Material data sheet

DirectMetal and DirectSteel materials for EOSINT M 250 Xtended

A number of different materials are available for use with EOSINT M systems, offering a broad range of e-Manufacturing applications. All of the materials were developed and optimised especially for Direct Metal Laser-Sintering (DMLS) on EOSINT M systems and are suitable for manufacturing moulds and tool inserts using the DirectTool process as well as functional prototypes using the DirectPart process.

This document provides brief descriptions of the most commonly used materials and their principle applications, and a table of technical data. For the machine requirements of the various materials please see the information quotes. Coarser versions of some materials are also available, details can be provided on request.

Laser-sintered parts made from any of these materials can be welded, machined, micro shot-peened, polished and coated if required. Unexposed powder can be reused without restriction or refreshing.

Description, Application

DirectMetal 20

DirectMetal 20 is a very fine grained bronze-based metal powder. The resulting parts offer good mechanical properties combined with excellent detail resolution and surface quality. The surfaces can be easily post-processed by shot-peening and can be polished with very little effort. The specially developed powder mixture contains different components which expand during the laser-sintering process, partially compensating for the natural sintering shrinkage and thereby enabling a very high accuracy to be achieved.

This material is ideal for most prototype injection moulding tooling applications and for many functional metal prototype applications (DirectPart). It offers the highest building speed so is particularly suitable for larger tools and parts. It also offers a very broad window of usable process parameters, e.g. a wide range of achievable mechanical properties and build speeds. Standard parameters use 20 µm layer thickness for the skin and 60 µm layers for the core, but for faster building the entire part can be built in 40 µm layers for the skin and 80 µm layers for the core, or even 60 µm layer thickness for skin and core. Using standard skin parameters the mechanical properties are fairly uniform in all directions, which is especially beneficial for many DirectPart applications. Parts built from DirectMetal 20 also have good corrosion resistance.

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Typical applications:

- injection moulds and inserts for moulding up to a few tens of thousands of parts in all standard thermoplastics using standard injection parameters
- direct manufacture of functional metal prototypes.

DirectSteel 20

DirectSteel 20 is a very fine grained steel-based metal powder. The resulting parts offer fine detail resolution and high accuracy with very good mechanical properties. They have a high density and strength, and can be post-processed by shot-peening, polishing etc. to achieve a high surface quality. The specially developed powder mixture contains different components which expand during the laser-sintering process, partially compensating for the natural sintering shrinkage and thereby enabling a very high accuracy to be achieved.

This material is suitable for heavy duty applications such as die-casting, sheet metal stamping or injection moulding of larger quantities of parts, as well as for functional metal prototypes (DirectPart). Standard parameters are 20 µm layer thickness for the outer skin and 60 µm layers for the core, but for faster building the entire part can be built in 40 µm layers for the skin and 80 µm layers for the core or even 60 µm layers for the skin and core. Using standard parameters the mechanical properties in the vertical (build) direction are lower than in the layer direction, which should be considered especially for DirectPart applications.

Typical applications:

- heavy duty injection moulds and inserts for moulding all standard thermoplastics using standard injection parameters, with achievable tool life of up to approx. 100,000 parts
- die casting moulds for small series of up to approx. 5,000 parts in light alloys
- direct manufacture of functional metal prototypes.

DirectSteel H20 (available from Q1/2004)

DirectSteel **H**20 is a very fine grained steel-based metal powder which offers the highest strength, hardness, wear resistance and surface density of all the available materials. The resulting parts have properties similar to conventional tool steels and can be polished to an excellent, pore-free surface finish. This material is particularly suitable for DirectTool applications such as injection moulds for series production, pressure die-casting tooling and other applications where high strength and wear resistance and/or best possible surface quality are important. Its high toughness, ductility, uniformity of properties and temperature resistance also make it very suitable for heavy duty DirectPart applications. Standard parameters are 20 µm layer thickness for the outer skin and 60 µm layers for the core, but for faster building thicker

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layers can be used as for DirectSteel 20. To achieve the high density and hardness, the skin area is completely melted, which results in slower build speed than for DirectSteel 20. This should be considered especially for large tools and parts.

Typical applications:

- heavy duty injection moulds and inserts for moulding all standard thermoplastics using standard injection parameters, with achievable tool life of up to approx. 1,000,000 parts
- die casting moulds for small series of up to approx. 5,000 parts in light alloys
- metal stamping and other heavy duty tooling applications
- direct manufacture of heavily loaded functional metal prototypes.

Technical Data

DirectSteel **H**20 will be available as a commercial product from approx. Q1/2004. The values given below are preliminary and subject to change.

Material composition

	DirectMetal 20	DirectSteel 20	DirectSteel H20
After laser-sintering	bronze-based matrix, containing Ni	steel-based matrix, containing Ni	alloy steel, containing Cr, Ni, Mo, Si, V, C

General process data

	DirectMetal 20	DirectSteel 20	DirectSteel H20
Minimum recommended layer thickness (µm)	20	20	20
Typical achievable part accuracy (µm) [1]	± 50	± 50	± 50
Accuracy specification for qualification (µm) [2]	± (0.07 % + 50)	± (0.07 % + 50)	± (0.07 % + 50)
Min. wall thickness (mm) [3]	0.6	0.7	0.7

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	DirectMetal 20	DirectSteel 20	DirectSteel H20
Volume rate (mm³/s) [4]			
20 µm layer thickness			
- skin: 20 µm layers	2 - 8	1.5 – 2.5	0.5-3
- core: 60 µm layers	15	7.5	4
40 µm layer thickness			
- skin: 40 µm layers	4 – 10	2 – 4	1 - 3
- core: 80 µm layers	16	8	5
60 µm layer thickness			
- skin: 60 µm layers	6 - 12	2.5 – 5	-
- core: 60 µm layers	18	10	-

[1] Based on users' experience of dimensional accuracy for typical geometries

[2] Valid for EOS standard qualification part and procedure

[3] Mechanical stability is dependent on geometry (wall height etc.) and application

[4] DMLS parts are typically build using Skin & Core strategy, in some cases using inner and outer skins. The average volume rate for a particular part is therefore geometry-dependent.

Mechanical properties of laser sintered parts

	DirectMetal 20	DirectSteel 20	DirectSteel H20
Density in skin areas (g/cm³)	7.6	7.6	7.8
Density in core areas (g/cm³)	6.3	6.3	7.0
Remaining porosity (min., %)	8	2	< 0.5
Tensile strength (MPa, MPIF 10)	up to 400	up to 600	up to 1100
Yield strength (MPa)	200	400	800
Young's Modulus (GPa)	80	130	180
Transverse rupture strength (MPa, MPIF 41)	700	1000	2000

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	DirectMetal 20	DirectSteel 20	DirectSteel H20
Hardness (HB, HV, HRB) [5]			
- as laser-sintered	110 HB, 115 HV (≅ 65 HRB)	220 HB, 225 HV, 94 HRB [6]	350 - 420 HV, 35 - 42 HRC
- after micro shot-peening			380 - 420 HV, 38 - 42 HRC
- after hard coating [7]	> 2000 HV	> 2000 HV	> 2000 HV
Surface roughness (µm)			
- without post-processing	R_a 9 R_z 40 - 50	R_a 10 R_z 50	R_a 10 R_z 40 - 50
- after shot-peening	R_a 3 R_z 15	R_a 4 R_z 15	R_a 5 R_z 25
- after polishing	R_z up to < 1	R_z up to < 1	R_z up to < 1

[5] Brinell hardness measurement (HB) according to DIN EN ISO 6506-1, abbreviated to HBW 2,5 / 62,5. Vickers hardness measurement (HV) according to DIN EN ISO 6507-1. Rockwell B (HRB) and Rockwell C (HRC) hardness measurement according to DIN EN ISO 6508-1. Values in parentheses are converted in accordance with DIN 50150, which is applicable to cast steels and therefore only gives an indication for laser-sintered materials.

[6] Surface hardness can be increased by post-processing, e.g. to 400 HV, (≅ 380 HB, 112 HRB) by short-term plasma nitriding

[7] Surface hardness of TiN or CrN coating applied by PVD

Thermal properties of laser sintered parts

	DirectMetal 20	DirectSteel 20	DirectSteel H20
Coefficient of thermal expansion (10^{-6}/K)	18	9 [8]	13 (100 - 250 °C) 14 (250 - 400 °C) 15 (400 - 550 °C)
Thermal conductivity (W/mK)	30 [8]	13 [8]	15 (at 50 °C) 18 (at 200 °C)
Maximum operating temp. (°C)	400	800	1100

[8] T = 50 °C

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The quoted values refer to the use of these materials with EOSINT M 250 Xtended according to current specifications and operating instructions. All values are approximate. The quoted mechanical and physical properties refer to standard building parameters and if not otherwise stated for (outer) skin areas. They depend on the building parameters and strategies used, which can be varied by the user according to the application.
The data are based on our latest knowledge and are subject to changes without notice. They are provided as an indication and not as a guarantee of suitability for any specific application.

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