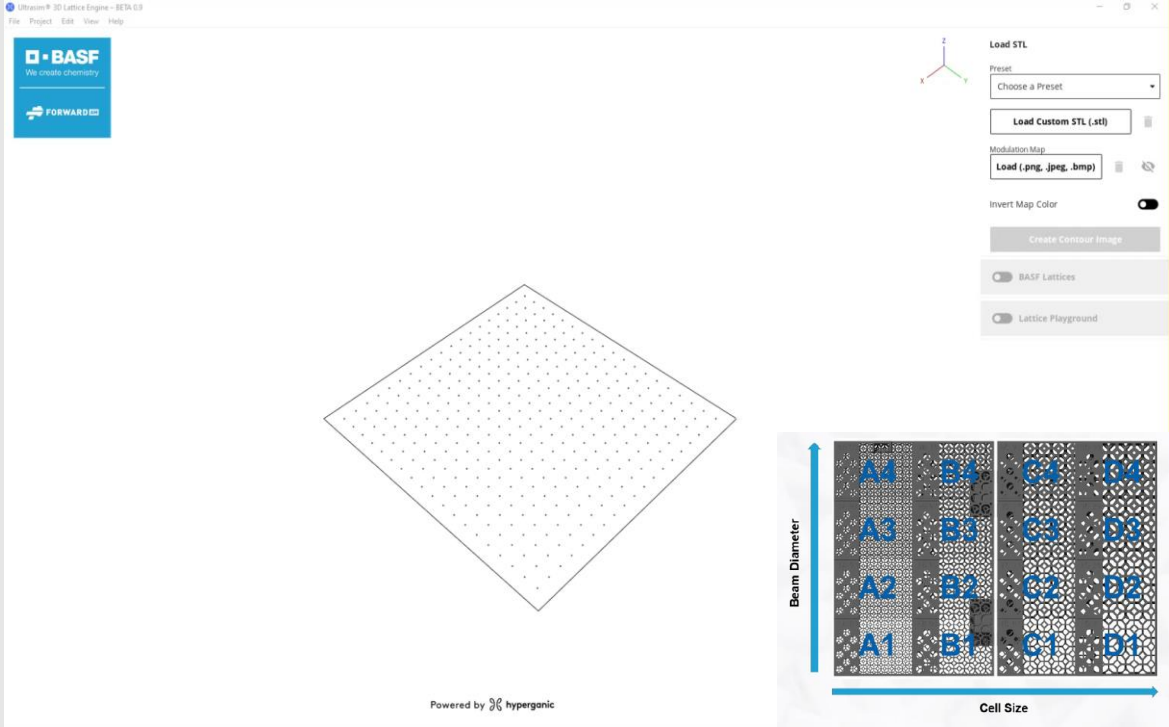
Ultrasint® TPU01

Value Proposition:

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- Use in wide range of industries
- Good chemical resistance
- Passed skin contact tests
- 80/20 (old/new) Recyclability ratio
- **Ultrasim® 3D Lattice Design for application enablement**
- Post-processing like coating and vapour smoothing



Engineering Services



Easy application development with Ultrasim® 3D Lattice Design Services

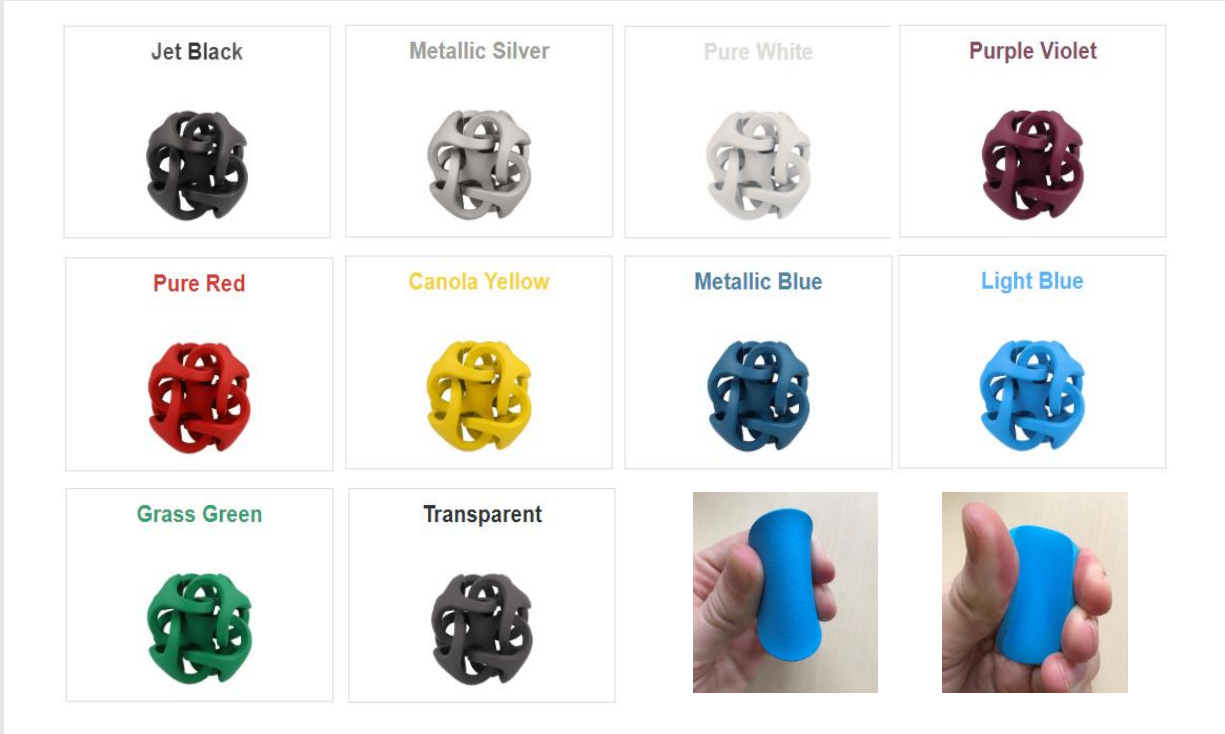
Ultrasint® TPU01

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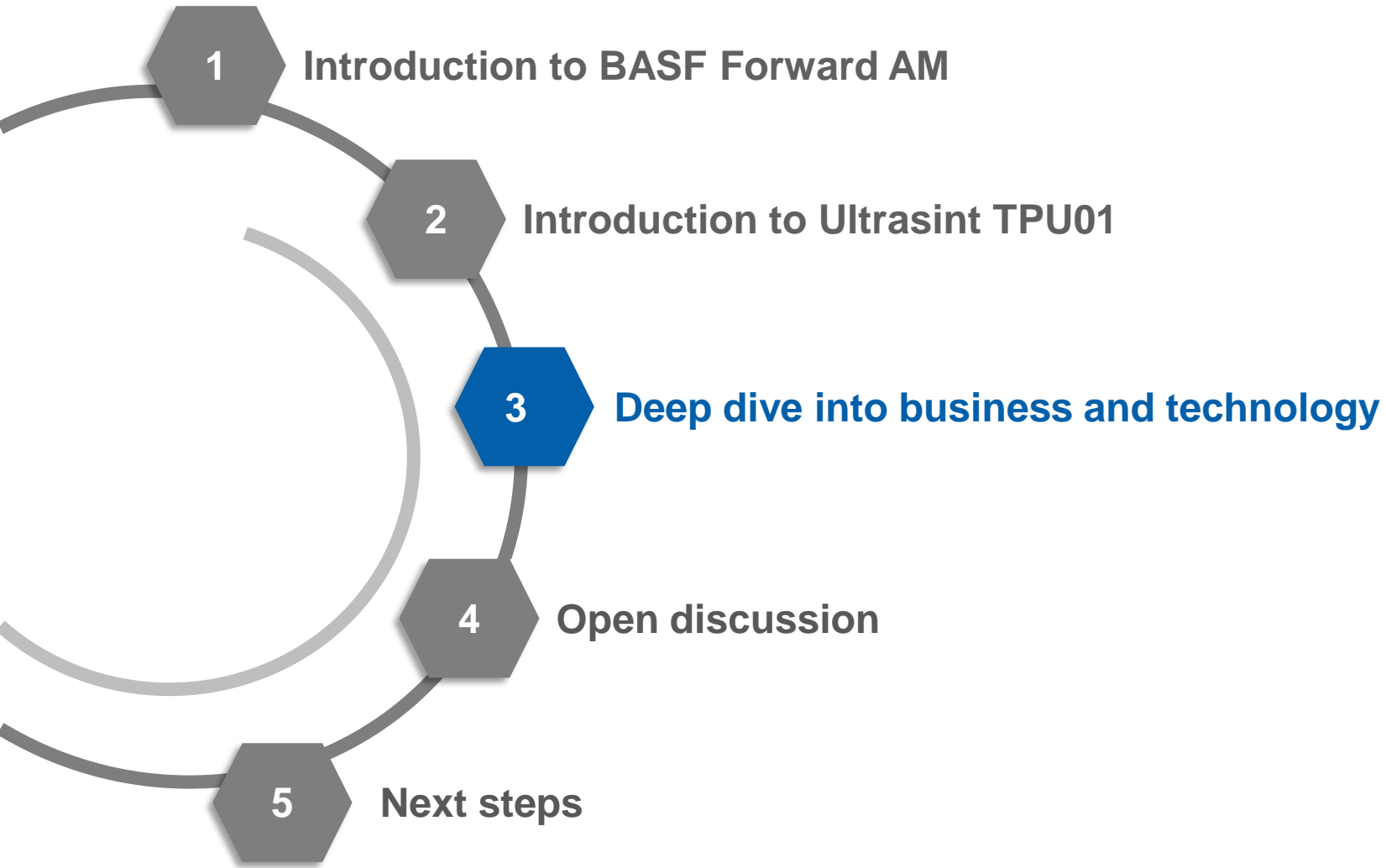


Coating Solutions



> Large post-processing solutions available for high-end quality


Talking Points




Overview for deep dive into business and technology

Business

Application and Usecases

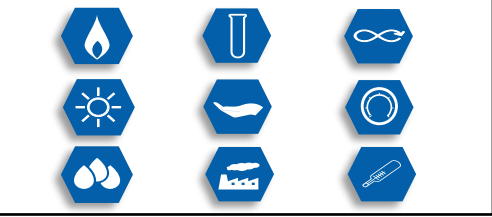


Sales Assets




Technical


Material Tests and Certificats



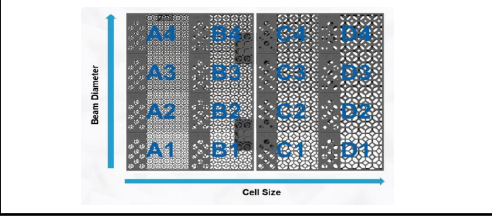
Printing Process



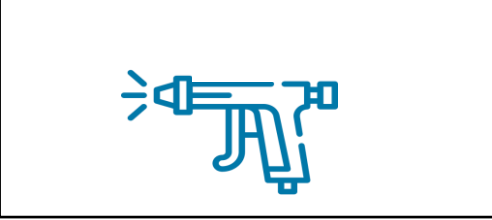
Coating



Ultrasim® 3D Lattice Design




Depowdering

















Sustainability

Environmental Impact

- LCA
- Recycling
- Carbon Compensation



Ultrasint® TPU01 certificates and tests

	Lattice design	Lattice identification through Ultrasim® material model DIN 1621-2 certification for protective gear		Post processing	Dying, smoothing, coating successfully tested
	Cyclic loading	Available Rossflex for plates at -10°C and 23°C and lattice at 23°C		Chemical resistance	Available for selected IRM oils and Fuel A.; washability and cleaning through soap, ethanol, isopropanol
	UV resistance	Available for ISO 4892-2A Cycle 1 and ISO 4892-2B Cycle 3		Burst pressure	Available for wall thicknesses 1 – 1.5 – 2 – 3 mm
	Hydrolysis resistance	Available for 40-60-70-80°C		Air and water tightness	Water tightness available, air tightness currently being verified
	Flame Resistance	UL blue card available (HB rating), as well as FMVSS 302		Skin contact	Statement available (ISO 10993-5, 10993-10); tests for vapour smoothed parts ongoing
	Low / high temperature resistance	Available for -50 to 100°C: impact, DMA, Vicat, HDT		Emissions	VDA 270, 275, 276, 278
	Regulation Documents	REACH, RoHS, PAHs, PFO, POP, ELV, SVHC, WEEE, GADSL. Material listed in IMDS. Others regulatory documents available upon request.		Sustainability	Investigations ongoing in recycling to filament and injection molding grade

Ultrasint TPU01 (MJF): current Technical Data Sheet (ISO)

General Properties	Test Method	Typical Values
Bulk Density / g/cm ³	DIN EN ISO 60	0.5
Printed Part Density / g/m ³	DIN EN ISO 1183-1	1.1
Mean particle size d50 / μm	ISO 13320	70-90
Glass transition Temperature / °C	ISO 11357 (20 K/min)	- 48
Melting Temperature / °C	ISO 11357 (20 K/min)	120-150

Thermal Properties	Test Method	Typical Values ¹ X-Direction	Typical Values ¹ Z-Direction
UL Flammability	UL 94	HB (1.0-3.0 mm)	HB (1.0-3.0 mm)
Vicat/A (10 N) / °C	DIN EN ISO 306	97	98

Mechanical Properties	Test Method	Typical Values ¹ X-Direction	Typical Values ¹ Z-Direction
Hardness Shore A	DIN ISO 7619-1	88-90	88-90
Tensile Strength / MPa	DIN 53504, S2	9	7
Tensile Elongation at break / %	DIN 53504, S2	280	150
Tensile Modulus / MPa	ISO 527-2, 1A	85	85
Flexural Modulus / MPa	DIN EN ISO 178	75	75
Tear resistance (propagation, Trouser) / kN/m	DIN ISO 34-1, A	21	18
Tear resistance (initiation, Graves) / kN/m	DIN ISO 34-1, B	38	32
Compression Set B (23°C, 72h) / %	DIN ISO 815-1	23	24
Rebound resilience / %	DIN 53512	63	63
Abrasion resistance / mm ³	DIN ISO 4649	96	100
Charpy Impact Strength (notched, 23°C) / kJ/m ²	DIN EN ISO 179-1	No break	No break
Charpy Impact Strength (notched, -10°C) / kJ/m ²	DIN EN ISO 179-1	46	44
Fatigue behavior (Rossflex, 100k cycles, 23°C)	ASTM D1052	No cut growth	
Fatigue behavior (Rossflex, 100k cycles, -10°C)	ASTM D1052	No cut growth	

Remarks

- All properties are measured after conditioning 3 days at 23°C and 50% RH
- All values represent the stable part performance obtained when using the recommended refresh rate of 20% fresh + 80% recycled powder

Ultrasint TPU01 (MJF): current Technical Data Sheet (ASTM)

General Properties	Test Method	Typical Values
Bulk Density	DIN EN ISO 60	0.5 g/cm ³
Printed Part Density	DIN EN ISO 1183-1	1.1 g/m ³
Mean particle size d50	ISO 13320	70-90 µm
Glass transition Temperature	ISO 11357 (20 K/min)	- 48°C / - 54°F
Melting Temperature	ISO 11357 (20 K/min)	120-150°C / 248-302°F

Thermal Properties	Test Method	Typical Values ¹ X-Direction	Typical Values ¹ Z-Direction
UL Flammability	UL 94	HB (1.0-3.0 mm)	HB (1.0-3.0 mm)
Vicat/A (10 N)	ASTM D1525	84°C / 183°F	96°C / 205°F

Mechanical Properties	Test Method	Typical Values ¹ X-Direction	Typical Values ¹ Z-Direction
Hardness Shore A	ASTM D2240	88	88
Tensile Strength	ASTM D412, type IV	8 MPa / 1160 psi	7 Mpa / 1015 psi
Tensile Elongation at break	ASTM D412, type IV	200%	120%
Tensile Modulus	ASTM D412, type IV	75 MPa / 11 ksi	85 MPa / 12 ksi
Flexural Modulus	ASTM D790	60 MPa / 8.7 ksi	80 MPa / 12 ksi
Tear resistance (propagation, Trouser)	ASTM D624, type T	20 kN/m	24 kN/m
Tear resistance (initiation, Graves)	ASTM D624, type C	46 kN/m	44 kN/m
Compression Set (method A, 23°C, 72h)	ASTM D395	4%	2%
Compression Set (method C, 23°C, 72h)	ASTM D395	23%	24%
Rebound resilience	ASTM D2632	60%	60%
Abrasion resistance (method A)	ASTM D5963	78 mm ³	70 mm ³
Izod Impact (notched, 3.2mm, 23°C)	ASTM D256	No break	No break
Izod Impact (notched, 3.2mm, -10°C)	ASTM D256	No break	No break
Fatigue (Rossflex, 100k cycles, 23°C)	ASTM D1052	No cut growth	
Fatigue (Rossflex, 100k cycles, -10°C)	ASTM D1052	No cut growth	

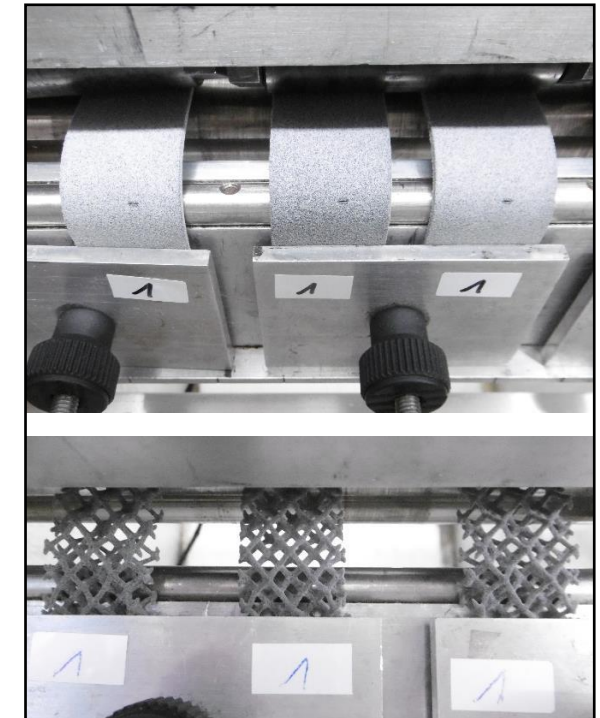
Remarks

- All properties are measured after conditioning 3 days at 23°C and 50% RH
- All values represent the stable part performance obtained when using the recommended refresh rate of 20% fresh + 80% recycled powder
- These data were still collected with an older firmware/printmode version. Some improvements, especially in Tensile elongation at break can be expected.

Ultrasint TPU01 (MJF): cyclic mechanical testing

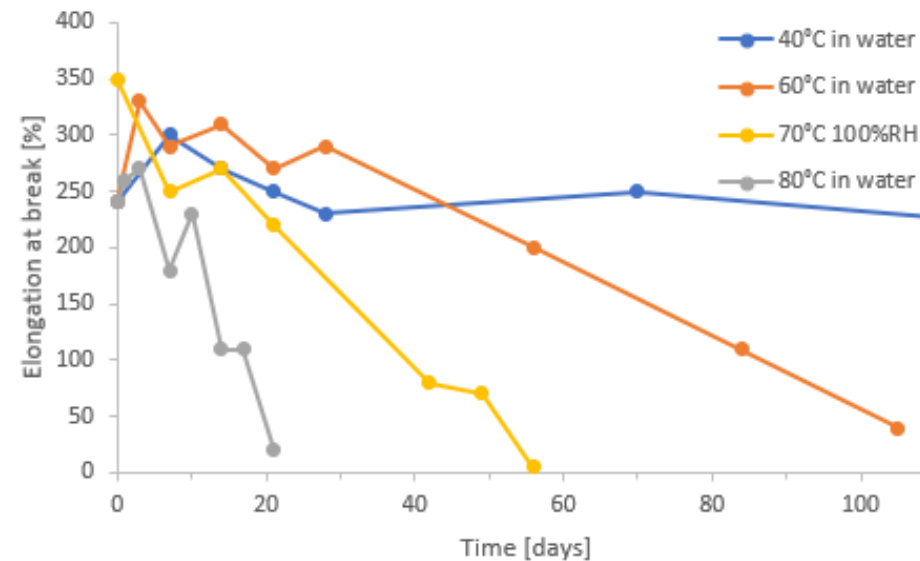
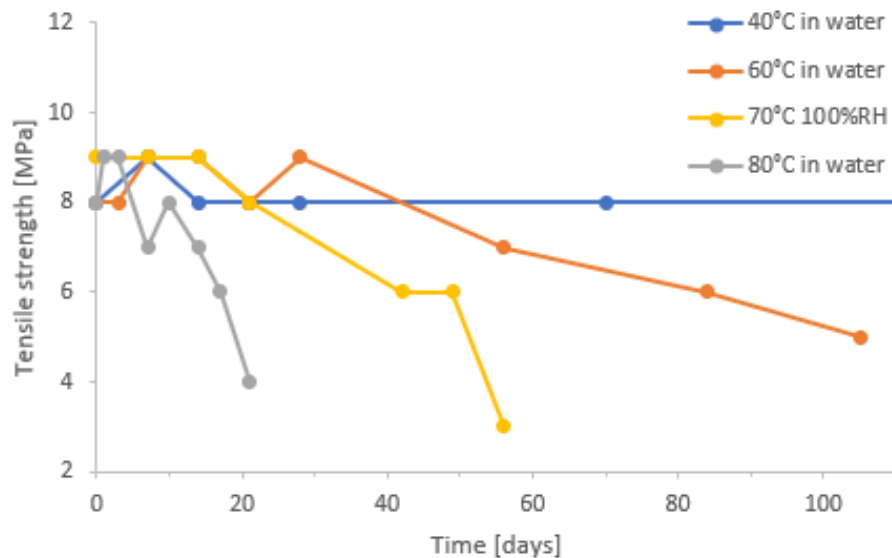
- Rossflex tests (ASTM D1052)
 - ▶ Plates (120x25x2mm, printed in XZ) and Lattices (150x20x10mm)
 - ▶ 60° or 90° bending angle, 100k bending cycles
 - ▶ 2 mm incision is made and possible growth of this cut during the bending is monitored

Rossflex tests	Reference	Etched	Coated (Ultracoat F)
	After 100k cycles		
Plate, 23°C, 90°, 2mm incision	No cut growth	No cut growth	No cut growth
Plate, -10°C, 90°, 2mm incision	No cut growth	No cut growth	No cut growth
Lattice, 23°C, 90°, no incision	No broken connections		
	After 1mio. cycles		
Plate, 23°C, 60°, 1mm incision	No cut growth	Not tested	Not tested
Plate, 23°C, 60°, 2mm incision	No cut growth	Not tested	Not tested
Plate, 23°C, 60°, 3mm incision	No cut growth	Not tested	Not tested
Plate, 23°C, 60°, 4mm incision	Broke after 350k cycles	Not tested	Not tested



Ultrasint TPU01 (MJF): Hydrolysis resistance

- Storage of S2 tensile bars (X-direction), immersed in water, at various temperatures
- Like for all polyester-based TPUs, water at high temperature can be a problem, but at 40°C the printed parts properties stay constant for >200 days (not shown in graphs)!



- Remark: parts may turn yellow after contact with water. This happens when there are copper traces present in the water or on the parts (for example when copper brushes are used). This does not affect part performance.

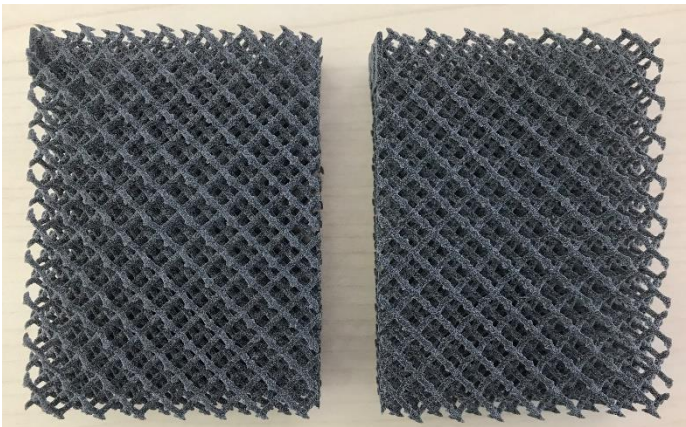


Ultrasint TPU01 (MJF): Part blooming

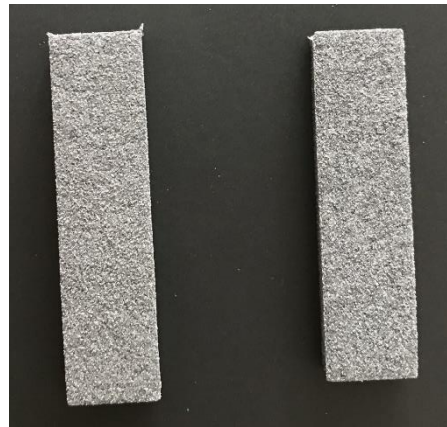
- Part blooming = migration of a component or additive to the surface of the part, causing discoloration
 - ▶ Test method 1: store lattice parts for various times at 60°C, 95% RH
 - ▶ Test method 2: store parts half under water (distilled) for 21 days at 48°C
- No visible blooming on any of the tested parts!
(in the pictures: left = reference, right = after 21 days)



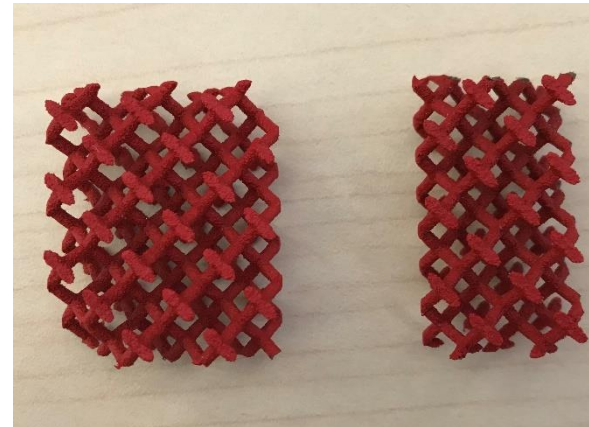
Method 1
(sandblasted)



Method 2
(sandblasted)



Method 2
(Ultracur3D coating)



Method 2
(chemically smoothed)



Ultrasint TPU01 (MJF): Chemical resistance

- TPU chemistry: this is an aliphatic polyester-based TPU

- General chemical resistance data for conventional TPU grades:

http://www.elastollan.basf.us/img/pdf/Elastollan_Chemical_Resistance.pdf

Of the three given grades, Elastollan C 85 A is chemistry-wise the closest to Ultrasint TPU01. So the data given for this Elastollan C 85 A can be used as a *non-binding indication* for the chemical resistance of Ultrasint TPU01.

Code	Tested	Elastollan S 85 A		Elastollan C 85 A		Elastollan 1185 A	
		20° C	60° C	20° C	60° C	20° C	60° C
0. Water	Tap Water	Years	Months	Years	Months	Years	Years
	Sea Water	Years	Months	Years	Months	Years	Years
1. Weak Acids, Carbonic Acids	3 % Acetic Acid	Weeks	Days	Weeks	Days	Years	Months
	3 % Lactic Acid	Weeks	Days	Weeks	Days	Years	Months
	3 % Boric Acid	Months	Weeks	Months/ Years	Weeks/ Months	Years	Months
	3 % Phenolic Solution	Weeks/ Months	Days	Months/ Years	Weeks	Years	Months However, tensile strength only 50 % due to swelling
The action of 3 % solutions of formic acid, propionic acid, butyric acid, lauric acid, oleic acid, stearic acid etc., will be comparable.							
2. Chelating Carbon Acids	3 % Citric Acid	Months	Days	Months	Days	Years	Months
3. Weak Mineral Acids	3 % Sodium Bisulphate Solution	Months	Days/ Weeks	Months/ Years	Weeks	Years	Months
	3 % Phosphoric Acid	Months	Days	Months	Weeks	Years	Months

Ultrasint TPU01 (MJF): Chemical resistance

- Tests on Ultrasint TPU01: S2 tensile bars, X-direction, immersed for 42 days at 23°C unless specified otherwise. Detailed results available upon request.

Tested fluid	Testing conditions / Fluid details	Tensile Strength	Elongation at Break	Hardness Shore A	Volume change
IRM 901	100°C	=	↓	=	+ 2.0%
IRM 902	100°C	=	↓	=	+ 5.4%
IRM 903	100°C	↓	↓	=	+ 8.7%
Fuel A	Comparable to gasoline	=	↓	=	+ 3.8%
Lubricating grease	“Nigrin Mehrzweckfett”	=	=	=	+ 7.1%
Brake fluid	“Bosch DOT 4”	↓	↓	=	+ 29%
Hydraulic fluid	“Febi 46161”	=	=	=	+ 2.3%
Engine oil	“Castrol Edge Professional 5W-30”	=	=	=	+ 3.5%
Gear oil, automatic transmission fluid	“Valvoline ATF PRO 236.14”	=	=	=	+ 2.6%
Engine coolant	“Glysantin G48 ready mix”	=	=	=	+ 2.3%
Washing machine	15 washing cycles of 1.5h each, 40°C, with regular soap and softener	=	=		
Ethanol	1 day	=	=		+ 3.2%
Isopropanol	1 day	=	=		+ 2.8%

Ultrasint TPU01 (MJF): UV resistance, accelerated weathering tests

■ Test method

	Example	UV exposure	Exposure period	Chamber temperature	Black-standard temperature	Relative humidity
ISO 4892-2A Cycle 1	Outdoor conditions	Daylight filters	102 min dry 18 min water spray	38 ± 3 °C	65 ± 3 °C	50 ± 10 %
ISO 4892-2B Cycle 3	Car dashboard	Window glass filters	Continuously dry	65 ± 3 °C	100 ± 3 °C	20 ± 10 %

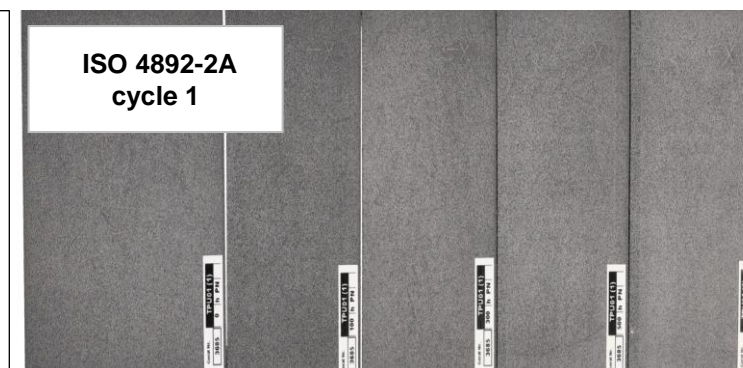
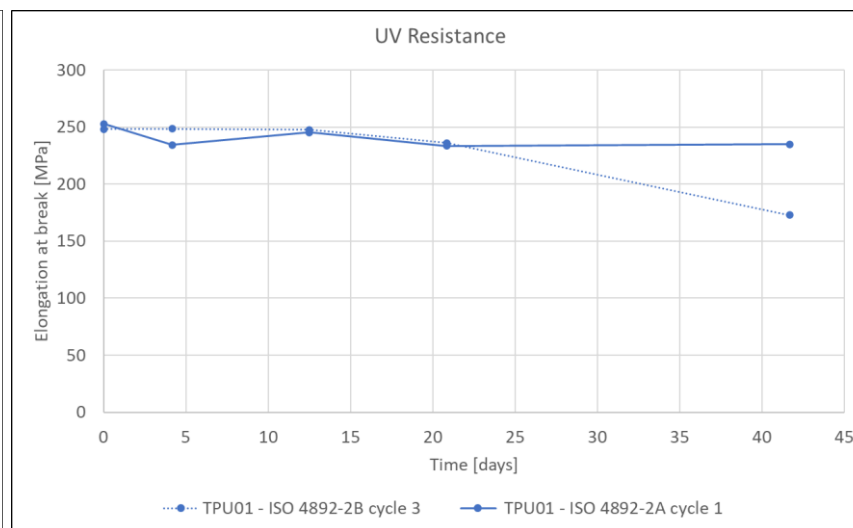
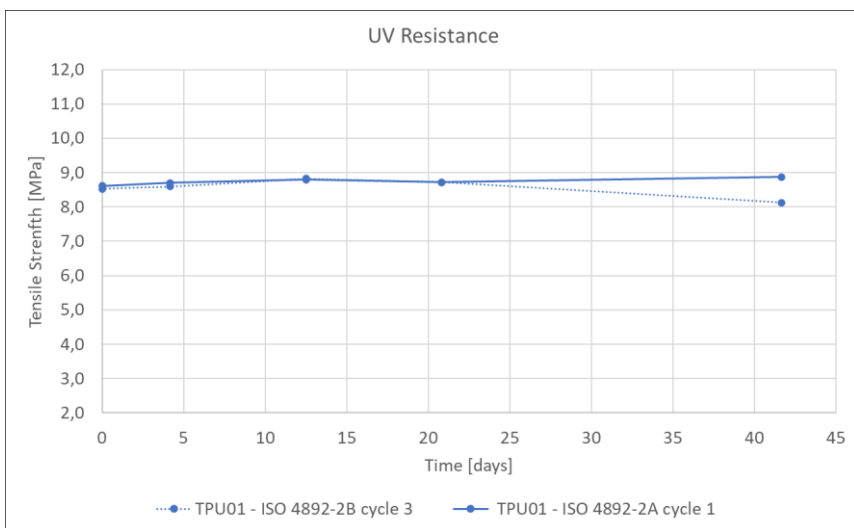
■ Remarks:

- ▶ Plates were printed vertically, cleaned by regular sandblasting, S2 tensile bars cut out afterwards in XZ-direction, exposure duration 42 days (1000h)
- ▶ Because of the UV radiation, samples heat up. The „black-standard temperature“ can be used as an approximate temperature for darker samples
- ▶ The TPU chemistry behind Ultrasint TPU01 (aliphatic) has an intrinsically high UV stability

Ultrasint TPU01 (MJF): UV resistance, accelerated weathering tests

■ Test results

	Tensile Strength	Elongation at Break	Color fastness
ISO 4892-2A Cycle 1	=	=	Some staining from the water spray
ISO 4892-2B Cycle 3	=	↓	Samples became a bit darker after long exposure times



0h	100h	300h	500h	1000h
L-Value: 47,6	L-Value: 43,8	L-Value: 45,5	L-Value: 45,2	L-Value: 46,1
a: -0,1 b: -1,0	a: -0,2 b: -0,8	a: -0,2 b: -0,8	a: -0,1 b: -0,8	a: -0,2 b: -0,9

Ultrasint TPU01 (MJF): Flame resistance

- This material does not contain any flame retardants, so the flammability behavior is in principle comparable to regular plastics.
- UL Blue card available:
 - ▶ HB rating for $t \geq 1.0\text{mm}$
- FMVSS 302 (car interior applications):
 - ▶ VERY geometry dependent!
Worst-case are thin plates or thin/fine lattices
 - ▶ Result for test plates 356x102mm, 5 samples:

Orientation	Thickness	Max. burning rate (limit $\leq 102\text{mm/min}$)
XY	1.16 mm	97 mm/min
Z	1.32 mm	63 mm/min

Plastics for Additive Manufacturing E506048

Guide Information Process Category: Powder Bed Fusion View Blue Card Format

BASF 3D Printing Solutions GmbH
Speyerer Str. 4, Heidelberg 69115 DE

Ultrasint TPU01(#)(R80)
Thermoplastic Polyurethane (TPU), furnished as powder

Color	Min. Thk (mm)	Flame Class	HWI	HAI	GWIT	GWFI	RTI Elec	RTI Imp	RTI Str
GY	0.75	-	-	-	700	675	50	50	50
	1.0	HB	-	-	675	650	50	50	50
	1.5	HB	-	-	675	650	50	50	50
	3.0	HB	-	-	675	650	50	50	50

Comparative Tracking Index (CTI): 0 Inclined Plane Tracking (IPT) kV: -
Dielectric Strength (kV/mm): 4.38 Volume Resistivity (10^x ohm-cm): 10
High-Voltage Arc Tracking Rate (HVTR): - High Volt, Low Current Arc Resis (D495): -
IEC Comparative Tracking Index (Volts Max): - ISO Charpy Impact (kJ/m²): -
IEC Ball Pressure (°C): - ISO Heat Deflection @1.80 MPa (°C): -
ISO Tensile Strength (MPa): - ISO Flexural Strength (MPa): -
ISO Tensile Impact (kJ/m²): - ISO Izod Impact (kJ/m²): -

Process Category: Powder Bed Fusion Printing Process Designation Number: 1

Build Plane: Horizontal & Vertical Laser Power (Watts): -
Layer Thickness (µm): 100 Scan Speed (m/s): -
Hatch Spacing (mm): - Scan Strategy: -
Post Processing Method: Bead blasting: Glass beads, 300-400µm, with 4-6 bars Air Pressure.
For use with UL Listed printer: HP Jet Fusion 5200 3D Printer, HP Jet Fusion 5210 3D Printer, HP Jet Fusion 5210 pro 3D Printer
Printer Preset: balanced

Limited properties and ratings assigned to samples produced by the Additive Manufacturing technique representing a specific set of printing parameters and build strategy. Other print parameters and build strategies may result in significantly different results.

(#) - For use with Fusing and detailing agents HP 3D600, HP 3D700 or HP 3D710.
(R80) - Material is approved for use with Reclaimed powder of 80%

IEC/ISO small-scale test data does not pertain to building materials, furnishings and related contents. IEC/ISO small-scale test data is intended solely for determining the flammability of plastic materials used in the components and parts of end-product devices and appliances, where the acceptability of the combination is determined by UL.

Report Date: 2020-03-13 © 2020 UL LLC
Last Revised: 2020-03-17

Ultrasint TPU01 (MJF): Electrical properties

- Mostly available on UL Blue card
- Some detailed results:

Plastics for Additive Manufacturing E506048
 Guide Information Process Category: Powder Bed Fusion View Blue Card Format

BASF 3D Printing Solutions GmbH
 Speyerer Str. 4, Heidelberg 69115 DE

Ultrasint TPU01(#)(R80)
 Thermoplastic Polyurethane (TPU), furnished as powder

Color	Min. Thk (mm)	Flame Class	HWI	HAI	GWIT	GWFI	RTI Elec	RTI Imp	RTI Str
GY	0.75	-	-	-	700	675	50	50	50
	1.0	HB	-	-	675	650	50	50	50
	1.5	HB	-	-	675	650	50	50	50
	3.0	HB	-	-	675	650	50	50	50

Comparative Tracking Index (CTI): 0
 Dielectric Strength (kV/mm): 4.38
 Voltage Arc Tracking Rate (HVTR): -
 Comparative Tracking Index (Volts Max): -
 IEC Ball Pressure (°C): -
 ISO Tensile Strength (MPa): -
 ISO Tensile Impact (kJ/m²): -

Inclined Plane Tracking (IPT) kV: -
 Volume Resistivity (10^x ohm-cm): 10
 High Volt, Low Current Arc Resis (D495): -
 ISO Charpy Impact (kJ/m²): -
 ISO Heat Deflection @1.80 MPa (°C): -
 ISO Flexural Strength (MPa): -
 ISO Izod Impact (kJ/m²): -

Process Category: Powder Bed Fusion Printing Process Designation Number: 1

Build Plane: Horizontal & Vertical
 Laser Power (Watts): -
 Layer Thickness (µm): 100
 Scan Speed (m/s): -
 Hatch Spacing (mm): -
 Scan Strategy: -
 Post Processing Method: Bead blasting: Glass beads, 300-400µm, with 4-6 bars Air Pressure.
 For use with UL Listed printer: HP Jet Fusion 5200 3D Printer, HP Jet Fusion 5210 3D Printer, HP Jet Fusion 5210 pro 3D Printer
 Printer Preset: balanced

Properties and ratings assigned to samples produced by the Additive Manufacturing technique representing a specific set of printing parameters and build strategy. Other print parameters and build strategies may result in significantly different results.
 For use with Fusing and detailing agents HP 3D600, HP 3D700 or HP 3D710.
 Material is approved for use with Reclaimed powder of 80%
 Test data does not pertain to building materials, furnishings and related contents. IEC/ISO small-scale test data is intended solely for determining the flammability of plastic materials used in the components and parts of end-product devices and appliances, where the acceptability of the combination is determined by UL.

20-03-13
 20-03-17 © 2020 UL LLC

Test	Norm	Orientation	Thickness	Conditioning	Result
Dielectric Strength	ASTM D149	XY	1.4 mm	48h 23°C 50%RH	4.38 kV/mm
				96h 35°C 90%RH	4.83 kV/mm
		Z	1.2 mm	48h 23°C 50%RH	5.81 kV/mm
				96h 35°C 90%RH	5.97 kV/mm
Volume resistivity	ASTM D257	XY	0.67 mm	48h 23°C 50%RH	1.45E11 ohm-cm
				96h 35°C 90%RH	6.79E10 ohm-cm
		Z	0.67 mm	48h 23°C 50%RH	2.09E11 ohm-cm
				96h 35°C 90%RH	1.05E11 ohm-cm



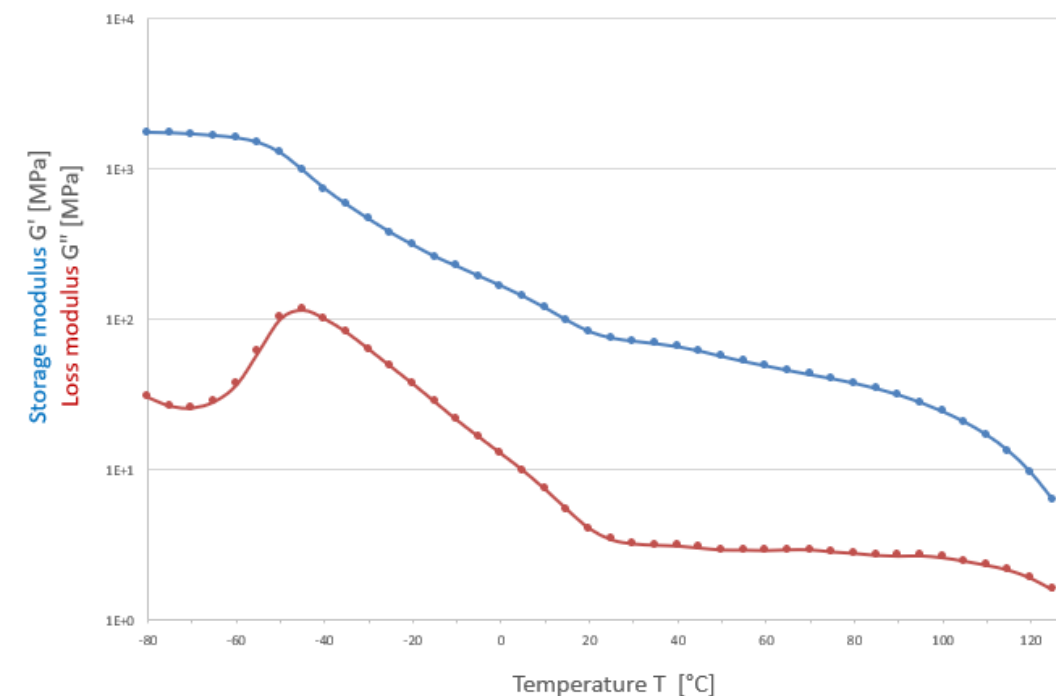
Ultrasint TPU01 (MJF): Temperature resistance

- Several values on TDS already + some additional values in the table below
- DMA measurement: see graph (storage modulus indicates stiffness of material)

General Properties	Test method	Typical values
Glass transition Temperature / °C	ISO 11357	- 48
Melting Temperature / °C	(20 K/min)	120-150

Mechanical Properties	Test method	Typical values x-direction	Typical values z-direction
Charpy Impact Strength (notched, 23°C) / kJ/m ²	DIN EN ISO 179-1	No break	No break
Charpy Impact Strength (notched, -10°C) / kJ/m ²		46	44
Charpy Impact Strength (notched, -20°C) / kJ/m ²		22	10
Charpy Impact Strength (notched, -30°C) / kJ/m ²		7.9	4.5
Charpy Impact Strength (notched, -40°C) / kJ/m ²		4.5	3.7
Rossflex testing (100k cycles, 23°C)	ASTM D1052	No cut growth	
Rossflex testing (100k cycles, -10°C)		No cut growth	

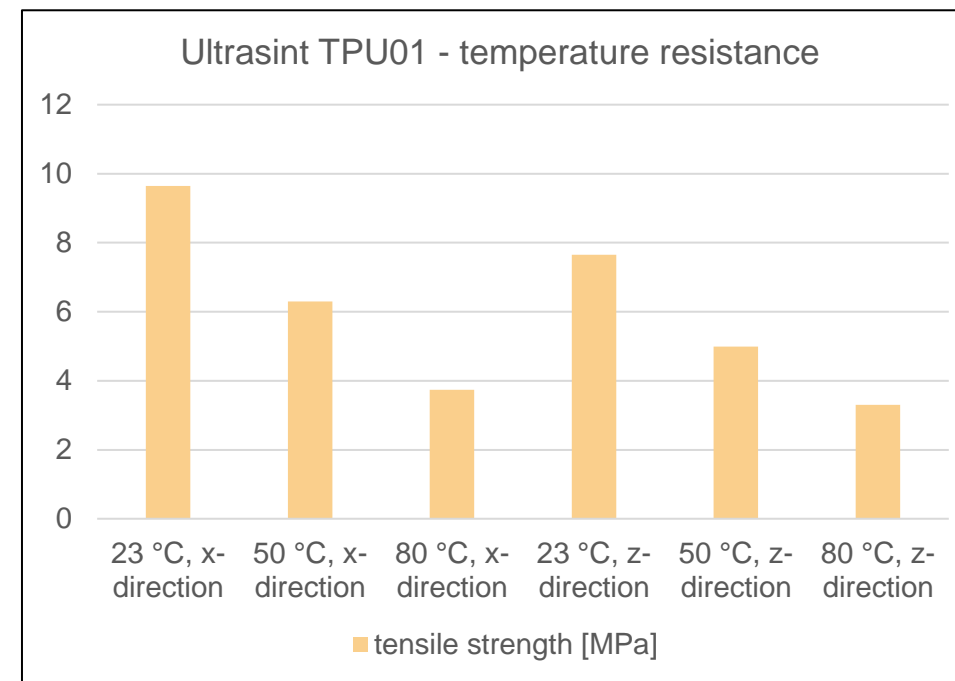
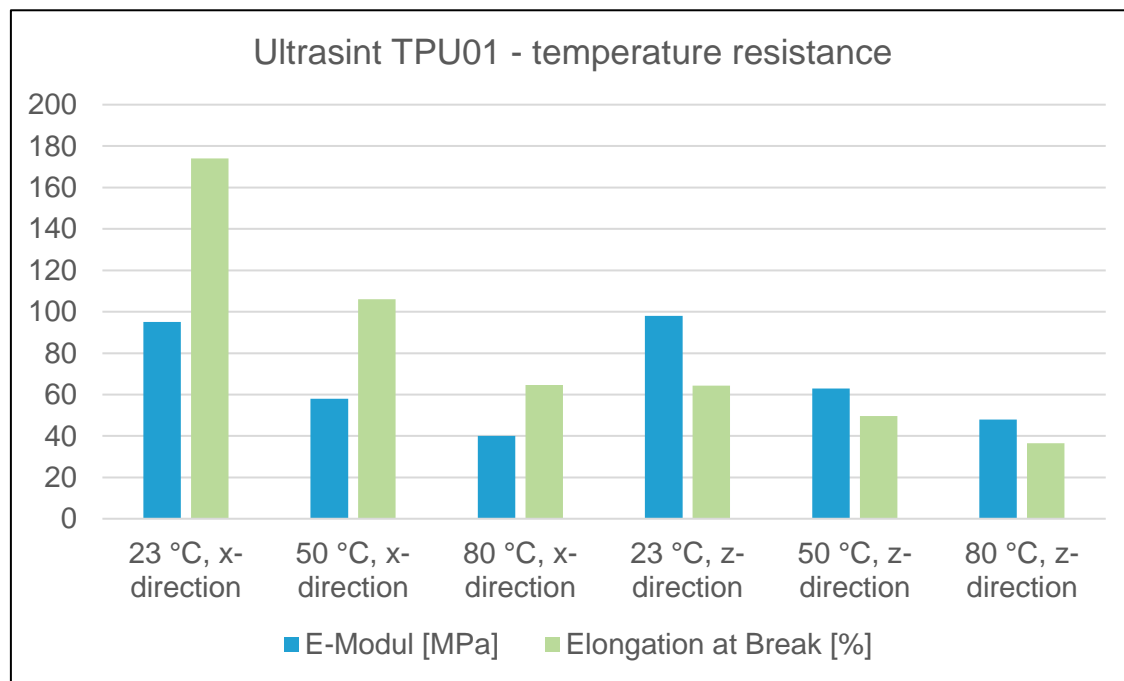
Thermal Properties	Test method	Typical values x-direction	Typical values z-direction
Vicat/A (10 N) / °C	DIN EN ISO 306	97	98
Heat Deflection Temperature ¹⁾ (HDT B, 0.45MPa)	DIN EN ISO 75	49-64	50-52



¹⁾ HDT is not a good method for flexible materials as they bend easily, measurement values fluctuate strongly.

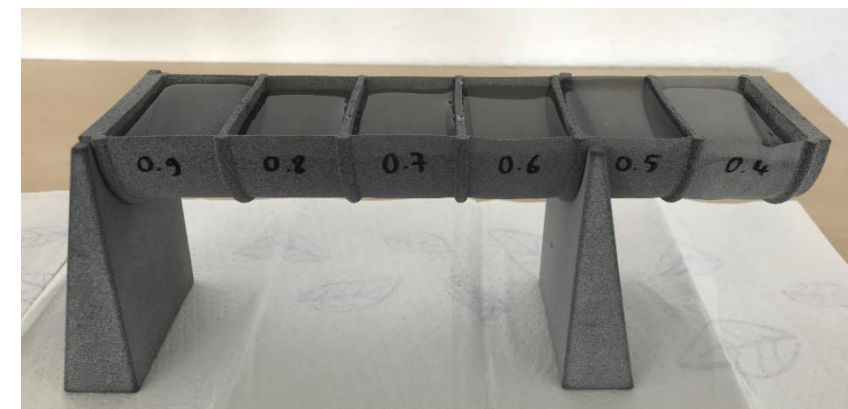
Ultrasint TPU01 (MJF): Temperature resistance

- Mechanics for TPU based on 1A on S2 tensile bars at 23°C (RT), 50°C and 80°C
- High temperature leads to reduction of mechanics



Ultrasint TPU01 (MJF): Water tightness

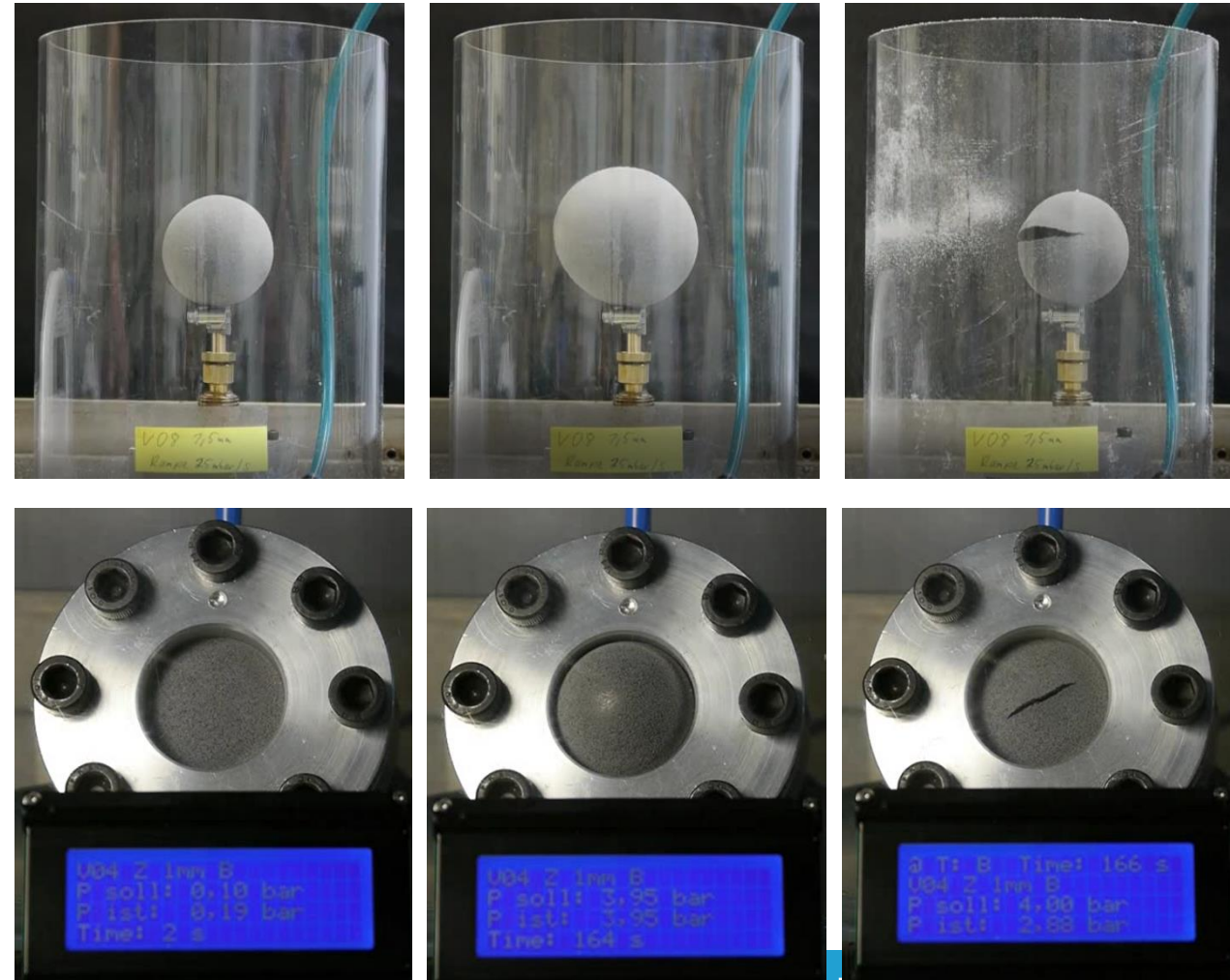
- Water tightness of printed parts will be dependent on
 - ▶ part geometry and orientation (overlap between printed layers)
 - ▶ testing conditions (pressure, temperature,...)
- Test results at room temperature, duration 1 week:



Wall thickness	Hollow spheres	Vertical cylinder
0.4 mm	not watertight	watertight
0.5 mm	not watertight	watertight
0.6 mm	watertight	watertight
0.7 mm	watertight	watertight
0.8 mm	watertight	watertight
0.9 mm	watertight	watertight
1.0 mm	watertight	

Ultrasint TPU01 (MJF): Burst pressure tests

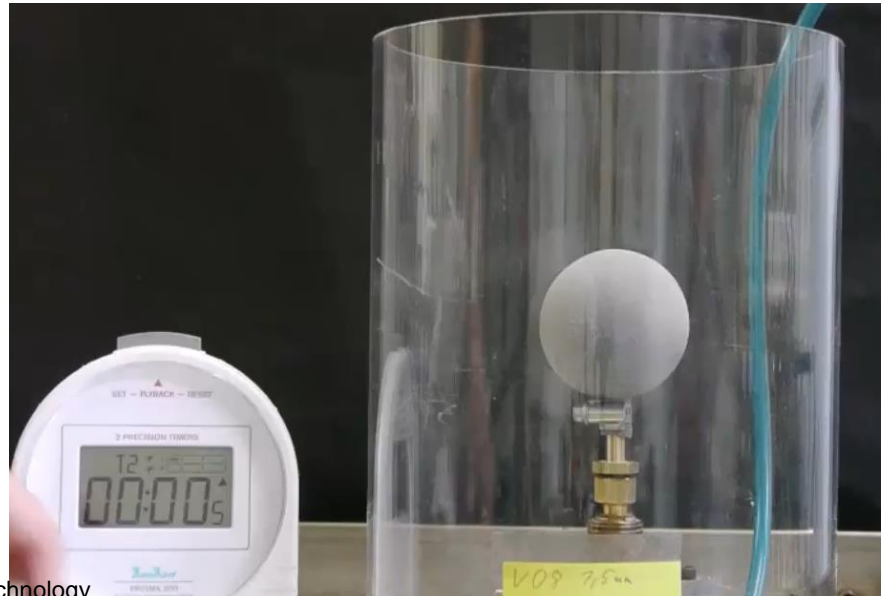
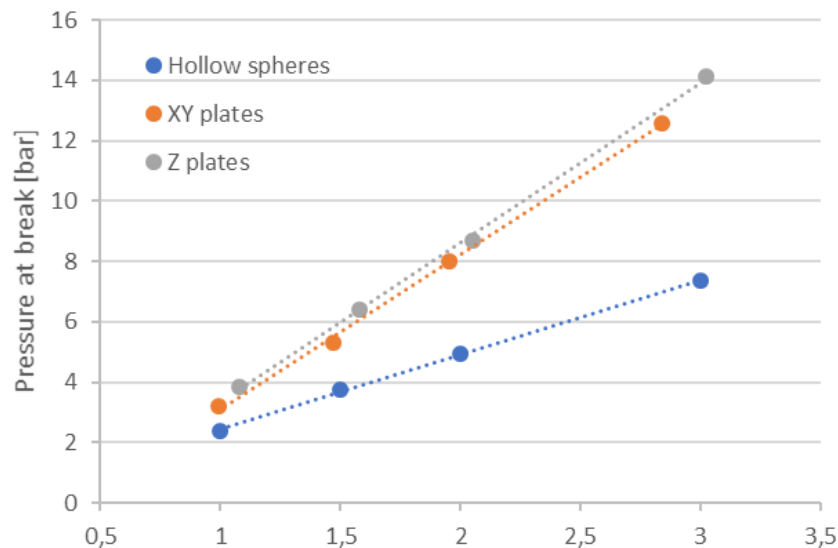
- Burst pressure of printed parts will depend on
 - ▶ part geometry and orientation (overlap between printed layers)
 - ▶ specific testing conditions used
- Procedure: pressure ramp 25mbar/s = 1.5bar/min until part breaks
- Geometries tested:
 - ▶ Hollow spheres
 - ▶ Plates printed horizontally in XY
 - ▶ Plates printed vertically in Z



Ultrasint TPU01 (MJF): Burst pressure tests

■ Results:

- ▶ At least two tests for each wall thickness, good reproducibility is obtained
- ▶ Quite good homogeneity between XY and Z directions in plates
- ▶ Spheres have lower burst pressure than plates, probably because small inhomogeneities in wall thickness and varying overlap of printed layers leads more easily to weak spots

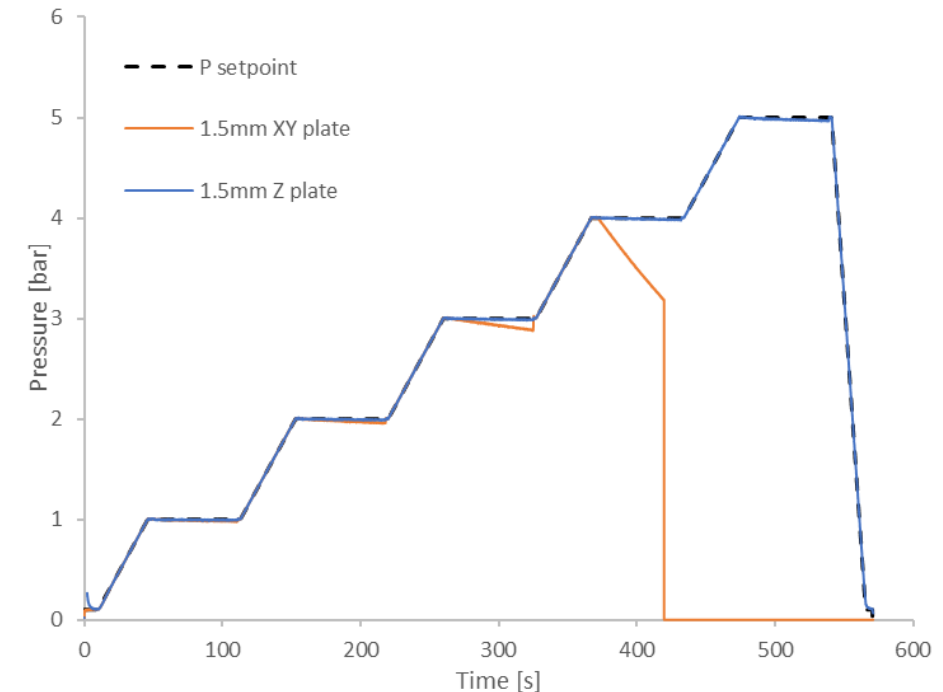
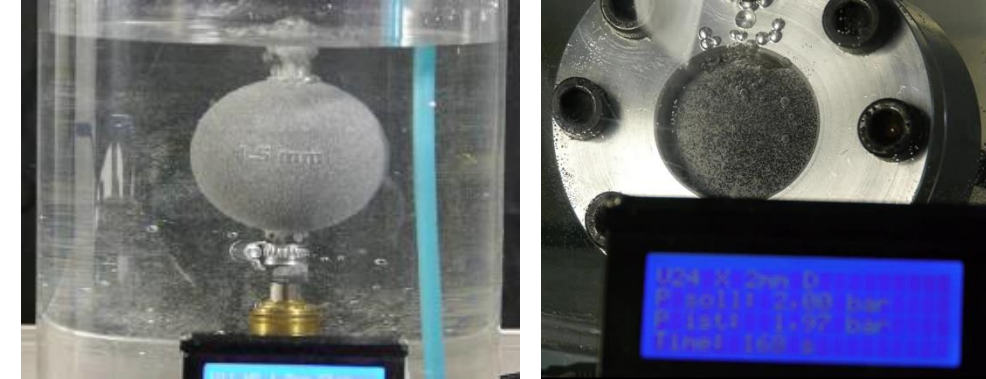


Ultrasint TPU01 (MJF): Air tightness

- Same measurement setup as burst tests, but under water, and pressure increase in steps. Leakage is detected through bubble formation and recorded pressure drop. Measurements up to burst pressure, or up to maximum 5 bar.

- Results:

- ▶ Best air tightness obtained in Z-direction plates. Hollow spheres were always leaking at the top and bottom of the sphere.



Wall thickness	Hollow spheres	XY plates	Z plates
1 mm	not airtight	not airtight	airtight up to 2 bar
1.5 mm	not airtight	airtight up to 2 bar	airtight up to 5 bar
2 mm	not airtight	airtight up to 2 bar	airtight up to 5 bar
3 mm	not airtight	airtight up to 4 bar	airtight up to 5 bar

Ultrasint TPU01 (MJF): Biocompatibility, skin contact

- Skin contact statement available on request; data stored [here](#)

Ultrasint TPU01	ISO 10993-5	ISO 10993-10	ISO 10993-10
	<i>Cytotoxicity</i>	<i>Skin Irritation</i>	<i>Skin Sensitization</i>
Printed	✓	✓	✓
Printed + vapour smoothed (AMT)	✓	✓	✓
Printed + coated (<i>Coat F Jet Black</i>)	✓	✓	✓

- General recommendations for the sterilization of TPU materials. These were not tested specifically on the Ultrasint TPU01!
 - ▶ Best is to use ethylene oxide or gamma radiation.
 - ▶ UV radiation or Ethanol are also possible, as long as times are kept relatively short and the parts do not change color.
 - ▶ Autoclaves with steam are in general not recommended, as TPU can possibly emit toxic components under these conditions.

Ultrasint TPU01 (MJF): Food contact

- The HP fusing agent does not have food contact approval. Also, the material Ultrasint TPU01 is not produced according to any food contact guidelines and does not have food contact approval.
- Applications close to food, but with no direct contact, e.g. robotic grippers: have to be investigated case-by-case, with a risk analysis.
- Alternatively, there would be the possibility to use a functional barrier, e.g. FDA accepted functional barriers are aluminum foil, and polyethylene terephthalate film (at least 25µm thick for room-temperature applications). Tests with parylene coating as a potential barrier are currently ongoing.

Ultrasint TPU01 (MJF): Car interior tests, emissions

- The values given in the table below are the results of a case study and **are not generally valid**. Test results will be dependent on the part geometry of the application and the exact production and postprocessing conditions.
- Our tests showed a positive effect of vacuum drying on the results. In our tests, the vacuum drying did not have a negative effect on part geometry, look & feel, or mechanical properties. Good temperature calibration of the oven is however crucial.

	VDA 270 (smell) Limit*: 3	VDA 275 (formaldehyde) Limit*: 5 mg/kg	VDA 276 (1m ³ room test)	VDA 278 – VOC (volatile organic compounds) Limit*: 220 ppm	VDA 278 – FOG (condensable substances) Limit*: 220 ppm	DIN 75201B (condensable substances) Limit*: 1 mg
Sandblasted	2.9	< 0.3	Data available on request	690-1032	461-532	5.9
Sandblasted + vacuum drying 8h 120°C				88-93	182-183	0.1
Chemically smoothed + Red Ultracur3D coating + vacuum drying 24h 120°C	2.7			51-64	142-151	0.8

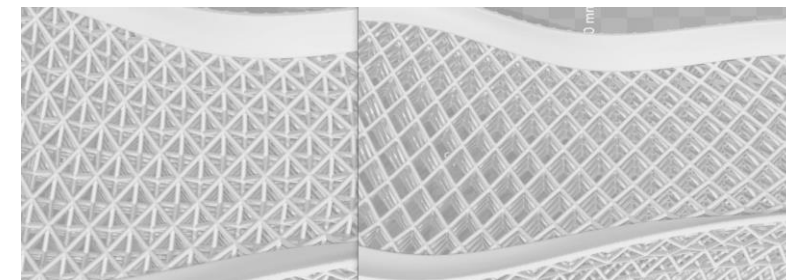
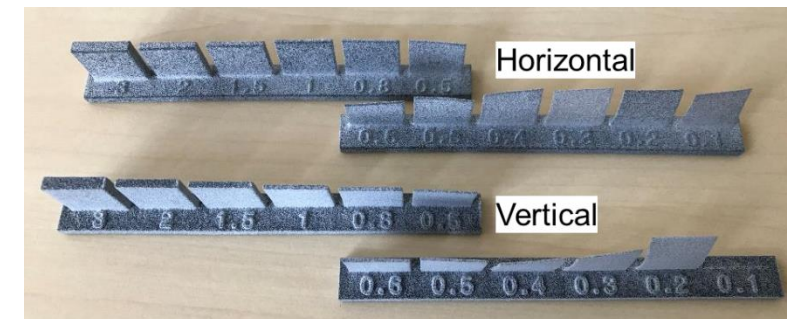
*Limits are manufacturer dependent, given are just typical limit values as an indication.

Ultrasint TPU01 (MJF): Design guidelines

- In general very high geometrical freedom: fine details, thin walls and overhangs are not a problem
- Maximum part size = usable build space JF 5200 = 380 x 284 x 380mm
- Minimum wall thickness
 - ▶ Vertical walls: printable down to 0.2mm (measured thickness 0.4mm)
 - ▶ Horizontal walls: printable down to 0.1mm (measured thickness 0.3mm)
 - ▶ Recommended minimum wall thickness: 0.5mm
- Lattices
 - ▶ For easy cleaning: use see-through structures (picture on the right vs. left), open from all sides (no sandwich)
 - ▶ Minimum strut thickness: 0.5mm possible, but minimum 1mm recommended for robustness, and minimum 2mm to have best part-to-part consistency
- Remark: large horizontal cross-sections during printing should always



Football helmet, 327 x 281 x 311mm



be avoided as they can be unexpectedly porous and weak!

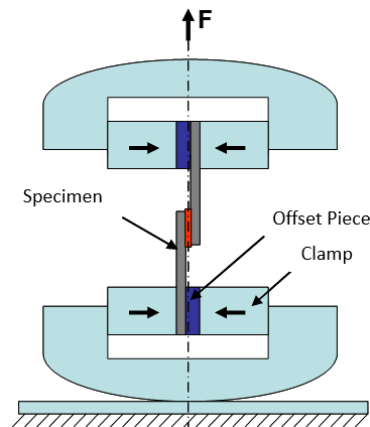
Ultrasint TPU01 (MJF): Bonding and gluing

- The preferred type of bonding or type of glue is very dependent on the requirements for the final part:
 - ▶ Meld bonding / welding introduces no extra substance, but may be hard to implement, also depending on the part geometry.
 - ▶ Gluing introduces an extra substance. Selection will depend on requirements for chemical resistance, air/fluid tightness, part flexibility, speed/ease of use.
 - ▶ Hot bonds allow using TPU based glues for perspective recycling

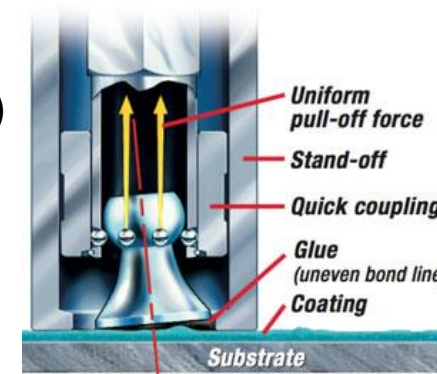
Bonding type	Tested	Result
Melt bonding / welding	Heated tools / hot plate (+-10s 200°C)	Very good bonding
	Vibrational welding	Material was too soft for vibrational welding
Solvent bonding	IPA, ethanol, DMF, DMSO, THF	With THF there was some adhesion, but parts became brittle. Other solvents did not work.
Gluing	Loctite 3D Printing universal Bonder, Delo PUR 9694, Dow Corning 866, UHU Plus Endfest 300	Generally good results, see next slides. Fracture always occurred within the material or within the glue layer, never between material and glue, so adhesion of the glue to the material was always good.
	Tested by Henkel: Loctite 401, 4850, HY 4090, AA 3038 and primer Loctite SF 770	Best results with Loctite 401 and 4850; primer showed no additional advantage. Detailed results upon request
	BASF Lemförde Hotbonds	In progress

Ultrasint TPU01 (MJF): Bonding and gluing

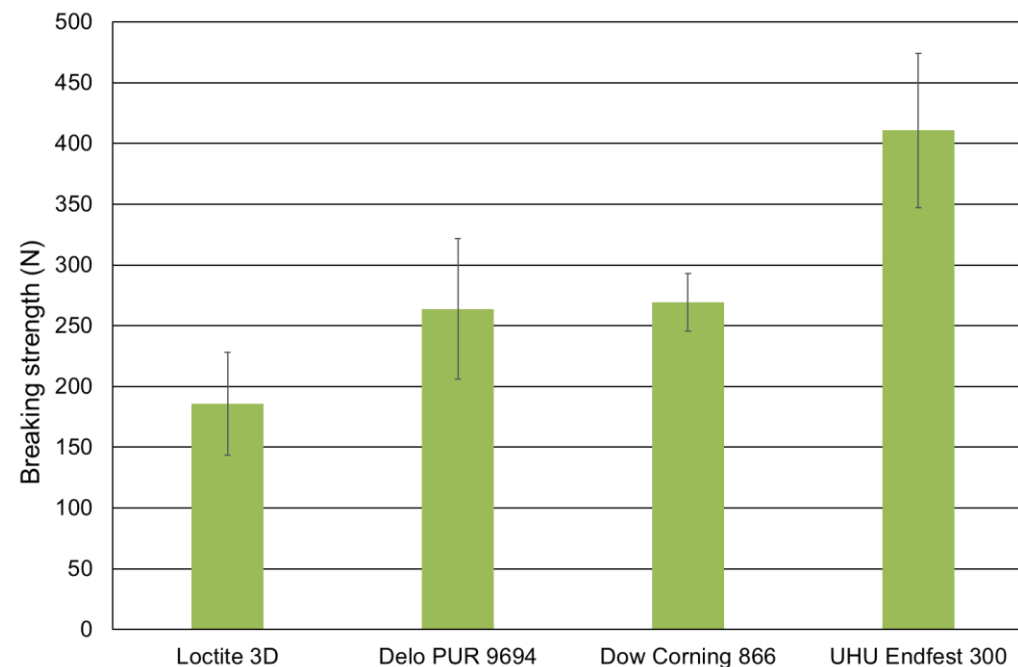
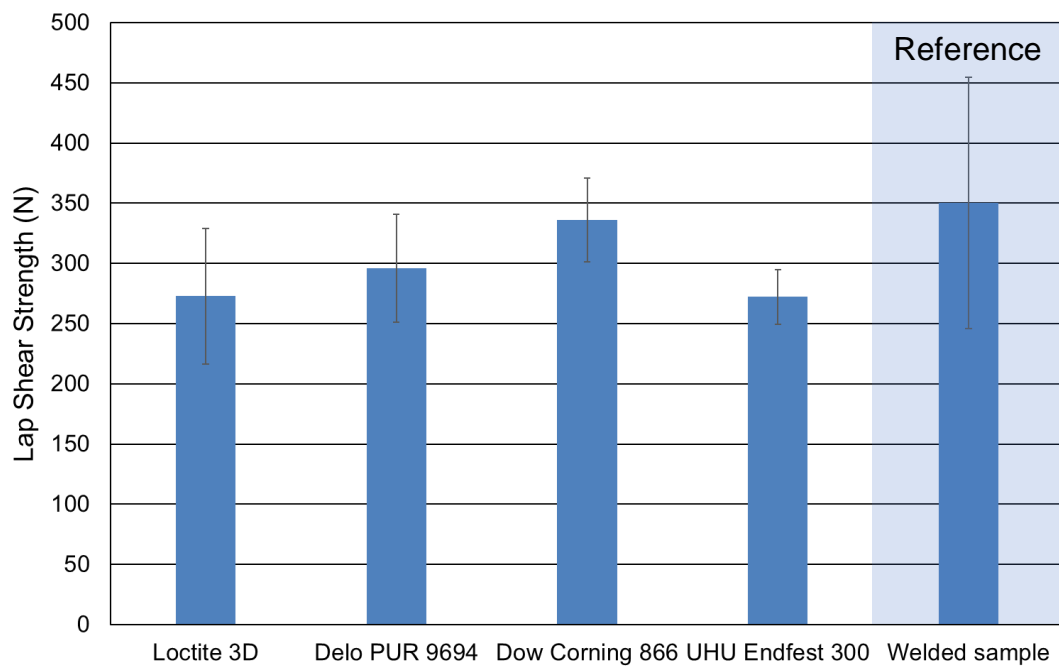
Tensile lap-shear strength
(DIN EN 1465)



Pull-off adhesion test
(based on DIN EN ISO 4624)



Source: DeFelsko



Ultrasint TPU01 (MJF): Sustainability

■ Production process

- ▶ BASF has optimized the production process to be as energy efficient as possible, and almost no waste is created in the production chain from raw material to powder
- ▶ In-depth sustainability study of the production process is currently ongoing at BASF


■ TPU printed parts

- ▶ Ultrasint TPU01 is not bio-based or biodegradable
- ▶ With the recommended 80-20 recycling rate, almost no waste is created in the MJF process
- ▶ The TPU is very stable during MJF processing (no degradation, yellowing, molecular changes), so parts or unused powder can be recycled / remolded like any regular thermoplastic polymer. Trials are currently ongoing at BASF where printed parts are shredded and added to fresh TPU for use in injection molding.
- ▶ Geometrical freedom in 3D-printing allows to make products (e.g. complete shoe) out of just 1 material, which makes recycling much easier.


Overview for deep dive into business and technology

Business

Application and Usecases

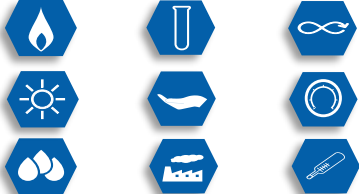


Sales Assets




Technical


Material Tests and Certificats



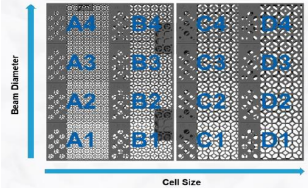
Printing Process



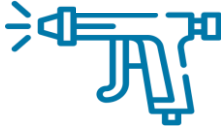
Coating



Ultrasim® 3D Lattice Design




Depowdering



Sustainability

Environmental Impact

- LCA
- Recycling
- Carbon Compensation





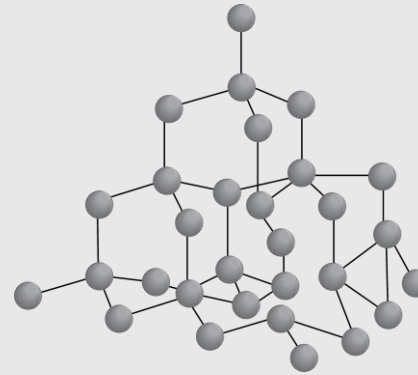
Ultrasim® 3D Lattice Design Introduction



Where you find Lattices today

Bendsøe and Sigmund, 2003:

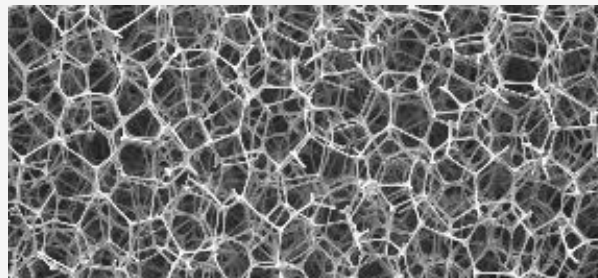
“ Any material is a structure if you look at it through a sufficiently strong microscope. ”



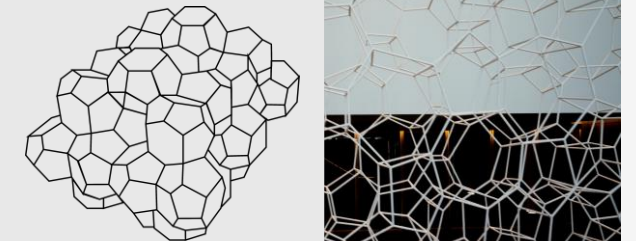
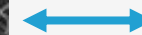
Diamond Structure



Architecture



Basotect® - BASF



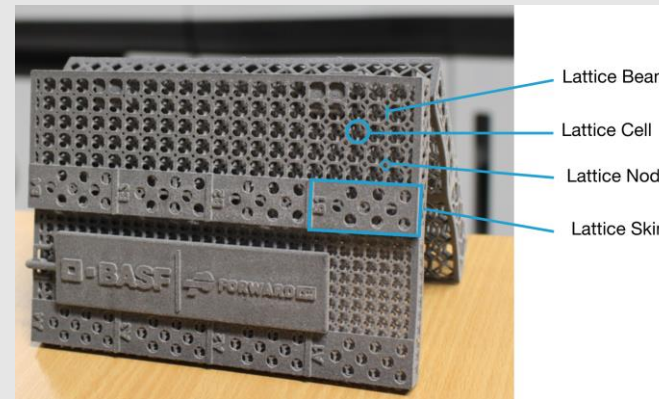
Weaire-Phelan Structure

What are 3D printed Lattices?

Lattices Background

- 3D-printed lattices are **repeated patterns** comprised of a network of cells, beams, and nodes.
- **Unlock entirely new designs** that have been considered before unmakeable.
- **One material** with a whole range of **different mechanical properties** by finetuning the combination of lattice characteristics.

Lattice Characteristics



Benefits at a Glance

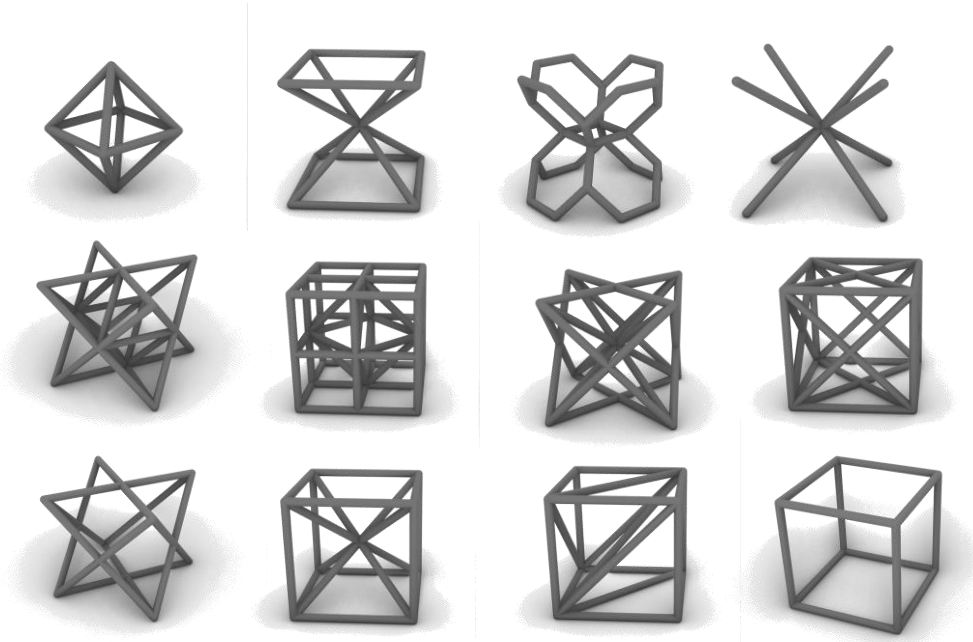
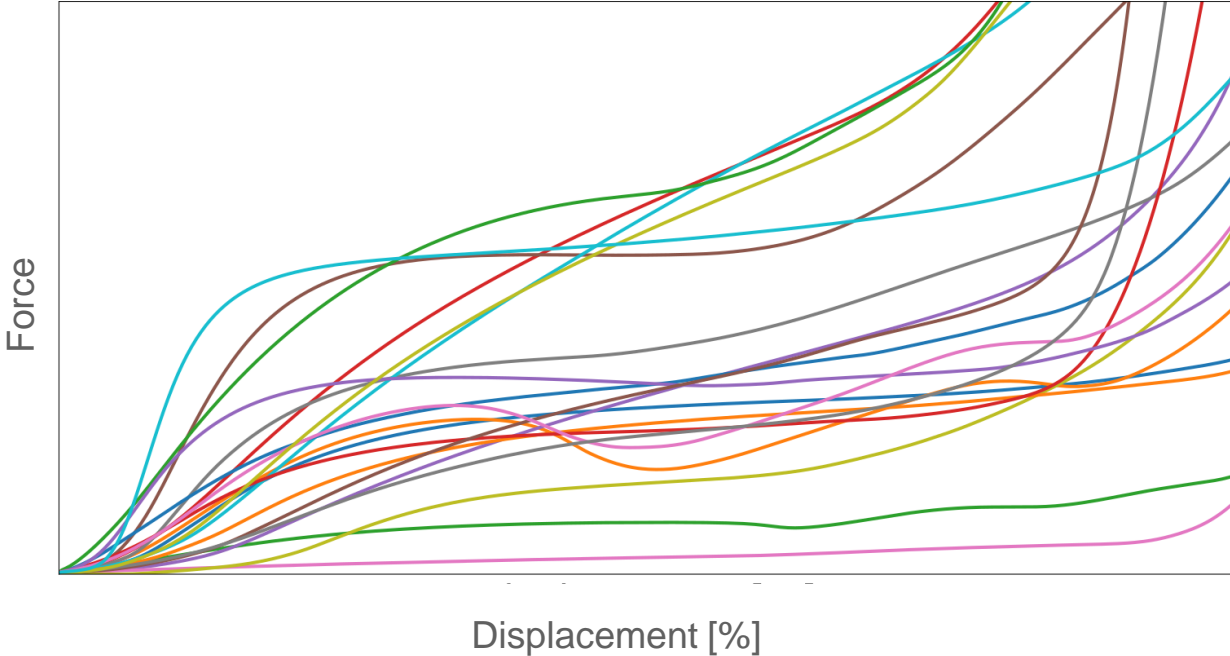
- Increased comfort
- Design controls function
- Aesthetics
- Heat transfer & ventilation
- Lightweight



Lattices unlock entirely new designs

There are millions of different lattices out there

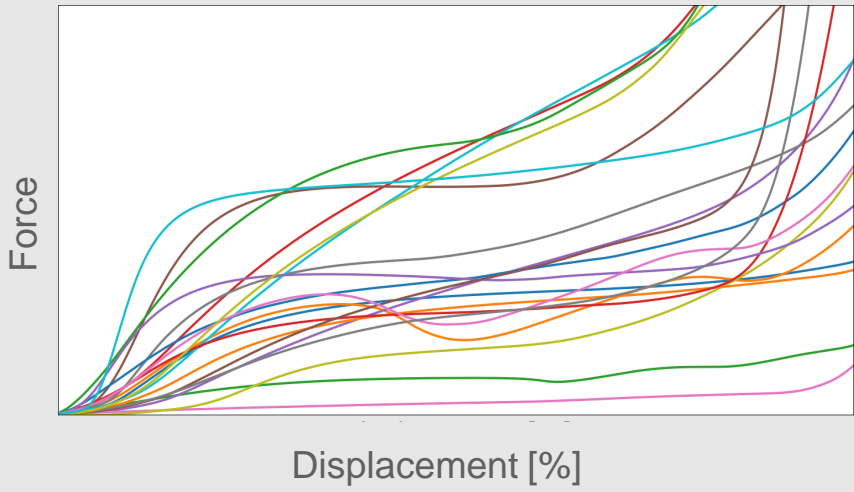
Example: Ultrasint® TPU01



*holds for equal volume density

Ultrasim® 3D Lattice Library

Digital Lattice Test Pad



BASF FORWARD AM
We create chemistry. Innovating Additive Manufacturing.

Footwear Protection Seating RESET

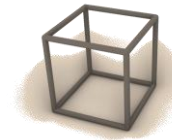
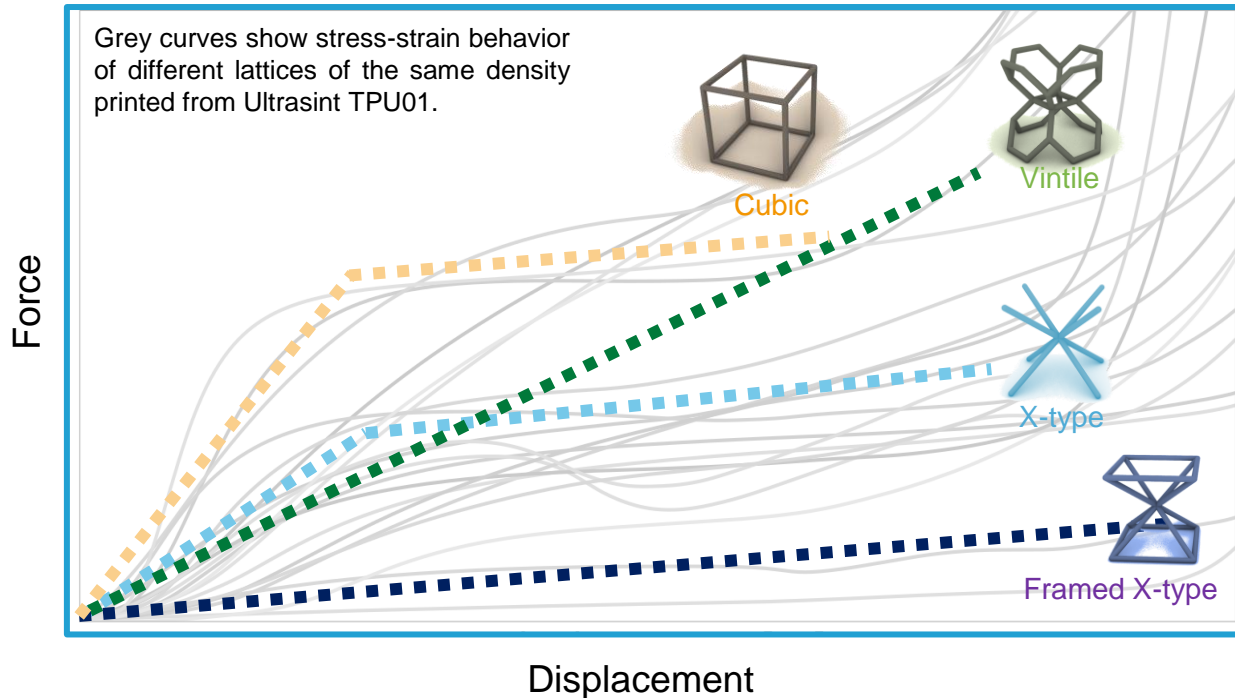
Category	Item	Stiffness	Density	Shore Hardness	Height
Footwear	Footwear - A1	0.18 MPa	0.09 g/cm ³	40-54	5.0 mm
	Footwear - A4	2 MPa	0.3 g/cm ³	40-54	5.0 mm
	Footwear - B2	0.49 MPa	0.15 g/cm ³	25-30	7.5 mm
	Footwear - B3	1.14 MPa	0.23 g/cm ³	30-40	7.5 mm
Footwear - C	Footwear - C1	0.15 MPa	0.09 g/cm ³	<25	10.0 mm
	Footwear - C2	0.48 MPa	0.15 g/cm ³	25-30	10.0 mm
	Footwear - C3	1.13 MPa	0.23 g/cm ³	40-54	10.0 mm
	Footwear - C4	1.93 MPa	0.3 g/cm ³	40-54	10.0 mm
Footwear - D	Footwear - D1	0.15 MPa	0.09 g/cm ³	<25	12.0 mm
	Footwear - D2	0.47 MPa	0.15 g/cm ³	25-30	12.0 mm
	Footwear - D3	1.11 MPa	0.23 g/cm ³	40-54	12.0 mm
	Footwear - D4	1.93 MPa	0.3 g/cm ³	40-54	12.0 mm
Seating	Seating - A4	1.11 MPa	0.23 g/cm ³	40-54	10.0 mm
	Seating - B2	0.38 MPa	0.13 g/cm ³	<25	15.0 mm
	Seating - B3	0.69 MPa	0.18 g/cm ³	30-40	15.0 mm
Seating - C	Seating - C1	0.19 MPa	0.09 g/cm ³	<25	20.0 mm
	Seating - C2	0.37 MPa	0.13 g/cm ³	30-40	20.0 mm
	Seating - C3	0.66 MPa	0.18 g/cm ³	30-40	20.0 mm
Protection	Protection - A1	0.46 MPa	0.1 g/cm ³	<25	7.5 mm
	Protection - C2	2.84 MPa	0.32 g/cm ³	40-54	25.0 mm
	Protection - D2	1.53 MPa	0.2 g/cm ³	30-40	25.0 mm
Protection - A	Protection - A2	0.78 MPa	0.14 g/cm ³	<25	7.5 mm
	Protection - B1	0.61 MPa	0.13 g/cm ³	<25	10.0 mm
	Protection - B2	0.76 MPa	0.14 g/cm ³	<25	10.0 mm
Protection - B	Protection - B3	0.91 MPa	0.16 g/cm ³	<25	10.0 mm
	Protection - A3	1.16 MPa	0.22 g/cm ³	25-30	7.5 mm
Protection - A4	Protection - A4	1.69 MPa	0.22 g/cm ³	25-30	7.5 mm
	Protection - B4	1.09 MPa	0.23 g/cm ³	40-54	15.0 mm

Control Panel:
 Stiffness: 0 to 5 MPa
 Density: 0.07 to 0.4 g/cm³
 Compression Stiffness @ 30%: 0 to 1200 kPa
 Compression Stiffness @ 40%: 0 to 1000 kPa
 Compression Stiffness @ 60%: 0 to 1500 kPa
 Minimum Part Thickness: 0 to 25 mm

Ultrasim® 3D Lattice Library allows to choose from a large database of lattices

How to find the right lattice for your application?

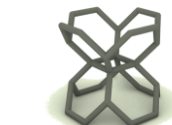
- One material many behaviors



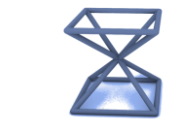
High energy absorber



Low energy absorber



High linear stiffness



Low linear stiffness



Ultrasim® 3D Lattice Test Pad

Touch & feel lattice

How to find the right lattice

- Find the right lattice using touch & feel lattice pads
- Each lattice pad has 4 diameters + 4 cell sizes giving you 16 options to choose from
- 3 lattice pads for different applications available:



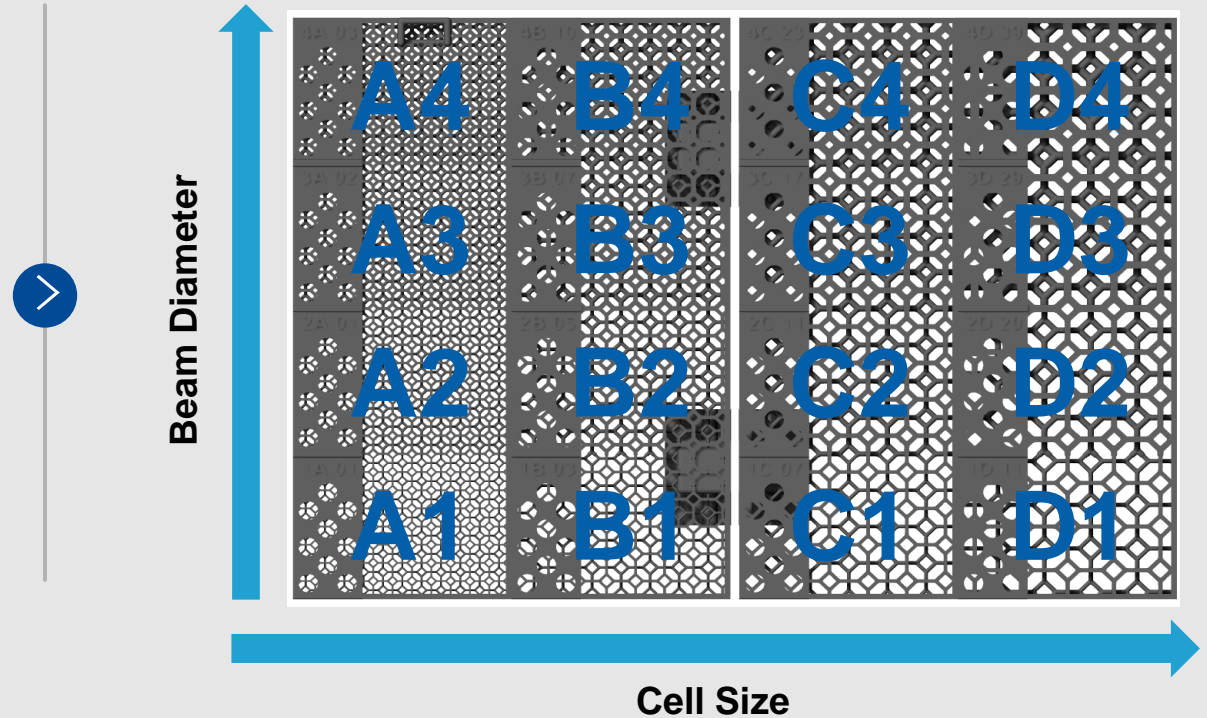
Protection



Seating



Footwear



Ultrasim® 3D Lattice Test Pad allows to directly feel & touch the right lattice

Ultrasim® 3D Lattice Engine – Beta

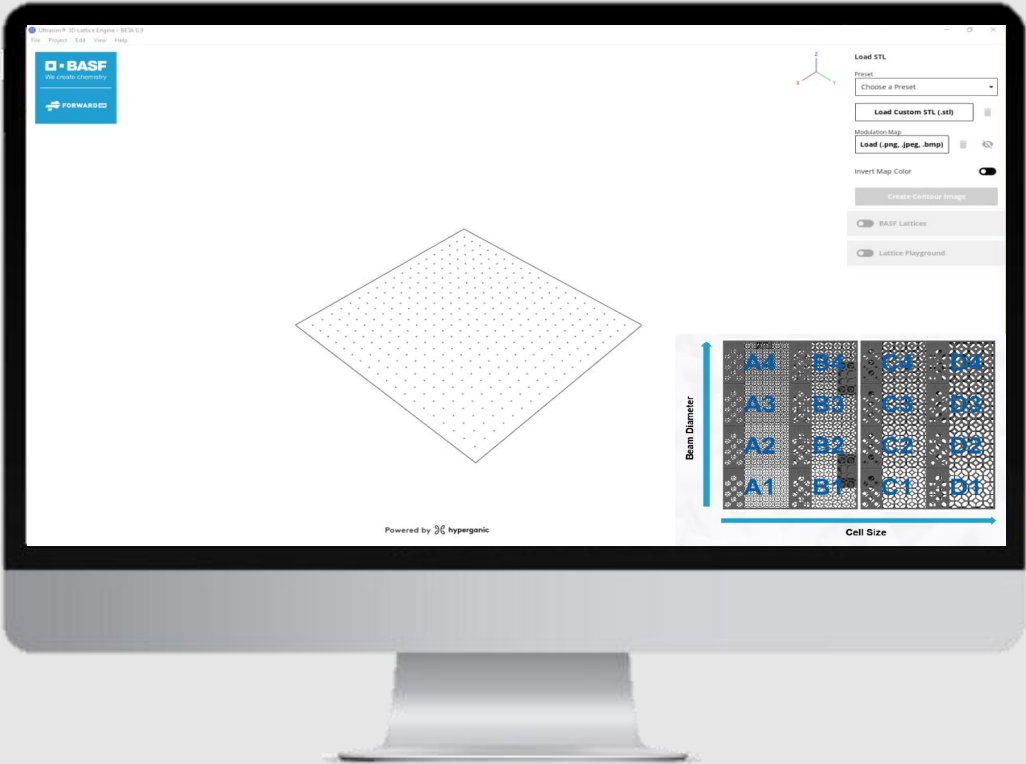
Many and expensive tools with no pre-set and no certified lattices included

What is the Lattice Engine:

- BASF FAM Ultrasim® 3D Lattice Engine powered by Hyperganic enables you quickly generate lattice parts

Benefits:

- ✓ Access free of charge
- ✓ Extremely user friendly – no engineering expertise needed
- ✓ Validated BASF lattices
- ✓ System integration with BASF material and services



 **Ultrasim® 3D Lattice Engine enables generate lattice parts instantly.**

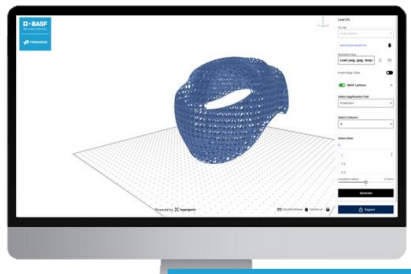
We support you in every stage – from starter to expert

To obtain the optimum performance the right lattice is key. We offer 4 easy methods to find the right lattice and generate the validated lattice design made from our Ultrasint® TPU01:

Lattice Engine - Beta

Starter 1:

Our Ultrasim3D Lattice Engine enables you to choose from BASF validated lattices and generate lattice parts instantly yourself.



Available Now

Lattice Design Service

Starter 2:

Get one of our lattice engineers to design your customized lattice design incl. partial, multi-zone lattices & more.



Foam Replacement

Premium:

Use our in-house developed FEA and lattice library to mimic a foam you use today by a lattice.



Full Engineering

Enterprise:


We support you in each step of the product design development for your ideal lattice design.




Overview for deep dive into business and technology

Business

Application and Usecases

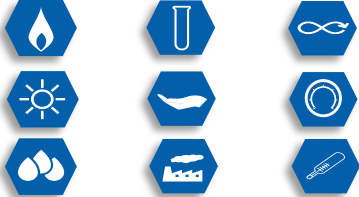


Sales Assets




Technical


Material Tests and Certificats



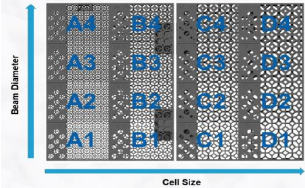
Printing Process



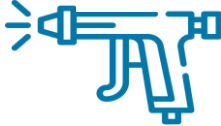
Coating



Ultrasim® 3D Lattice Design




Depowdering



Sustainability

Environmental Impact

- LCA
- Recycling
- Carbon Compensation



Sales Assets

Partner Resource Center

PARTNER RESOURCE CENTER


All the sales resources you need in one place

Get the documentation, images, and sales resources to stay up to date and provide the most accurate information for your customers.

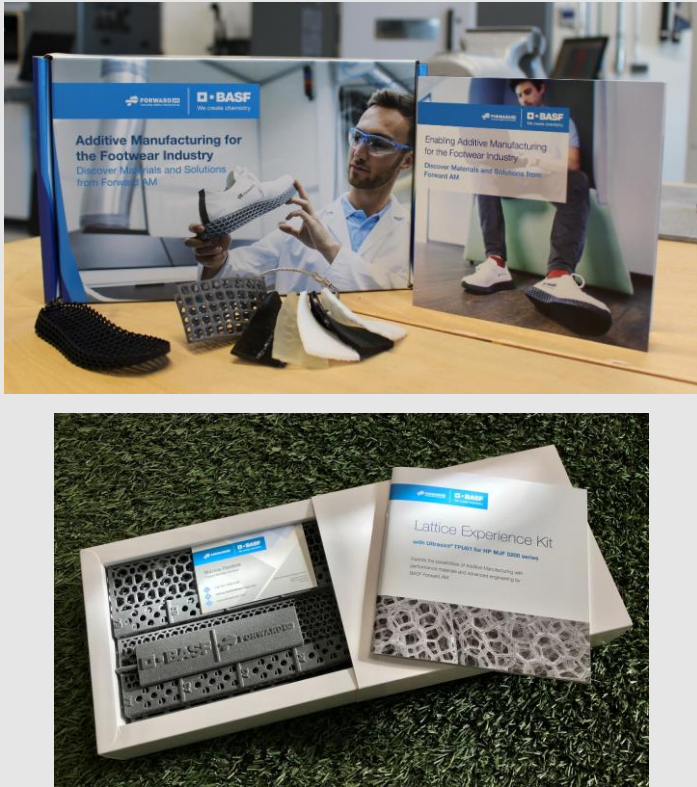
[GET STARTED](#) [Download the Catalogue](#)

Whitepaper

WHITE PAPER
BASF Forward AM and DyeMansion:
Optimizing Post-Processing for Ultrasint® TPU01



Sales Kits




Large Toolbox for selling TPU


Overview for deep dive into business and technology

Business

Application and Usecases

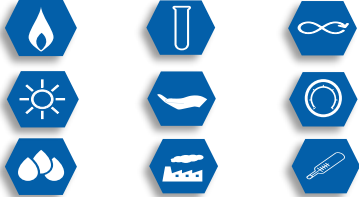


Sales Assets




Technical


Material Tests and Certificats



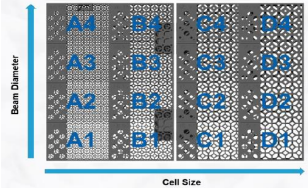
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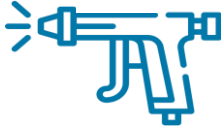
Coating



Ultrasim® 3D Lattice Design




Depowdering



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Environmental Impact

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Environmental Impact

Life Cycle Assessment

Calculation of environmental impact for complete TPU production from raw material to powder according to ISO 14040:2006 and ISO 14044:2006

- Climate Change
- Ecotoxicity, freshwater
- Eutrophication, marine
- Resource use, fossils
- Photochemical ozone formation, human health
- Resource use, mineral and metals
- Water use

Baseline for reduction of carbon emission

Recycling

Take-back program for end-of-life TPU parts and powder

1. Downcycling for injection molding
2. Recycling within 3D printing from powder to filament



Carbon Compensation

Forest protection and economic growth

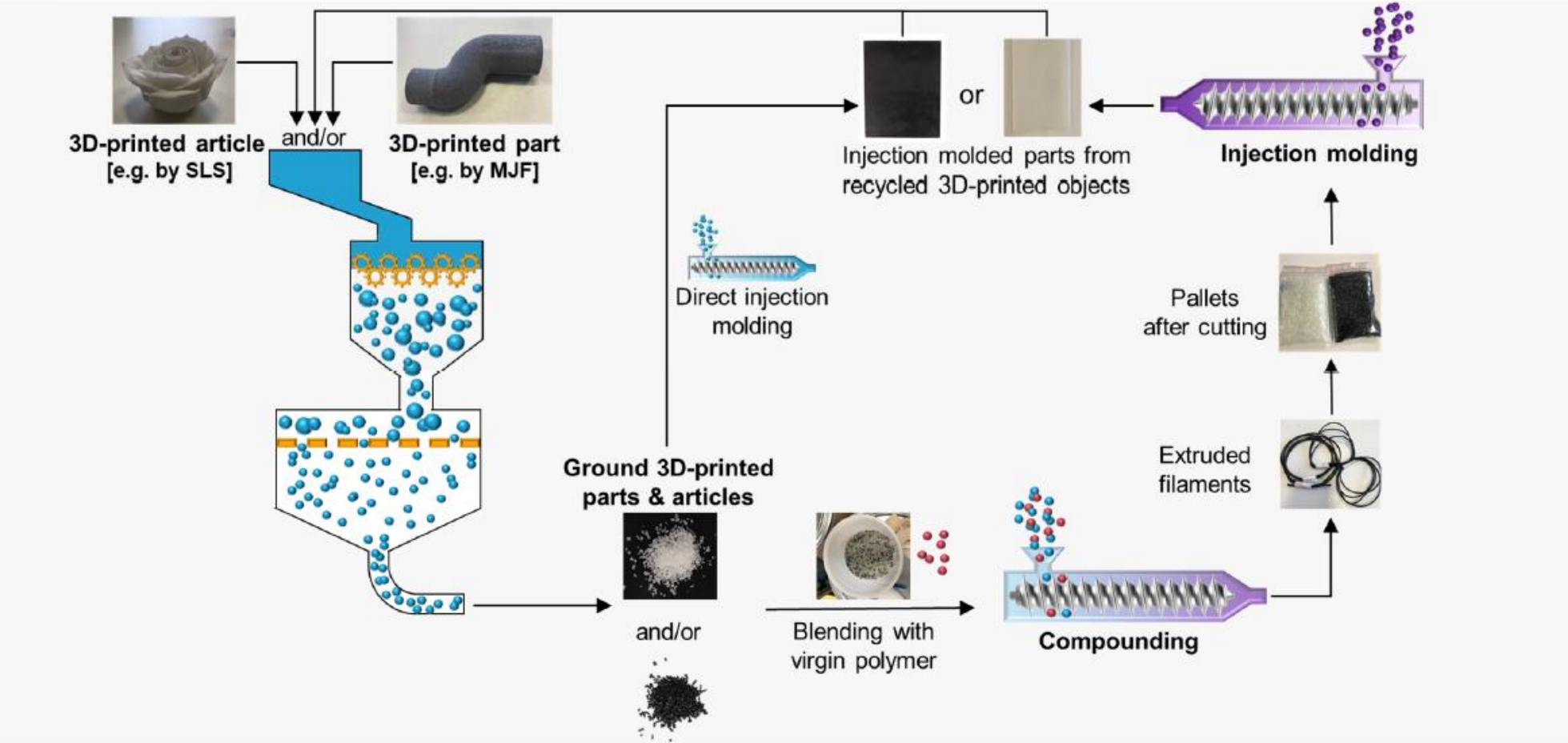
- **Location:** Mataven, Colombia
- **Certificate:** Verified Carbon Standard (VCS)
- **Capacity:** 70.000 tons

Project's mission: Preserving existing forests is one of the best solutions to maintain carbon absorption and sequestration processes. The project works hand-in-hand with indigenous communities to shift towards sustainable economic practices (no deforestation).



Ultrasint TPU01: Downcycling

Downcycling process of 3D-printed parts



Ultrasint TPU01: Downcycling

Mechanical properties after recycling printed Ultrasint TPU01 parts

MJF Results		Shore	Tensile strength	Elongation @ break	Tear strength	Abrasion	Density
#	Description	[Shore A]	[MPa]	[%]	[N/mm]	[mm ³]	[g/cm ³]
Reference – Ultrasint® TPU01	Pellets of raw material	89	15	750	39	87	1,142
1- Ultrasint® TPU01	Pellets + 10% 3D Parts (MJF)	90	15	750	39	76	1,141
2- Ultrasint® TPU01	Pellets + 20% 3D Parts (MJF)	90	15	750	40	75	1,141
3- Ultrasint® TPU01	Pellets + 30% 3D Parts (MJF)	90	15	710	39	74	1,14
4- Ultrasint® TPU01	100% 3D Parts (MJF)	90	15	760	40	75	1,142

Visual development during recycling

No significant changes in mechanical performance



TPU Recycling Study



Ultrasint TPU01
(powder, MJF)

TPU01 filament
out of granulate

TPU01 filament out of
recycled powder printed parts
(mixed by 50% with granulate)

Mechanics*	TPU01 powder,	Recycled TPU01 filament, white	Recycled TPU01 filament, black
Tensile modulus	85 MPa	38 MPa	42 MPa
Tensile strength	9 MPa	15 MPa	15MPa
Elongation at break	280%	825%	880%

S2-tensile bars printed in x-direction

Polyester based
= better chemical resistance (oil, solvent, acids)
= higher abrasion resistance

Ultrasint TPU01 powder recycling to TPU01 filament




Mechanical Properties	MJF	FFF
Tensile modulus [MPa]	85	32
Tensile strength [MPa]	9	16
Elongation at break [%]	280	580


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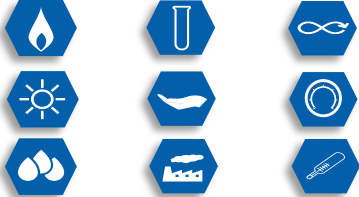


Sales Assets




Technical


Material Tests and Certificats



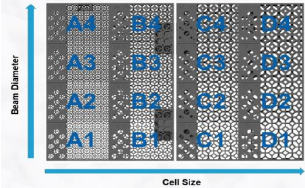
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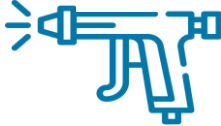
Coating



Ultrasim® 3D Lattice Design




Depowdering



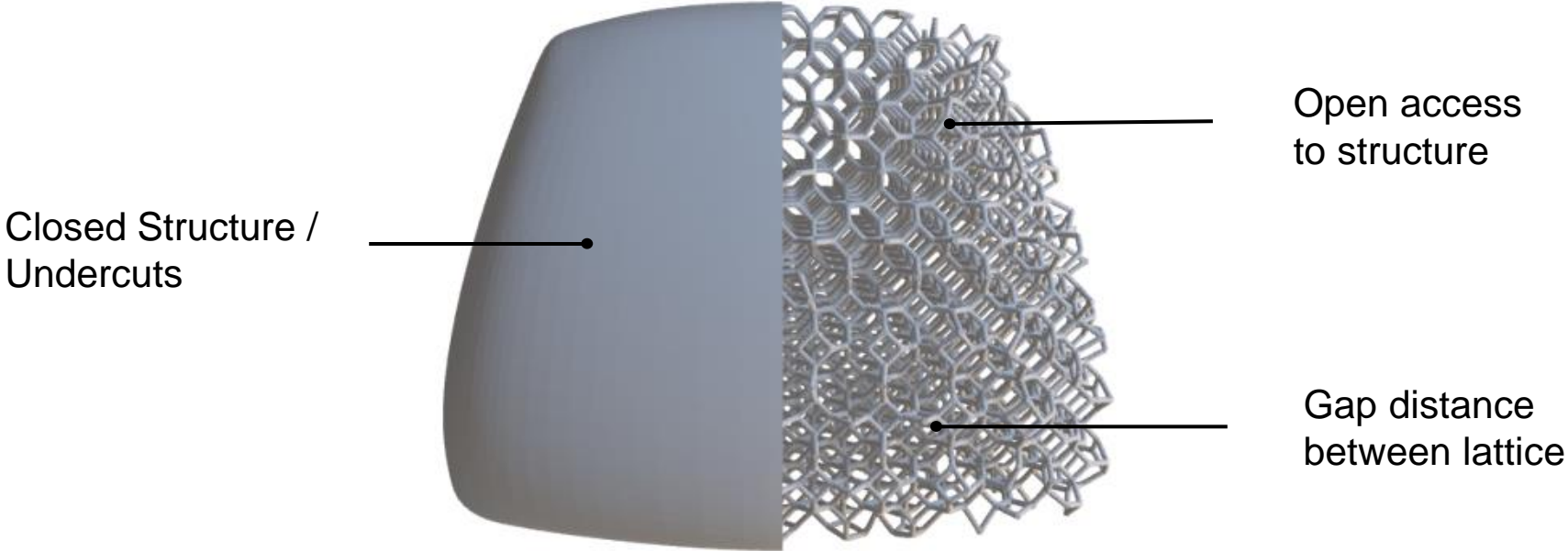
Sustainability

Environmental Impact

- LCA
- Recycling
- Carbon Compensation



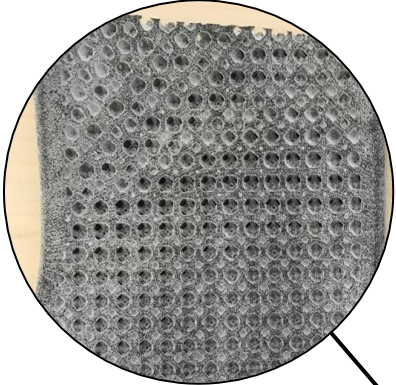
Why you should include your post-processing steps into your design phase



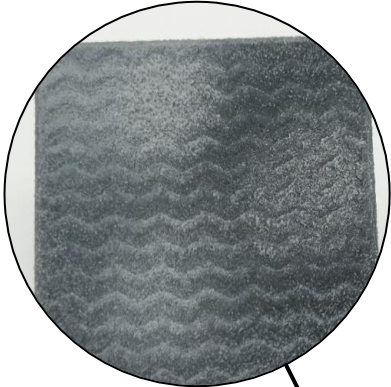
> Design determines the final post-processing quality.

Hurdles and challenges

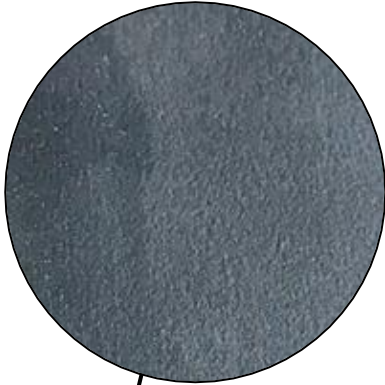
Powder Residue



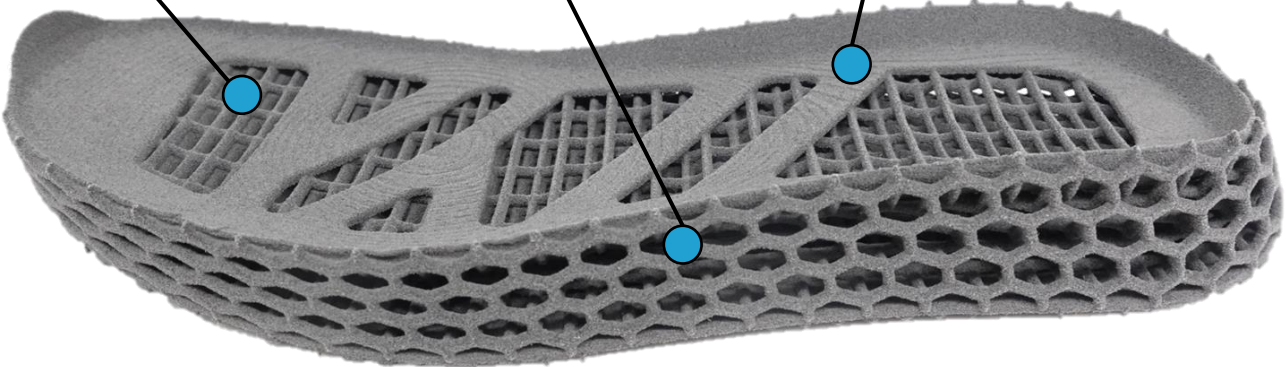
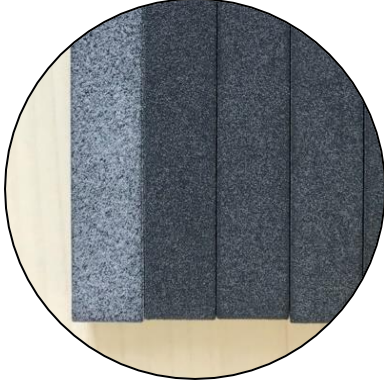
No Uniform Surface



Burned Marks



Inconsistent Quality



What are the main influences?

1. Blast Time

- Min. 20 min

2. Blast Media

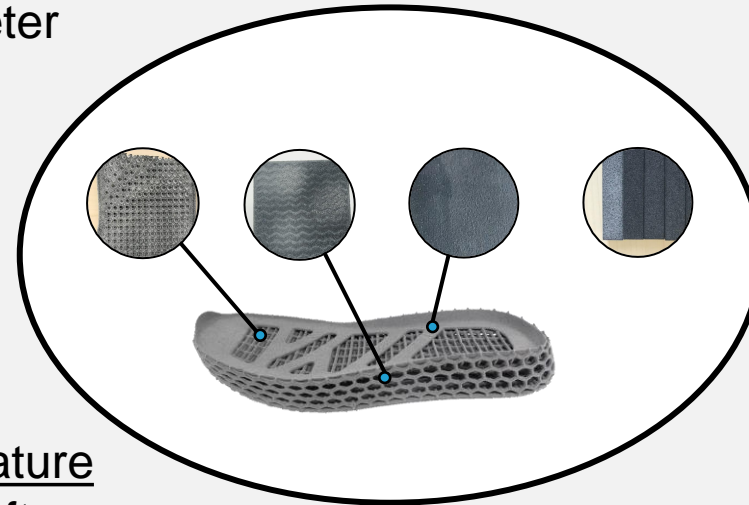
- Glass Beads
- Plastic Beads
- Steel Beads
- Diameter

3. Blast Pressure

- 3 bar (steel beads)
- 4 bar (glass beads)
- 5 bar (plastic beads)

4. Part Geometry

- Balanced mix of bulky parts and lattices



6. Powder Temperature

- Warm (directly after unpacking)

5. Machine Settings

- Nozzle Distance
- Nozzle Quantity
- Ionizing Nozzles

How to depowder Ultrasint TPU01

Part Geometry

- Balanced mix of bulky parts and lattices

Blast Time

- 66min

Blast Media

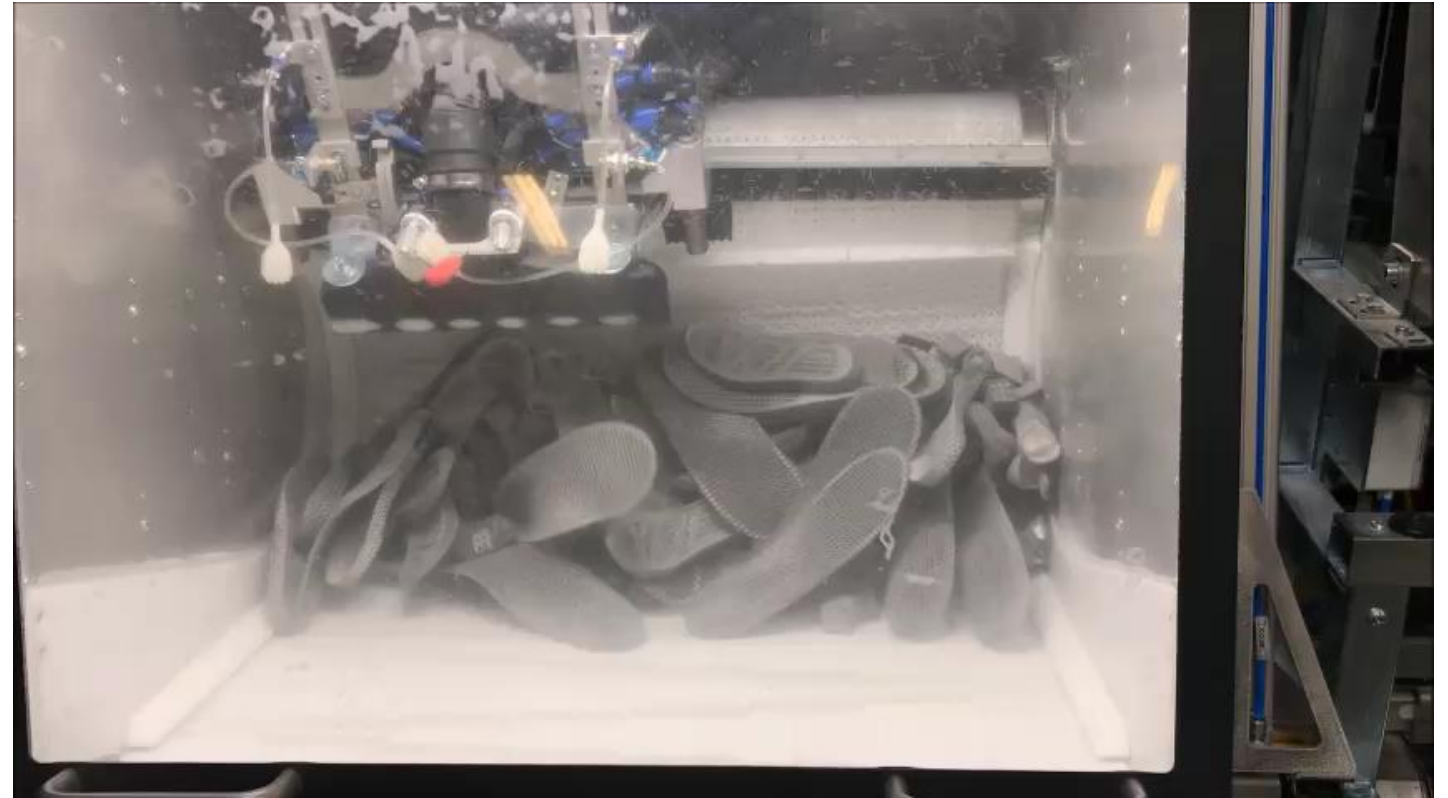
- Plastic Beads (400 μ m)

Blast Pressure

- 5 bar

Powder Temperature

- Cooled down to room temperature



How to depowder Ultrasint TPU01

Blast Time

- 1x 15min
- Additional 30min

Blast Media

- Glass Beads (300 – 400µm)

Blast Pressure

- 4 bar – glass beads

Powder Temperature

- Cooled down to room temperature

15min Additional 30min
↑ ┌──────────┐



Before depowdering



How to depowder Ultrasint TPU01

Blast Media

- Steel Beads
- Plastic Beads
- Glass Beads

Blast Time

- 22 min

Blast Pressure

- 3 bar – steel beads (100-200µm)
- 5 bar – glass beads and plastic beads (300-400µm)

Powder Temperature

- Cooled down to room temperature

After depowdering

Glass beads

Plastic beads

Steel beads



Depowdering White Paper: BASF and Dyemansion

Key Results of TPU01 White Paper

- Plastic beads achieve better quality than glass beads
- Glass beads need high pressure (>5 bar) to fully depowder lattices, but therefore break and might destroy the surface which influence post-processing
- For printed only parts → deep dark color
- For parts with post-processing → greyish surface recommended
- Powershot Performance C for high throughput and serial production
- TPU01 “depowdering mode” on Powershot Performance C




 **Good depowdering results with the right process parameters**


Overview for deep dive into business and technology

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Application and Usecases

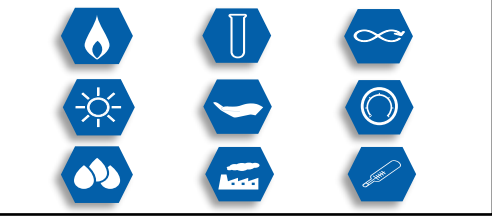


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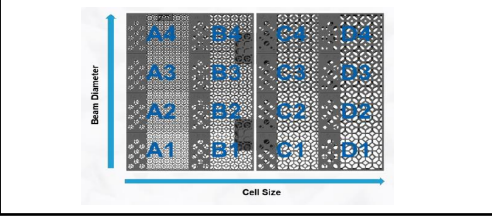
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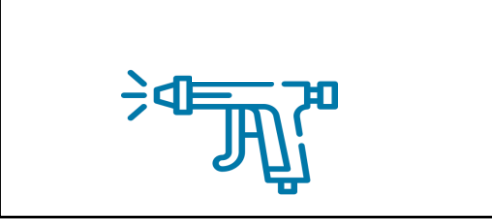
Coating



Ultrasim® 3D Lattice Design




Depowdering



Sustainability

Environmental Impact

- LCA
- Recycling
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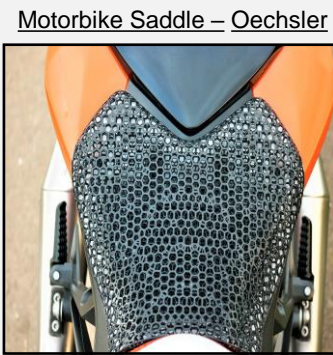
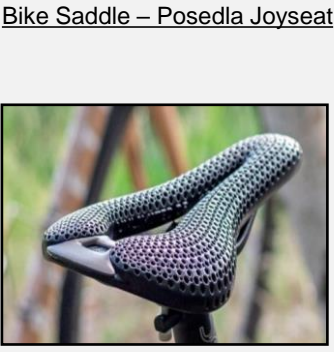


BASF TPU powders: applications and use cases

Consumer

Automotive

Industrial / Medical



Spoiler closeout seal - GKN

- **Bridge Manufacturing** helped GM deliver vehicles on time
- Late into the development process of its 2022 full-size SUV, General Motors added a spoiler closeout seal to improve aerodynamics and increase fuel-efficiency. As a result, **GM** needed **60,000 parts** manufactured within **six weeks** or they risked delaying delivery of 30,000 vehicles to dealerships.



WHY BASF Ultrasint™ TPU01

- Closed surface as sealing through vapour smoothing
- Weatherability properties
- flexible and durable part performance

Use case available!

Clamp for Wind Turbines

Wind turbine blades are 67+ meters long and require a tool to rotate the blade component (structural shear-web) from horizontal to vertical. This application serves as a safety aid to mount and protect the turbine blade component during handling. These parts need to be changed yearly.



WHY BASF Ultrasint™ TPU01

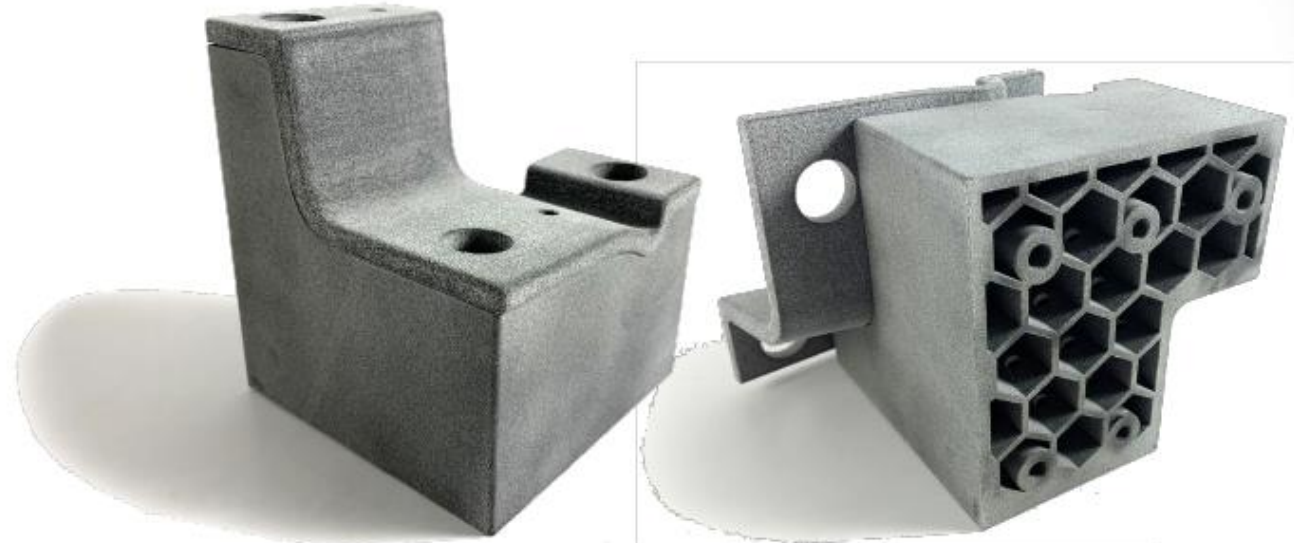
- Impact absorption – protecting the blade from delamination and crushing
- Reusability rate
- Time to manufacturing is 2% that of conventional Injection Molding (3-4 days vs. 3-3.5mo)



SOFT TOUCH TOOLING

Data credits from Extol

- Assembly equipment fixtures
- Shipping dunnage
- Prevent marking on A-surface



© Extol, Inc.



AMT VAPOR FINISHING BENEFITS




- Smooth Surface
- Seal TPU
- Clean Easier
- Avoid Collecting Debris

Data credits from Extol



COMPARISON

Data credits from Extol

	Traditional Manufacturing		Soft Touch Tooling
Lead Time	4 weeks	75% reduction	5 days
Performance	Great		Great
Cost	\$3026		\$3000
Design Changes	2 weeks	80% faster	2 days
Design Freedom	Very Low		Very High

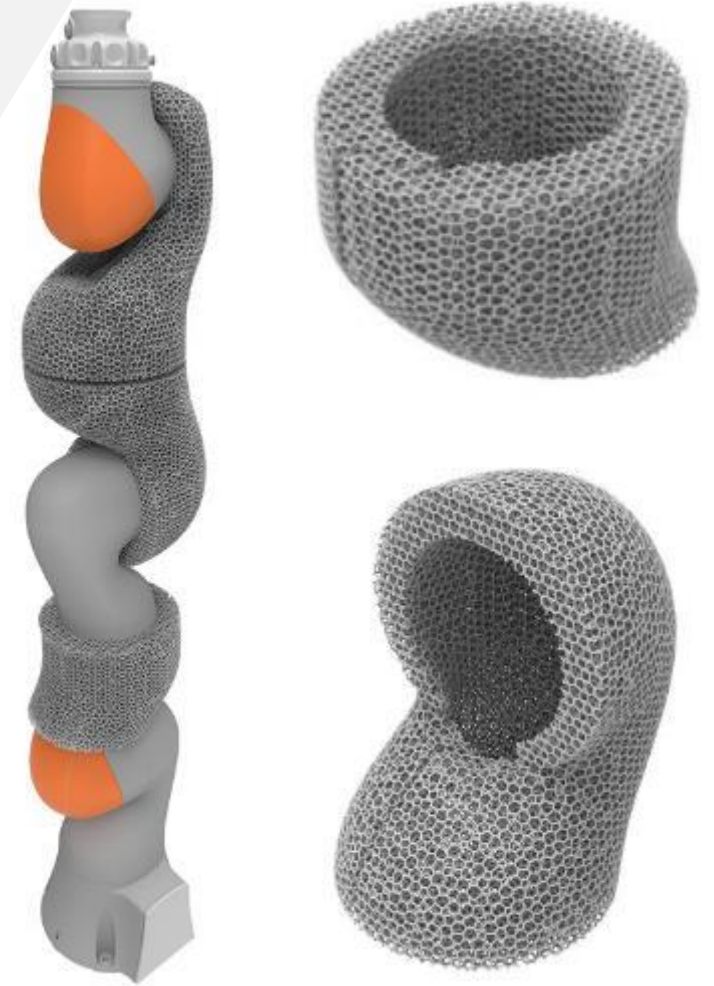


Lattice Layer – RoboSkin

- RoboSkin works as a mechanical collision buffer, it requires no additional sensors, just the TPU layer that takes up only minimal installation space and is mounted with an easy system. Need to be flexible and cushioning, when changing end of arm tooling
- The lattice design of the skin is easily, rapidly and cost-effectively adaptable to every robot type

WHY BASF Ultrasint™ TPU01

- High abrasion resistance and E@B
- Skin Contact
- Volume saving to the lattices design
- Reusability rate
- Crash Test Dataset ISO 10218-4, fulfillment of all requirements of ISO TS 15066



Use case available!

Designed by Oechsler

Auto Seat

Enables additional functionalities such as sound equipment, background lighting, better heating and ventilation.

WHY BASF Ultrasint™ TPU01

- The lattice structure provides same cushioning effect with much less weight, essential for vehicles
- Tested for durability (fatigue bending ASTM D1052)
- VDA emission tests (VDA 270, 276, 278)
- Flame resistance (FMVSS 302) and UV resistance (ISO 4892-2A Cycle 1)
- Post-Processing coating compatibility*

[White Paper Available!](#)

*Coated with Ultracur3D Coat F, a coating developed by BASF to ensure a perfect match in between flexible substrate and applied coating.



Spring Sleeve for Dual-Rate Spring Assemblies

Ford-First, and potentially Industry-First use of additively manufactured thermoplastic urethane for a vehicle chassis application. The sleeves were designed & manufactured in-house by Ford Motor Company.

Short run production

WHY BASF Ultrasint™ TPU01

- Meets functional requirements
- Improved water shedding
- Eliminates the need for an adhesive
- Weight and volume saving to material utilization (47% reduction, when compared to the same design without holes)
- 33% reduction in per piece price



Prosthetic Socket

Dynamic process that can offer complete customization for each patient.

Perfect for the creation of the soft part

WHY BASF Ultrasint™ TPU01

- Biocompatible, ideal for skin contact
- The right balance between flexibility and stiffness of the component
- Lightweight (**TPU01 Ultrasint Density 1.1 g/cm3**)
- [Skin Contact Statement Available](#)

[White Paper Available!](#)

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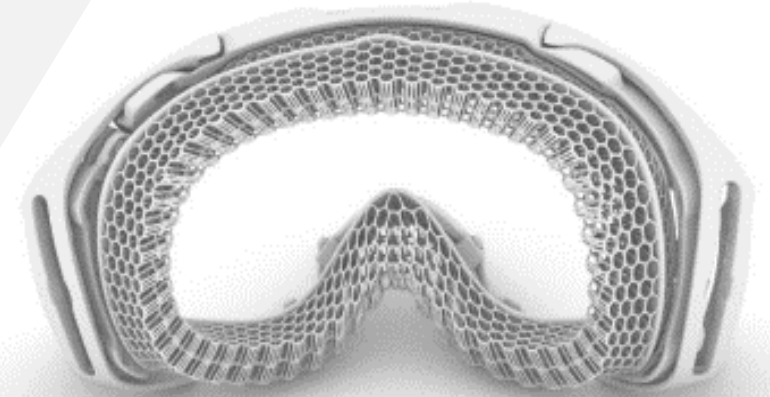


SKIING GOGGLES

The customer was looking for parts consolidation. Reduction of production costs due to the elimination of mounting steps

WHY BASF Ultrasint™ TPU01

- Lattice structure enables a variety of comfort
- Gluing
- UV Resistance
- Hydrolysis resistance
- Lightweight (**TPU01 Ultrasint Density 1.1 g/cm³**)
- Skin Contact Certificate



Footwear

Faster product development cycle and new product go-to-market in only two weeks instead of months

Improved inventory management

WHY BASF Ultrasint™ TPU01

- Increased comfort and durability with new materials
- Complete recyclability of the product
- Hydrolysis resistance
- **Wearability test**



Data credits from Athos



Data credits from Hilos



Protective Helmet

The customer was looking to create an intelligent impact absorbing helmet

WHY BASF Ultrasint™ TPU01?

- Impact resistance
- Lattice engineering and simulation
- Flexible coating
- Skin contact
- Hydrolysis resistance




[Use case available!](#)


Overview for deep dive into business and technology

Business

Application and Usecases

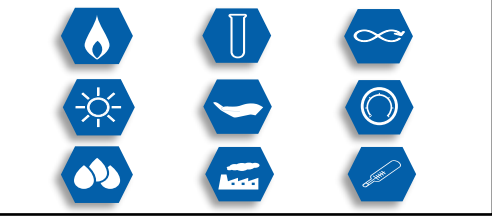


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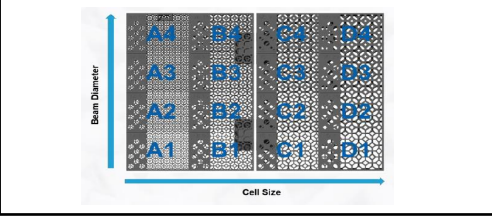
Printing Process



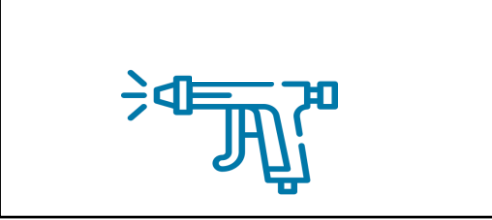
Coating



Ultrasim® 3D Lattice Design




Depowdering



Sustainability

Environmental Impact

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WORKFLOW & POST-PROCESSING - Workflow



Media:

- Plastic beads
- Steel beads
- Ceramic beads
- Glass beads

Pressure :

- 3-5 bar

Time:

- 15-60min




Whitepaper: Unpacking & Cleaning Guidelines - 52x0


Overview for deep dive into business and technology

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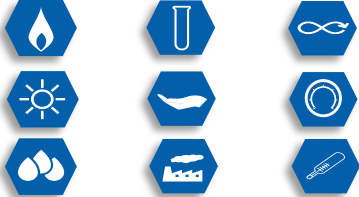


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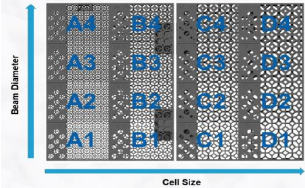
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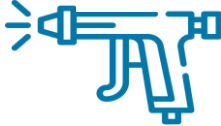
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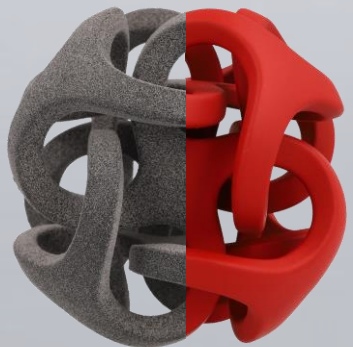


B3DPS Coating Solutions

Ultracur3D Coat F+ Product Presentation

BASF 3D Printing Solutions (B3DPS)
Status January 2023

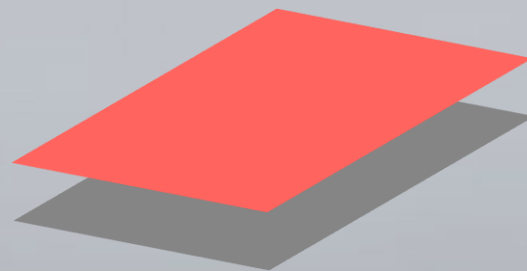






Ultracur3D® Coat F+ by Forward AM is a flexible waterborne 2k-basecoat designed to offer **exceptional flexibility** for elastic 3D Printing Materials and enables new possibilities for advanced applications – from functional prototyping through to end use serial production parts. Together with BASF Coatings GmbH we can offer **outstanding technical support** and an **extensive range of colors** to identify the ideal surface finish for your specific application.

Waterborne based coatings can be applied with a wide range of industrial spray guns, which allows **easy handling** and **reduces expensive hardware investments**.

In addition, a **customized color development** based on a physical sample, RAL or Pantone code is offered.



-  Ultracur3D Coat F+
-  Substrate



Consumer



Automotive Interior



Medical O&P



 **High flexibility**



**Wear and scratch
resistance**



Skin contact



**Waterbased
formulation**



**Large color
portfolio**



Color



Application



Equipment

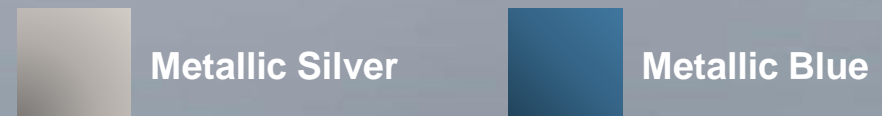




Ultracur3D Coat F+ Uni Colors

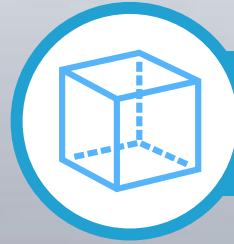


Ultracur3D Coat F+ Effect Colors





1. Color reference



2. Material selection



3. Customized color



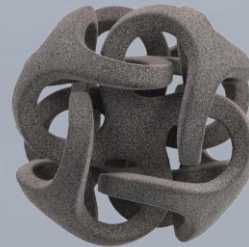
RAL



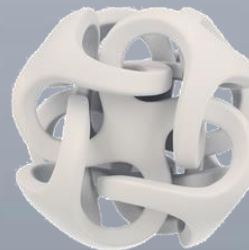
Pantone



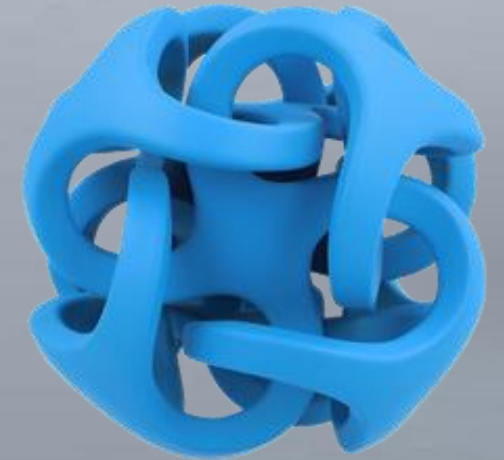
Physical master sample












TPU01



TPU 88A



	Mixing ratio:	100 : 4 by weight		Spray passes	1.5 - 2
	Hardener:	Ultracur3D® Hardener F+		Layer thickness	25 ± 5µm
	Reducer:	DI-Water		Flash of at 23°C	5min
	Potlife at 20°C:	2h		Intermediate drying	10min at 80°C
	Shelf life (5 – 35°C)	6 months		Final drying	30min at 80°C



Find further information in our processing guideline.



Protective clothing

- 1) Coating suit
- 2) Coating Mask + Filter



E.g.: 3M™ 7500 Series Face Mask

- 3) Safety shoes
- 4) Single use gloves
- 5) Safety glasses



E.g.: HONEYWELL SVP200 ANTI-FOG

Coating equipment

- 1) Spray gun:



E.g.: SATAjet 5000 B



E.g.: Iwata WS 400 Evo

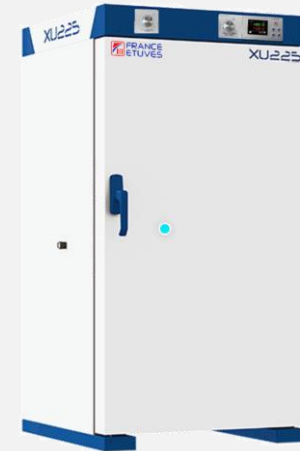
- 2) Spray booth

- Spray wall with filters
- Spray wall with air/water separation
- Closed spray cabin with air regulation

Drying equipment

- 1) Drying oven:

- Minimal drying temperature: 80°C
- Air circulation




E.g.: XUE225 universal oven Essential


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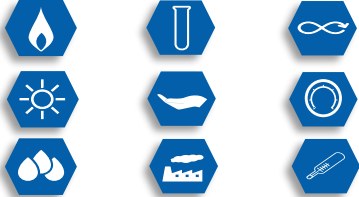


Sales Assets

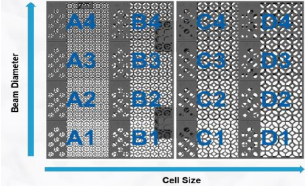


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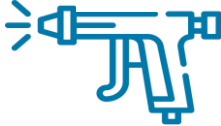
Ultrasim® 3D Lattice Design




Printing Process



Depowdering




Coating



Sustainability

Environmental Impact

- LCA
- Recycling
- Carbon Compensation



 **BASF**

We create chemistry



FORWARD AM

Innovating Additive Manufacturing

BASF Elastollan® Applications

Where do we meet TPU?

Consumer Goods



Automotive & Mobility



Industry



➤ Rubber like material used in wide range of industries