MATERIAL DATA SHEET

Our materials

- Laser melting of metals
- Laser sintering of plastics
- Laser sintering – fire behaviour
- Stereolithography

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NOTE ON THIS DATA SHEET All information given is based on our knowledge and experience at the time of publication. In addition, material properties can be influenced by component geometry, environmental influences and material additives. The stated material or component properties, as well as their suitability for specific applications, are neither agreed nor guaranteed, despite regular quality controls. The customer is responsible for checking the component properties and their suitability for a specific application.

Phoenix Contact campus in Blomberg, Germany

In selective laser melting (SLM), metal powder is fused layer by layer into solid components. We manufacture high-precision parts from copper, zinc, brass, steel and aluminium. The components are media-tight, stable and – depending on the material – can be produced with wall thicknesses from 0.4 mm.

MATERIAL DATA SHEET
LASER MELTING OF METALS

Property	Condition	Unit	Pure copper	RS-Copper	CuCr1Zr	Zamak 5	RS-Brass
GENERAL PROPERTIES							
Density (laser-melted)		g/cm³	8.9	8.7 – 8.9	8.8 – 8.9	6.2 – 6.4	8.2 – 8.6
Roughness after sandblasting (Ra/Rz)		µm	8 – 9 / 40 – 50	8 – 10 / 40 – 50	7 – 10 / 35 – 50	4 – 6 / 25 – 35	7 – 9 / 40 – 50
Accuracy		mm	± 0.7 %, min. 0.1 mm	± 0.7 %, min. 0.1 mm	± 0.7 %, min. 0.1 mm	± 0.7 %, min. 0.1 mm	± 0.7 %, min. 0.1 mm
Minimum wall thickness		mm	0.6	0.6	0.6	0.6	0.6
Wall thickness for media-tight parts		mm	min. 1	min. 1	min. 1	–	–
Leak test		bar	6 bar compressed air	6 bar compressed air	6 bar compressed air	–	–
MECHANICAL PROPERTIES							
Tensile strength	as built	MPa	220 ± 10	–	–	218 ± 40	310 ± 30
	after heat treatment	MPa	–	220 ± 30	220 ± 30	–	–
Yield strength (Rp 0.2 %)	as built	MPa	140 ± 20	–	–	185 ± 15	260 ± 10
	after heat treatment	MPa	–	165 ± 20	170 ± 20	–	–
Elongation at break	as built	%	50 ± 10	–	–	1.5 ± 0.5	8 ± 3
	after heat treatment	%	–	20 ± 5	25 ± 5	–	–
Young's modulus	as built	GPa	–	–	–	28 ± 3	80 ± 5
Hardness	as built	HV10	61 – 66	62 – 71	62 – 71	61 – 64	100 – 109
THERMAL PROPERTIES							
Thermal conductivity	as built	W/(m·K)	415 ± 10	–	–	85	–
	after heat treatment	W/(m·K)	–	265	260	–	–
Specific heat capacity	after heat treatment	J/(kg·K)	–	394	394	–	–
	as built	J/(kg·K)	–	–	–	389	–
ELECTRICAL PROPERTIES							
Electrical conductivity (edge / core)		MS/m	58	51 / 32	49 / 32	–	8 / 8

* These values may vary depending on component geometry and dimensions. Mechanical properties may vary depending on the X, Y, Z orientation of the test specimens and the exposure parameters.

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MATERIAL DATA SHEET
LASER MELTING OF METALS

Property	Condition	Unit	PH1 – 1.4540	1.4542	316L – 1.4404	MS1 – 1.2709	AlSi10Mg
GENERAL PROPERTIES							
Density (laser-melted)		g/cm³	7.7	7.7 – 7.8	7.9	8 – 8.1	2.67
Roughness after sandblasting (Ra/Rz)		µm	5 / 25	2.5 – 4.5 / 15 – 40	3 – 7 / 20 – 40	4 – 6.5 / 20 – 50	7 – 10 / 50 – 60
Accuracy		mm	± 0.7 %, min. 0.1 mm	± 0.7 %, min. 0.1 mm	± 0.7 %, min. 0.1 mm	± 0.7 %, min. 0.1 mm	± 0.7 %, min. 0.1 mm
Minimum wall thickness		mm	0.4	0.4	0.4	0.4	0.6
MECHANICAL PROPERTIES							
Tensile strength	as built	MPa	1,200 ± 50	1,100 ± 50	670 ± 50	1,100 ± 100	410 ± 20
	after heat treatment	MPa	min. 1,340	1,150 ± 150	–	2,030 ± 70	340 ± 20
Yield strength (Rp 0.2 %)	as built	MPa	950 ± 150	750 ± 80	570 ± 50	1,000 ± 100	250 ± 20
	after heat treatment	MPa	min. 1,200	1,050 ± 150	–	1,950 ± 70	220 ± 10
Elongation at break	as built	%	17 ± 4	13 ± 2	min. 30	9 ± 4	6 ± 2
	after heat treatment	%	min. 10	18 ± 3	–	4 ± 2	7 ± 2
Young's modulus	as built	GPa	–	–	–	–	65 ± 5
	after heat treatment	GPa	–	–	–	–	65 ± 5
Hardness	as built	HRC	30 – 35	35	–	33 – 37	–
	after heat treatment	HRC	min. 40	approx. 40	–	53 ± 2	–
	as built	HRB	–	–	85	–	–
	as built	HBW	–	–	–	–	120
THERMAL PROPERTIES							
Thermal conductivity	as built	W/(m·K)	13.7 ± 0.8	–	–	–	103 ± 5
	after heat treatment	W/(m·K)	15.7 ± 0.8	–	–	–	–
Specific heat capacity	as built	J/(kg·K)	460 ± 20	–	–	–	–
	after heat treatment	J/(kg·K)	470 ± 20	–	–	–	–
		J/(kg·K)	–	–	–	450 ± 20	–

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3D PRINTING WITH MECHANICALLY RESILIENT PLASTICS

Polyamides are durable, resilient plastics with high chemical resistance. They can be dyed in almost any colour and, on request, manufactured media-tight. PROTIQ also offers filled, flexible and high-temperature-resistant plastic variants.

MATERIAL DATA SHEET
LASER SINTERING OF PLASTICS

Property	Condition	Test standard	Unit	PA 12	PA 12 GF	PA 2210 FR	PA 6X
GENERAL PROPERTIES							
Base material			–	PA 12	PA 12 + glass beads	PA 12	PA 6X
Colour			–	white	white / greyish	white / beige	white / yellowish
Density (laser-sintered)			g/cm³	0.9 – 1.0	1.2 – 1.3	1.06	1.00 – 1.04
Roughness after sandblasting (Ra/Rz)			µm	8 – 11 / 50 – 70	6 – 7 / 40 – 50	6 – 10 / 30 – 55	5 – 10 / 30 – 50
Accuracy			mm	± 0.7 %, min. 0.1 mm	± 0.7 %, min. 0.1 mm	± 0.7 %, min. 0.1 mm	± 0.7 %, min. 0.1 mm
Minimum wall thickness			mm	1.0	1.0	1.0	1.0
MECHANICAL PROPERTIES							
Tensile strength		DIN EN ISO 527	MPa	45 – 50	45 – 53	38 – 46	54 – 60
Elongation at break		DIN EN ISO 527	%	15 ± 10	5 – 9	3 – 7	15 – 25
Shore D hardness		ISO 868	–	75 ± 2 D	80 D	79 D	78 D
Flexural modulus		DIN EN ISO 178	MPa	1,500	2,600 – 2,900	2,300	–
Flexural strength		DIN EN ISO 178	MPa	58	73 – 78.3	65	–
Tensile modulus		DIN EN ISO 527	MPa	1,700 ± 150	2,800 – 3,200	2,200 – 2,500	2,200 – 2,500
Ball indentation hardness		DIN EN ISO 2039	N/mm²	78	–	–	–
Izod impact strength		DIN EN ISO 180	kJ/m²	32.8 ± 3.4	15 – 21	–	–
Izod notched impact strength		DIN EN ISO 180	kJ/m²	4.4 ± 0.4	4 – 4.2	–	–
Charpy impact strength		DIN EN ISO 179/1eU	kJ/m²	53 ± 3.8	21.8 – 35	–	–
Charpy notched impact strength		DIN EN ISO 179/1eA	kJ/m²	4.8 ± 0.3	4.1 – 5.4	–	–
THERMAL PROPERTIES							
Melting temperature		EN ISO 11357-1	°C	176	176	185	215
Heat deflection temperature (1.80 MPa)		ISO 75-1/-2	°C	70	96 – 101	–	80
Heat deflection temperature (0.45 MPa)		ISO 75-1/-2	°C	–	157 – 163	–	195
Heat deflection temperature (0.65 MPa)		ISO 75-1/-2	°C	154	–	–	–
Vicat softening temperature	B/50	DIN EN ISO 306	°C	163	163 – 166	–	–
	A/50	DIN EN ISO 306	°C	181	175 – 179	–	–
ELECTRICAL PROPERTIES							
Volume resistivity		DIN 53482	Ω·cm	10^{13} – 10^{15}	–	–	–
Surface resistance		DIN 53482	Ω	10^{13}	–	–	–
Dielectric constant (1 kHz)			–	3.8	–	–	–
Dielectric strength		DIN 53481	kV/mm	92	–	–	–

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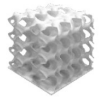
MATERIAL DATA SHEET
LASER SINTERING OF PLASTICS

Property	Condition	Test standard	Unit	PA 11	PA 11 ESD	PEKK	TPU 80A
							
GENERAL PROPERTIES							
Base material			–	PA 11	PA 11	PEKK	Thermoplastic polyurethane (TPU)
Colour			–	white	black / anthracite grey	yellowish / brownish	white / yellowish
Density (laser-sintered)			g/cm³	1.02	1.07	1.29	1.1 – 1.2
Roughness after sandblasting (Ra/Rz)			µm	6 – 10 / 35 – 45	6 – 10 / 35 – 45	–	13 – 17 / 72 – 84
Accuracy			mm	± 0.7 %, min. 0.1 mm	± 0.7 %, min. 0.1 mm	± 0.7 %, min. 0.1 mm	± 0.7 %, min. 0.2 mm
Minimum wall thickness			mm	1.0	1.0	–	1.0
MECHANICAL PROPERTIES							
Tensile strength		DIN EN ISO 527	MPa	45 – 46	47 – 55	60 – 81	5.5 – 8
Elongation at break		DIN EN ISO 527	%	31 – 45	22 – 31	1.6 – 2.3	300 – 550
Shore A hardness		ISO 7619-1	–	–	–	–	80 A
Flexural modulus		DIN EN ISO 178	MPa	1,250 – 1,300	1,650 – 2,550	–	–
Tensile modulus		DIN EN ISO 527	MPa	1,100 – 1,250	1,550 – 2,300	3,900 – 4,000	55
Izod impact strength		DIN EN ISO 180	kJ/m²	86 – no break	81 – 83	–	–
Izod notched impact strength		DIN EN ISO 180	kJ/m²	5.2 – 7.7	5.5 – 7.9	–	–
Charpy impact strength		DIN EN ISO 179/1eU	kJ/m²	85 – 198	101 – 107	6.5 – 10.4	–
Charpy notched impact strength		DIN EN ISO 179/1eA	kJ/m²	4.5 – 8.3	5.3 – 7.3	1.7 – 2.7	–
THERMAL PROPERTIES							
Melting temperature		EN ISO 11357-1	°C	203	204	298	95
Heat deflection temperature (1.80 MPa)		ISO 75-1/-2	°C	76	111	–	–
Heat deflection temperature (0.45 MPa)		ISO 75-1/-2	°C	176	186	–	–
Vicat softening temperature	B/50	DIN EN ISO 306	°C	177	183	–	60
	A/10	DIN EN ISO 306	°C	191	192	–	–
Melt flow index			g/10 min	–	–	8	–
ELECTRICAL PROPERTIES							
Volume resistivity		DIN 53482	Ω·cm	$1.2 \cdot 10^{14}$	–	–	–
	X direction	DIN 53482	Ω·cm	–	$2.3 \cdot 10^{6}$	–	–
	Z direction	DIN 53482	Ω·cm	–	$2.1 \cdot 10^{5}$	–	–
Surface resistance		DIN 53482	Ω	10^{6}	–	–	–
	X direction	DIN 53482	Ω	–	$1.3 \cdot 10^{4}$	–	–
	Z direction	DIN 53482	Ω	–	$3.4 \cdot 10^{4}$	–	–
Dielectric strength		DIN 53481	kV/mm	31	–	–	–
	X direction	DIN 53481	kV/mm	–	0	–	–
	Z direction	DIN 53481	kV/mm	–	0	–	–

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For components with fire-protection requirements, we offer the flame-retardant polyamide PA 2210 FR, which passes aviation-standard and UL 94 tests.

MATERIAL DATA SHEET
LASER SINTERING – FIRE BEHAVIOUR

Property	Condition	Test standard	Unit	PA 2210 FR
FIRE BEHAVIOUR				
Flammability	12 s · 1.7 mm	CS 25 / JAR 25 / FAR 25 §25.853	–	Test passed
	12 s · 2.0 mm	CS 25 / JAR 25 / FAR 25 §25.853	–	Test passed
	0.75 mm	UL 94	–	HB – test passed
	3.0 mm	UL 94	–	V-0 – test passed
Smoke density	1.7 mm	ABD 0031 (Issue F), AITM 2.0007	–	Test passed
	2.0 mm	ABD 0031 (Issue F), AITM 2.0007	–	Test passed
Toxicity	1.7 mm	ABD 0031 (Issue F), AITM 3.0005	–	Test passed
	2.0 mm	ABD 0031 (Issue F), AITM 3.0005	–	Test passed

3D PRINTING WITH PLASTICS FOR MAXIMUM DETAIL

Epoxy resins enable components with very high detail accuracy and smooth surfaces. They are particularly suited to delicate structures, design models and demanding prototypes. The components are manufactured using stereolithography (SLA).

MATERIAL DATA SHEET
STEREOLITHOGRAPHY

Property	Condition	Unit	VisiJet Tough	RS High Temp	RS Clear
GENERAL PROPERTIES					
Colour		–	grey	amber	transparent
Density (cured)		g/cm³	1.19	–	–
Accuracy		mm	± 0.05 mm / ± 0.3 %	± 0.1 mm / ± 0.5 %	± 0.1 mm / ± 0.3 %
MECHANICAL PROPERTIES					
Tensile strength		MPa	41	58.3	65
Elongation at break		%	18	3.3	6.2
Shore D hardness		–	86 D	–	–
Flexural modulus		MPa	1,850	2,620	2,200
Flexural strength		MPa	62	94.5	–
Tensile modulus		MPa	1,890	2,750	2,800
Izod notched impact strength		J/m	44	18.2	25
THERMAL PROPERTIES					
Heat deflection temperature (1.82 MPa)		°C	54	–	58.4
	after thermal treatment	°C	–	101	–
Heat deflection temperature (0.45 MPa)		°C	62	–	73.1
	after thermal treatment	°C	–	238	–
Thermal expansion (0 – 150 °C)		µm/(m·°C)	–	79.6	–

* after thermal treatment

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