Material Data Sheet

Fe-Alloy Invar 36® / 1.3912[1]

General

Invar 36® is an iron-based alloy with 36 % nickel. A special feature of this material is its low coefficient of thermal expansion below its Curie temperature of 280°C. Invar 36® also has excellent mechanical properties and a low tendency to fatigue in cryogenic environment. Fields of application are components that require both a high reliability and a high dimensional stability. For example, Invar 36® is used for space equipment, clocks, valves in engines, bimetallic thermostats, optic and laser systems, and precision instruments.

Material Structure

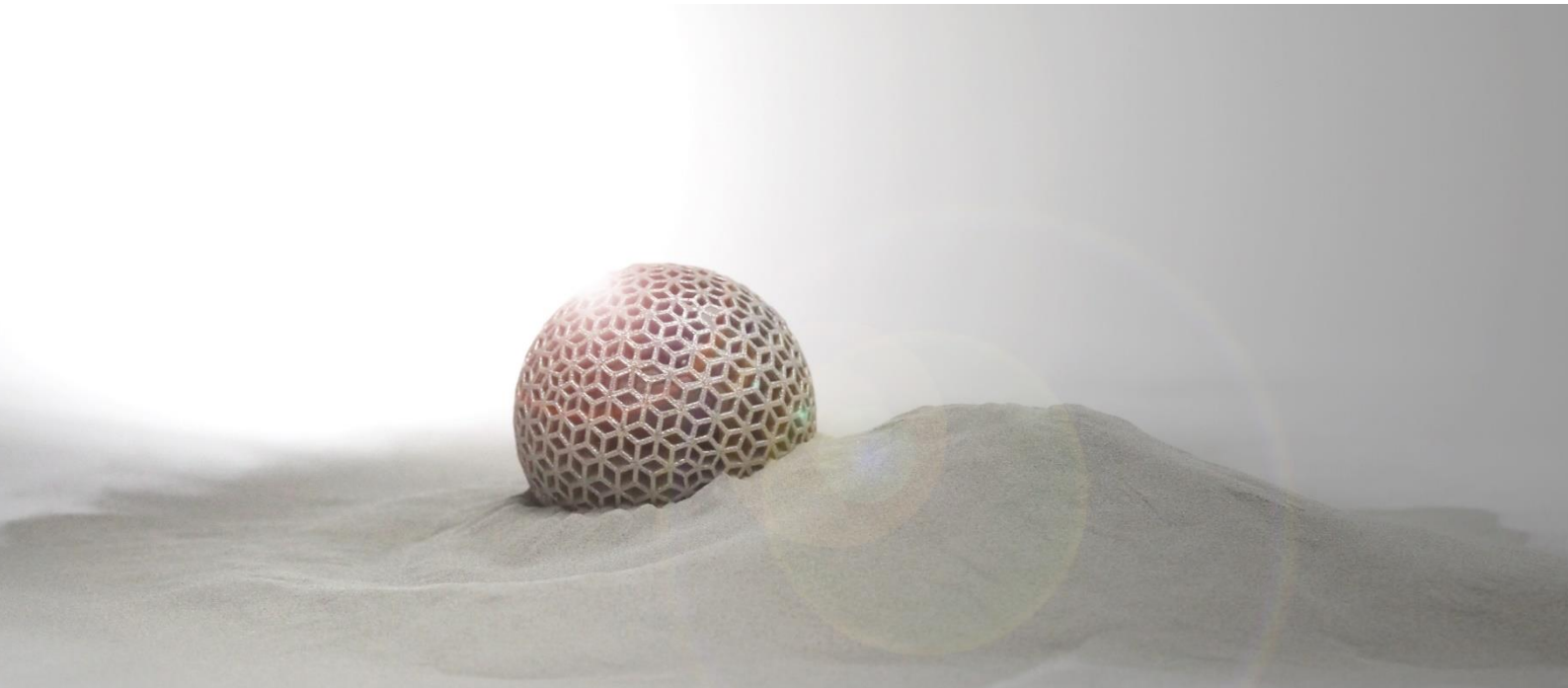
SLM®-processed components out of Invar 36® show a homogenous, nearly void free structure, with mechanical characteristic values in the range of material specifications. By post processing like heat treatment (e.g. stress-relief annealing, soft annealing, stabilizing annealing), material properties can be adjusted to individual required conditions.

Chemical composition [Mass fraction in %][6]

Fe	Ni	Cr	Mn	Si	C	Other each	Other total	P	C	N	O
Balance	35.00 – 37.00	0.50	0.50	0.50	0.10	0.20	0.50	/	/	/	/

Powder properties

Particle size[6]	10 – 45 µm	Particle shape[7]	Spherical
Mass density[1]	8.1 g/cm³	Thermal conductivity	12.8 W/(m·K)



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Layer thickness 30 µm[3]	As-built	Heat-treated [11]
Build-up rate [5] [cm³/h]	10.0 cm³/h	
Component density[4] [%]	> 99.5 %	

Tensile test[8]			M	SD	M	SD
Tensile strength	R_m [MPa]	0°	508	15	510	15
		45°	457	15	487	15
		90°	443	15	443	5
Offset yield strength	$R_{p0,2}$ [MPa]	0°	404	4	392	14
		45°	394	2	386	2
		90°	352	4	354	4
Elongation at break	A [%]	0°	31	5	33	5
		45°	33	5	32	5
		90°	35	5	34	5
Reduction of area	Z [%]	0°	71	1	71	3
		45°	72	3	71	5
		90°	80	2	79	2
Young's modulus	E [GPa]	0°	153	11	138	13
		45°	125	17	151	13
		90°	131	8	126	5

Hardness test[9]		M	SD	M	SD
Vickers hardness	HV10	149	2	-	-

Roughness measurement[10]		As-built		Corundum blasted	
		M	SD	M	SD
Roughness average	Ra [µm]	13	3	-	-
Mean roughness depth	Rz [µm]	82	21	-	-

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The properties and mechanical characteristics apply to powder that is tested and sold by SLM Solutions, and that has been processed on SLM Solutions machines using the original SLM Solutions parameters in compliance with the applicable operating instructions (including installation conditions and maintenance). The part properties are determined based on specified procedures. More details about the procedures used by SLM Solutions are available upon request.

The specifications correspond to the most recent knowledge and experience available to us at the time of publication and do not form a sufficient basis for component design on their own. Certain properties of products or parts or the suitability of products or parts for specific applications are not guaranteed. The manufacturer of the products or parts is responsible for the qualified verification of the properties and their suitability for specific applications. The manufacturer of the products or parts is responsible for protecting any third-party proprietary rights as well as existing laws and regulations.

[1] Material according to DIN 1715-1:1983.

[2] Material density varies within the range of possible chemical composition variations.

[3] Material data file: Invar_SLM_MBP2.2_30_CE2_400W_Stripes_V1.0

[4] Optical density determination at test specimens by light microscopy.

[5] Theoretical build-up rate for each laser = layer thickness x scan speed x track distance.

[6] With respect to powder material.

[7] According to DIN EN ISO 3252:2001.

[8] Tensile test according to DIN EN ISO 6892-1:2017 B (DIN 50125:2016 – D6x30); orientation: 0°, 45°, 90°.

[9] Hardness testing according to DIN EN ISO 6507-1:2018.

[10] Roughness measurement according to DIN EN ISO 4288:1998; λc = 2,5 mm.

[11] Heat treatment for stabilization of thermal expansion coefficient: 1) Annealing at 880 °C for 0,5 h and quenching in water 2) Annealing at 300 °C for > 1h and cooling with air 3) Heating to 100 °C and furnace cooling for 48 h.

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