Material Data Sheet

Ni-Alloy IN939

General

This highly heat-resistant and corrosion resistant alloy IN939 ranks among nickel-based alloys. In most cases, these alloys contain chromium, iron, niobium, and molybdenum and other alloying elements. They are often known as superalloys. Nickel-based alloys withstand higher temperatures than steels and are also highly weldable. Their temperature resistance is achieved through a mixture of dispersion hardening, precipitation hardening, and solid solution strengthening. Nickel-based alloys exhibit good mechanical characteristic values such as high tensile strength and good endurance strength. IN939 can be used at temperatures of up to 700 °C, which makes this alloy ideally suited for aerospace technologies and turbine production. Another field of application for nickel-based alloys is toolmaking. These alloys are also suitable for heat treatment and mechanical post treatment.

Material Structure

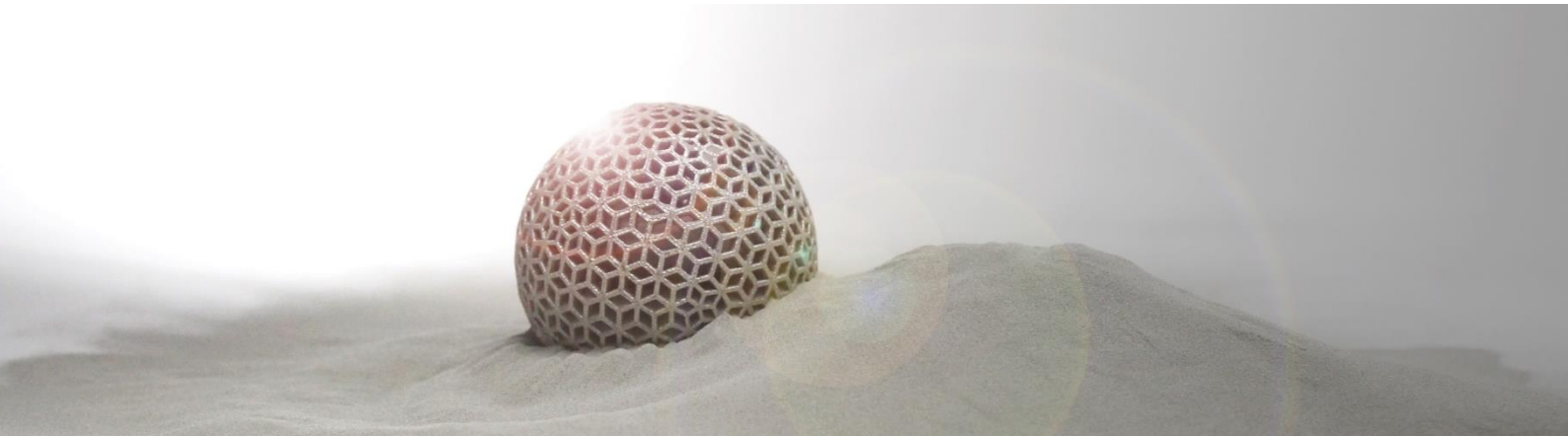
SLM®-processed components out of IN939 exhibit a homogeneous, nearly non-porous texture, with mechanical characteristic values in the range of material specifications. Through subsequent processing such as heat treatment (e.g. precipitation hardening) or hot isostatic pressing (HIP), the components' properties can be adapted to meet specific requirements.

Chemical composition [Mass fraction in %][6]

Ni	Cr	Co	Ti	W	Al	Ta	Nb	Mn	Si	C	Zr
Balance	22.00 – 23.00	18.00 – 20.00	3.00 – 4.50	1.00 – 3.00	1.00 – 3.00	1.00 – 1.80	0.50 – 1.50	0.50	0.50	0.15	0.10

Powder properties

Particle size[3]	10 – 45 µm	Particle shape[4]	Sphärisch
Mass density[5]	8.2 g/cm³	Thermal conductivity[6]	/



Material Data Sheet

Ni-Alloy IN939

Layer thickness 30 µm [2]	As-built	Heat-treated [11]	Heat-treated + HIP[12]

Build-up rate [5]	[cm³/h]	9.1 cm³/h
Component density[4]	[%]	> 99.5%

Tensile test[8]			M	SD	M	SD	M	SD
Tensile strength	R_m	[MPa]	1009	35	1247	76	1348	57
Offset yield strength	$R_{p0,2}$	[MPa]	735	41	749	21	957	18
Elongation at break	A	[%]	30	5	13	5	11	5
Reduction of area	Z	[%]	45	7	12	3	12	2
Young's modulus	E	[GPa]	177	8	201	3	156	6

Hardness test[9]		M	SD	M	SD	M	SD
Vickers hardness	HV10	302	3	-	-	-	-

Roughness measurement[10]			As-built		Corundum blasted		Corundum- and Glass-bead blasted	
			M	SD	M	SD	M	SD
Roughness average	Ra	[µm]	6	1	-	-	-	-
Mean roughness depth	Rz	[µm]	42	6	-	-	-	-

Ni-Alloy IN939

Layer thickness 50 µm [3]			As-built
Build-up rate [5]		[cm³/h]	16.4 cm³/h
Component density[4]		[%]	> 99,5%

Tensile test[8]			M	SD
Tensile strength	R_m	[MPa]	928	72
Offset yield strength	$R_{p0,2}$	[MPa]	633	33
Elongation at break	A	[%]	23	10
Reduction of area	Z	[%]	28	9
Young's modulus	E	[GPa]	156	12

Hardness test[9]		M	SD
Vickers hardness	HV10	305	7

Roughness measurement[10]			As-built	
			M	SD
Roughness average	Ra	[µm]	7	1
Mean roughness depth	Rz	[µm]	48	7

Material Data Sheet

Ni-Alloy IN939

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 density varies within the range of possible chemical composition variations.

[2] Material data file: Inc_SLM_BP2.1_30_Stripes-US_T200_S09-02_V4101

[3] Material data file: Inc_SLM_BP2.1_50_Stripes-US_T0_S32-04_V4101

[4] Optical density determination 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 – B6x30); orientation: 0°, 90°; heat treatment: none; testing machine: Zwick 1484; load range: 200 kN; testing speed: 0,008 1/s; testing temperature: room temperature; test laboratory: EWIS GmbH/EADS. Test samples were turned before tensile test.

[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: 1107 °C/2 h + cool 3 °C/min to 899 °C + 913 °C/8 h + 982 °C/6 h + 802 °C/4 h

[12] Heat treatment: 1107 °C/2 h + cool 3 °C/min to 899 °C + 913 °C/8 h + 982 °C/6 h + 802 °C/4 h + HIP

SLM Solutions Group AG | Estlandring 4 | 23560 Lübeck | Germany
+49 451 4060 - 3000 | info@slm-solutions.com | slm-solutions.com