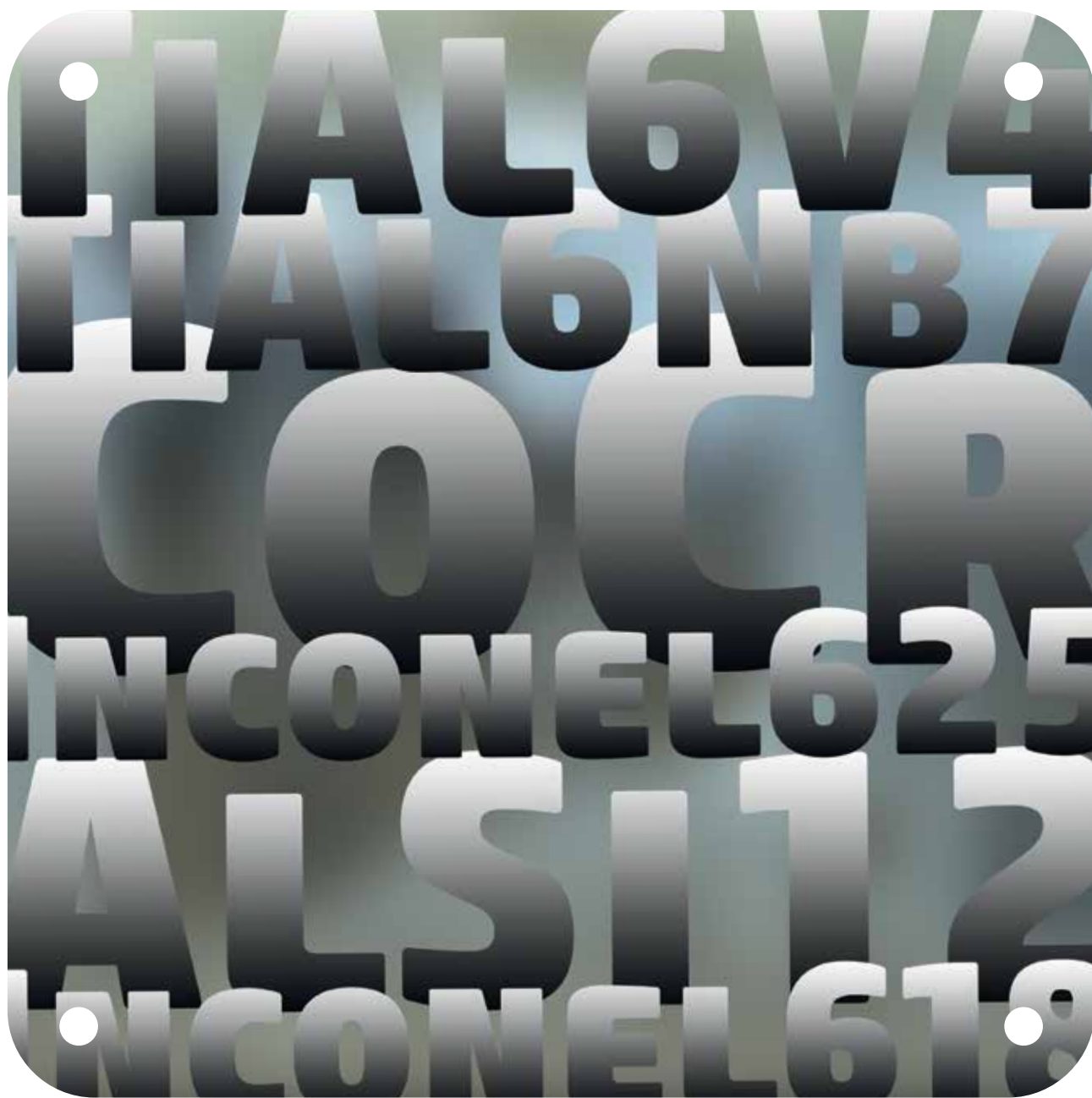


# SLM<sup>®</sup> METAL POWDER

Discover the variety



**The range of our standard metal powder**

Non Ferrous, Tool Steel, Stainless Steel and Light Alloys

# Titanium



Individual hip implantat in titanium

## Material Properties

- Corrosion resistance
- Bio-compatibility
- Low thermal expansion
- High strength at low density

## Areas of Application

- Medical technology
- Aerospace
- Automotive
- Jewellery and Design
- Maritime applications

## General

Thanks to their high strength and relatively low density, as well as excellent corrosion resistance, titanium components are found across a broad spectrum of applications. Titanium and its alloys have already been successfully put to use, for example, in the automotive industry and in aerospace engineering, since around 1950.

Pure titanium is used primarily in chemical industries, process engineering or in medical technologies, wherever good corrosion resistance is especially required. An added advantage here is titanium's low thermal expansion. Its bio-compatibility also makes titanium suitable for use in medical technologies. Therefore, dental implants or prosthetic hips, for example, can be made from titanium.

The alloy Ti6Al4V is by far the most common titanium alloy worldwide. The main reason for this is its well-balanced mechanical properties and the many years of industrial experience with this material.

## Material Composition

Following the SLM<sup>®</sup>-process, titanium components exhibit a homogeneous, nearly poreless texture, whereby the mechanical characteristic values lie within the range of the material specifications. Through subsequent post treatment, such as hardening, heat treatment or hot isostatic pressing (HIP), the components' properties can be adapted to meet specific requirements.

Mechanical Data	Formula Symbol and Unit	Ti6Al4V <sup>1,3</sup>	Ti6Al7Nb <sup>1,3</sup>	Reintitan <sup>1,3</sup>
Tensile strength	R <sub>m</sub> [MPa]	1286 ± 57	1308 ± 76	> 290
Offset yield stress	R <sub>p0,2</sub> [MPa]	1116 ± 61	1147* ± 35	> 180
Break strain	A [%]	8 ± 2	5 ± 1	> 20
Reduction of area	Z [%]	30 ± 10	12 ± 4	-
E-Modul	E [GPa]	111 ± 4	108 ± 1	105
Hardness by Vickers	[HV10]	384 ± 5	348 ± 4	130 - 210
Surface roughness	R <sub>a</sub> [µm]	12 ± 1	12 ± 1	-
Surface roughness	R <sub>z</sub> [µm]	70 ± 3	69 ± 8	36 ± 4

1 Layer thickness 30 µm

2 Layer thickness 50 µm

3 As built

4 Heat treated

\* Yield strength R<sub>e</sub>

# Tool Steel and Stainless Steel



Mould inserts with integrated, surface conformal cooling channels, Gardena AG

## Material Properties

- Great hardness and high ductility
- Corrosion resistance with stainless steels
- High resistance to wear and tear
- Hardenable

## Areas of Application

- Automotive industry
- Toolmaking
- Maritime applications
- Medical technology
- Mechanical engineering

## General

Components made from tool or stainless steels are known for great hardness with a high ductility. Through selective application of alloying components, the material properties can be precisely adjusted. This means that even corrosion-resistant steel alloys like 1.4404 (316L) can be treated using the SLM®-process. Applications for corrosion-resistant alloys are found in medical technologies, the automotive industry as well as in aerospace engineering. Tool steel is used above all to produce tools and moulds, and its layered structure enables components to be fitted with integrated cooling canals.

The good mechanical characteristic values of tool and stainless steel make it suitable for use in places that are exposed to heavy strain, because its high resistance to wear and tear or surface hardening keep abrasion to a minimum. Steel can also be used at high operating temperatures which reduces the amount of wear and tear on the tools.

## Material Composition

Following the SLM®-process, steel components exhibit a homogeneous, nearly poreless texture, whereby the mechanical characteristic values lie within the range of the material specifications. Through subsequent post treatment, such as hardening, heat treatment or hot isostatic pressing (HIP), the components' properties can be adapted to meet specific requirements.

Mechanical Data	Formula Symbol and Unit	1.4404 / 316L <sup>2,3</sup>	1.2709 <sup>2,3</sup>	1.4540 / 15-5PH <sup>1,3</sup>	17-4PH <sup>2,3</sup>
Tensile strength	$R_m$ [MPa]	633 ± 28	1011 ± 39	1100 ± 50	832 ± 87
Offset yield stress	$R_{p0,2}$ [MPa]	519 ± 25	837 ± 76	1025 ± 25	572 ± 25
Break strain	A [%]	30 ± 5	7 ± 2	16 ± 4	31 ± 3
Reduction of area	Z [%]	49 ± 11	20 ± 6	-	55 ± 4
E-Modul	E [GPa]	184 ± 20	167 ± 24	-	155 ± 22
Hardness by Vickers	[HV10]	209 ± 2	321 ± 7	-	221 ± 4
Surface roughness	$R_a$ [µm]	10 ± 2	8 ± 4	-	9 ± 2
Surface roughness	$R_z$ [µm]	50 ± 12	41 ± 9	14 ± 2	54 ± 15

1 Layer thickness 30 µm

2 Layer thickness 50 µm

3 As built

4 Heat treated

# Aluminium



Propeller for racing boats as a scaled model for flow measurements

## Material Properties

- Low material density
- Good alloying properties
- Good processability
- Good electrical conductivity
- Light metal

## Areas of Application

- Automotive
- Aerospace
- Prototype construction

## General

With a density of 2.7 g/cm<sup>3</sup>, aluminium is classified as a light metal. It is highly suited to processing and is used, for example, in thin-walled components with complex geometries. Aluminium also displays good electrical conductivity. Due to its low strength, it is used above all in alloys; currently the most common alloy is AlSi10Mg. Typical alloying additions are silicon, magnesium, copper or manganese. In alloyed forms, aluminium is used to produce components with high strength and high dynamic loadability. The components are optimal for use in areas such as aerospace engineering and the automotive industry.

## Material Composition

Following the SLM<sup>®</sup>-process, aluminium-alloy components exhibit a homogeneous, nearly poreless texture, whereby the mechanical characteristic values lie within the range of the material specifications. Through subsequent post treatment, such as hardening, heat treatment or hot isostatic pressing (HIP), the components' properties can be adapted to meet specific requirements.

Mechanical Data	Formula Symbol and Unit	AlSi10Mg <sup>2,3</sup>	AlSi12 <sup>2,3</sup>	AlSi7Mg <sup>2,3</sup>	AlSi9Cu3 <sup>2,3</sup>
Tensile strength	R <sub>m</sub> [MPa]	397 ± 11	409 ± 20	294 ± 17	415 ± 15
Offset yield stress	R <sub>p0,2</sub> [MPa]	227 ± 11	211 ± 20	147 ± 15	236 ± 8
Break strain	A [%]	6 ± 1	5 ± 3	3	5 ± 1
Reduction of area	Z [%]	8 ± 1	-	-	11 ± 1
E-Modul	E [GPa]	64 ± 10	-	-	57 ± 5
Hardness by Vickers	[HV10]	117 ± 1	110	112 ± 3	129 ± 1
Surface roughness	R <sub>a</sub> [µm]	7 ± 1	-	6 ± 1	7 ± 1
Surface roughness	R <sub>z</sub> [µm]	46 ± 8	34 ± 4	45 ± 5	46 ± 7

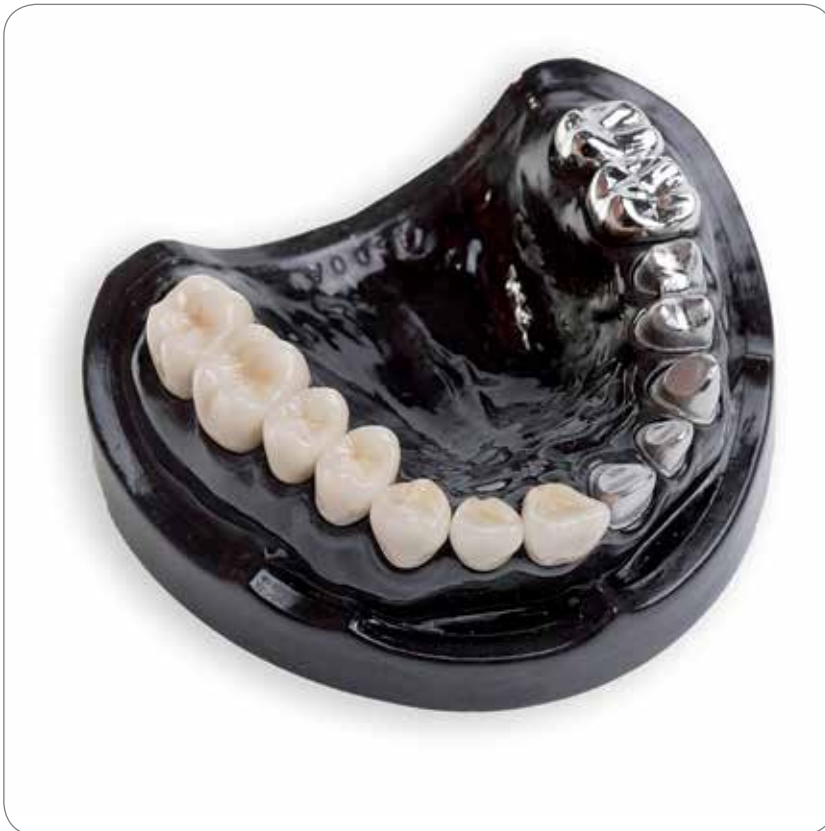
1 Layer thickness 30 µm

2 Layer thickness 50 µm

3 As built

4 Heat treated

# Cobalt-Chrome



Individual bridges and crowns in cobalt-chrome

## Material Properties

- High strength and high ductility
- Very high hardness
- Bio-compatibility
- Corrosion resistance

## Areas of Application

- Medical technology
- Dental technology
- High-temperature fields



## General

Cobalt-chrome alloys are distinguished by their especially high hardness as well as high ductility. Additionally they are corrosion resistant. Due to their high bio-compatibility, cobalt-chrome alloys are among the standard alloys used in medical and dental technologies. They are used to produce dental as well as knee and hip prostheses.

Their resistance to heat makes them well-suited for use in high-temperature areas, such as in jet engines. Since cobalt-chrome components are very hard, there are limitations when it comes to exposing them to cutting processes. The SLM®-process provides a low-effective option to quickly produce cobalt-chrome components.

## Material Composition

Following the SLM®-process, cobalt-chrome components exhibit a homogeneous, nearly poreless texture, whereby the mechanical characteristic values lie within the range of the material specifications. Through subsequent post treatment, such as hardening, heat treatment or hot isostatic pressing (HIP), the components' properties can be adapted to meet specific requirements.

Mechanical Data	Formula Symbol and Unit	CoCr <sup>1,3</sup>	CoCr <sup>2,3</sup>	SLM-Medi-Dent
Tensile strength	R <sub>m</sub> [MPa]	1101 ± 78	1039 ± 91	1062 ± 46
Offset yield stress	R <sub>e</sub> [MPa]	720 ± 18	705 ± 73	319* ± 18
Break strain	A [%]	10 ± 4	10 ± 4	-
Reduction of area	Z [%]	11 ± 4	11 ± 3	-
E-Modul	E [GPa]	194 ± 9	191 ± 10	114 ± 5
Hardness by Vickers	[HV10]	375 ± 2	372 ± 7	-
Surface roughness	R <sub>a</sub> [μm]	10 ± 1	10 ± 2	7 ± 1
Surface roughness	R <sub>z</sub> [μm]	64 ± 6	65 ± 12	43 ± 2

1 Layer thickness 30 μm

2 Layer thickness 50 μm

3 As built

4 Heat treated

\* Yield strength R<sub>p0,2</sub>

# Nickel based alloys



Turbine blade with internal conformal cooling channels to improve performance of jet engines

## Material Properties

- Corrosion resistance
- Excellent mechanical strength up to 1200 °C
- Outstanding weldability
- Hardenable

## Areas of Application

- Aerospace engineering
- High-temperature fields
- Toolmaking

## General

Materials like Inconel or Hastelloy X are examples of highly heat-resistant and corrosion resistant nickel-based alloys. In most cases, these alloys contain chrome, iron, niobium and molybdenum and other alloy components and they are often known as superalloys. Nickel-based alloys withstand higher temperatures than steels and they are also highly weldable. Their resistance to temperature 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. Inconel can be used at temperatures of up to 700 °C. Hastelloy X can even be used at temperatures of up to 1200 °C. This makes these alloys ideally suited for aerospace technologies and for turbine production.

Another area where nickel-based alloys are used is toolmaking. These alloys are also suitable for sustained heat treatment and mechanical post treatment.

## Material Composition

Following the SLM®-process, nickel-based components exhibit a homogeneous, nearly poreless texture, whereby the mechanical characteristic values lie within the range of the material specifications. Through subsequent post treatment, such as hardening, heat treatment or hot isostatic pressing (HIP), the components' properties can be adapted to meet specific requirements.

Mechanical Data	Formula Symbol and Unit	Inconel 718 <sup>2,3</sup>	Inconel 625 <sup>1,3</sup>	Inconel 939 <sup>1,3</sup>	Inconel 939 <sup>1,4</sup>	Hastelloy X <sup>1,3</sup>
Tensile strength	$R_m$ [MPa]	994 ± 40	961 ± 41	1009 ± 35	1348 ± 57	772 ± 24
Offset yield stress	$R_{p0,2}$ [MPa]	702 ± 65	707 ± 41	735* ± 41	957* ± 18	595 ± 28
Break strain	A [%]	24 ± 1	33 ± 2	30 ± 4	11 ± 2	20 ± 6
Reduction of area	Z [%]	40 ± 7	51 ± 5	45 ± 7	12 ± 2	21 ± 7
E-Modul	E [GPa]	166 ± 12	182 ± 9	177 ± 8	195 ± 6	162 ± 11
Hårdness by Vickers	[HV10]	293 ± 3	285 ± 3	302 ± 3	-	248 ± 4
Surface roughness	$R_a$ [µm]	7 ± 2	8 ± 1	6 ± 1	-	8 ± 3
Surface roughness	$R_z$ [µm]	36 ± 8	57 ± 11	42 ± 6	-	40 ± 14

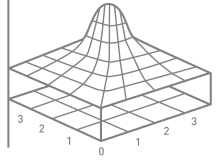
1 Layer thickness 30 µm

2 Layer thickness 50 µm

3 As built

4 Heat treated and hipped

\* Yield strength  $R_e$



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