ŽOLLERN

Solid metals. Fine solutions.

Investment Casting

Alloys

The ZOLLERN Group
ZOLLERN is one of the pioneers in the metal industry. At several locations in Europe, North America and Asia, 2,000 employees develop, produce and service a wide range of high-quality metal products. ZOLLERN supplies sophisticated solutions for a wide range of applications with its business areas of drive technology, investment casting, sand casting and forging as well as steel profiles.

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Investment casting alloys

ZOLLERN Investment Casting produces sophisticated investment casting products at its headquarters in Laucherthal, as well as at other company sites in Germany, Slovenia, Romania and Portugal. The in-house manufacturing ranges from the master melt through to ready-to-be-installed, highly sophisticated investment casting parts with mechanical machining, surface treatment and assembly. The experienced specialists from ZOLLERN cast virtually all standardised alloys. Non-standardised special alloys are also produced to customer specifications or modified using existing alloys.

Investment casting is a precision process. It offers enormous design freedom at the same time. The variety of possible alloys permits cost-effective solutions for the most diverse applications. Investment casting parts can therefore be found in many industries, such as automotive, aeronautics, power engineering, mechanical engineering and medical engineering.

The cost-effective investment casting method offers enormous technical possibilities, such as:

- Almost unlimited design freedom
- Wide range of alloys
- Precise casting method
- Near net shape casting
- High surface quality

Steels for general use

Designation	Material no.	Standard	Typical heat treatment state	Mechanical and technological characteristics			Notched-bar impact work (ISO-V)	Annealing hardness	Intended use/ Particular application examples
				0.2% proof stress $Rp_{0.2}$	Tensile strength Rm (MPa)	Percent elongation at failure A_5 (%)	(J)	(HB)	
GS 38.3 GE 200	1.0420	DIN 1681 EN 10293	Annealed	≥ 200	≥ 380	≥ 25	≥ 35		General mechanical engineering; good weldability; magnetically soft for pressure-bearing components in accordance with AD-W5 up to 300°C
GS 45.3 GE 240	1.0446	DIN 1681 EN 10293	Annealed	≥ 230	≥ 450	≥ 22	≥ 27		General mechanical engineering; magnetically soft, at least 1.70 T at 100 A/cm
GS 52.3 GE 260	1.0552	DIN 1681	Annealed	≥ 260	≥ 520	≥ 18	≥ 27		General mechanical engineering; magnetically soft, at least 1.70 T at 100 A/cm
GS 60.3 GE 300	1.0558	DIN 1681 EN 10293	Annealed	≥ 300	≥ 600	≥ 15	≥ 27		General mechanical engineering; magnetically soft, at least 1.70 T at 100 A/cm

Case-hardening steels

Designation	Material no.	Standard	Typical heat treatment state	Mechanical and technological characteristics			Hardness	Annealing hardness	Intended use/ Particular application examples
				0.2% proof stress $Rp_{0.2}$	Tensile strength Rm (MPa)	Percent elongation at failure A_5 (%)		(HB)	
C 15	1.0401	DIN 17210 DIN EN 10084	Case-hardened	≥ 430	700-900	≈12	-	143	Parts for general mechanical engineering with low core strength; levers
14 NiCr 14	1.5752	WL 1.5752	Case-hardened	≥ 835	930-1230	≈10	-	190	Components resistant to sudden stress, tough at subzero temperature; high core strength even with thick cross sections; pinion shafts, pins
GS 15 CrNi 6	1.5919 1.5924	DIN 17210 WL 1.5924	Case-hardened	≥ 680	1000-1300	≈8	-		Parts subject to high stresses with small wall thicknesses, inferior full hardening compared to 14 NiCr 14
18 CrNi 8	1.5920 1.5934	 WL 1.5934	Case-hardened	≥ 785	1180-1420	≈7	-	190	Machine components subject to highest amounts of stress, better full hardening compared to 17 CrNiMo 6, therefore particularly suited to larger parts
17 CrNiMo 6	1.6587	DIN 17210 DIN EN 10084	Case-hardened	≥ 830	1050-1350	≈8	-	183	Machine components subject to highest amounts of stress, very good wear resistance
15 Cr 3	1.7015	DIN 17210 DIN EN 10084	Case-hardened	≥ 440	690-880	≈11	-	174	Machine components subject to average stress, higher core strength compared to C 15; roller bearings, measuring tool
17 Cr 3	1.7016	DIN 17210 DIN EN 10084	Case-hardened	≥ 450	750-1050	≈11	-	174	As 15 Cr 3, but slightly higher core strength; parts used in the construction of vehicles
GS 16 MnCr 5	1.7131	DIN 17210 DIN EN 10084	Case-hardened	≥ 600	800-1100	≈10	-	164	Standard quality for components subject to average and higher stresses with cross sections that are not too large; cog toothed wheels, control components
16 MnCrS 5	1.7139	DIN 17210 DIN EN 10084	Case-hardened	≥ 600	800-110	≈10	-	164	As 16 MnCr 5; better and more uniform machining possible due to modified sulphur content
GS 20 MnCr 5	1.7147	DIN 17210 DIN EN 10084	Case-hardened	≥ 680	1000-1300	≈8	-	178	As 16 MnCr 5, but suitable for larger cross sections or higher core strengths

Quenched and tempered, nitriding and spring steels

Designation	Material no.	Standard	Typical heat treatment state	Mechanical and technological characteristics			Hardness	Annealing hardness	Intended use/ Particular application examples
				0.2% proof stress $Rp_{0.2}$	Tensile strength Rm (MPa)	Percent elongation at failure A_5 (%)		(HB)	
GS C TL	TL 2350-002	BWB	Quenched and tempered	≥ 785	930-1180	≥ 10	260-330	≤ 230	Reinforced cast steel; for components with high heat-treated strength and toughness
C 22	1.0402	DIN EN 10083 EN 10250	Quenched and tempered	≥ 350	550-700	≥ 15	-	≤ 160	For components with small wall thickness and subject to low stress; mechanical engineering and apparatus construction
C 35	1.0501	DIN EN 10083 EN 10343	Quenched and tempered	≥ 430	630-780	≥ 15	-	≤ 185	For thin-walled components subject to slightly higher stress in mechanical engineering
C 45	1.0503	DIN EN 10083 EN 10343	Quenched and tempered	≥ 500	700-850	≥ 10	-	≤ 210	Castings of higher strength with small cross sections and subject to average stress
C 55	1.0535	DIN EN 10083 P1 - P2	Quenched and tempered	≥ 550	800-950	≥ 10	-	≤ 230	For thin-walled castings of high strength
CK 60	1.1221	DIN EN 10083 P1 - P2	Quenched and tempered	≥ 580	850-1000	≥ 8	-	≤ 240	For components of high strength with small cross section/higher degree of purity
GS 36 CrNiMo 4	1.6511	DIN EN 10083 EN 10297	Quenched and tempered	≥ 900	1100-1300	≥ 8	-	248	Quenched and tempered cast steel for components subject to high stress with good full quenching and subsequent drawing up to 50 mm wall thickness; parts subject to highest amounts of stress used in the construction of vehicles
30 CrNiMo 8	1.6580	DIN EN 10083 P1 - P2	Quenched and tempered	≥ 800	1000-1200	≥ 8	-	248	Quenched and tempered cast steel for large cross sections; full quenching and subsequent drawing up to 100 mm wall thickness possible; high toughness and elasticity
67 SiCr 5	1.7103	DIN EN 10132 P - P4	Quenched and tempered	≥ 1320	1450-1650	≥ 3	-	240	Castings subject to impact and bending stress with small cross section
60 SiCr 7	1.7108	DIN EN 10089	Quenched and tempered	~ 1100	1350-1550	≥ 4	-	≤ 240	Highly quenched and tempered components with high requirements in terms of spring characteristics
GS 25 CrMo 4	1.7218	DIN 17205	Quenched and tempered	≥ 600	750-900	≥ 10	-	215	Aeronautical parts as well as parts used in mechanical engineering and apparatus construction; for further data, see WL 1.7254
	1.7254	WL 1.7254		≥700	900-1100	≥ 9	≥ 265 HV	215	
GS 34 CrMo 4	1.7220	DIN 17205	Quenched and tempered	≥ 700	850-1000	≥ 10	-	200	High-strength quenched and tempered cast steel; wall thickness < 50 mm
GS 42 CrMo 4	1.7225	DIN 17205	Quenched and tempered	≥ 800	900-1100	≥ 10	-	240	Universal, high-strength quenched and tempered cast steel with average requirements in terms of toughness
42 CrMo S4	1.7227	DIN EN 10083 P1 - P2	Quenched and tempered	≥ 750	850-1050	≥ 8	-	240	Equivalent to material 1.7225; good machinability due to modified sulphur content
GS 50 CrMo 4	1.7228	DIN EN 10083 P1 - P2	Quenched and tempered	≥ 800	1050-1250	≥ 5	-	245	Quenched and tempered cast steel equivalent to 1.7225; however, with higher strength
15 CrMoV 69	1.7744	WL 1.7744	Quenched and tempered	≥ 800	1000-1150	≥ 10	≥ 290	220	Aeronautical material with high heat-treated strength for temperatures from –75°C to approx. 500°C
			Quenched and tempered	≥ 930	1030-1180	≥ 10		≥ 310	
15 CrMoV 59	1.8521	DIN 17211	Quenched and tempered	≥ 900	1000-1150	≥ 10	≥ 300	220	Steel with good weldability even in quenched and tempered state; nitriding steel for machine parts subject to wear
GS 50 CrV 4	1.8159	SEW 835	Quenched and tempered	≥ 850	1100-1250	≥ 6	≥ 330	245	Highly wear-resistant quenched and tempered steel with good toughness characteristics
58 CrV 4	1.8161		Quenched and tempered	≥ 1000	≥ 1200	≥ 5	-	235	Components with maximum wear resistance; also spring steel; cog toothed wheels, shafts
31 CrMoV 9	1.8519	DIN 17211	Quenched and tempered	≥ 900	≥ 1050	≥ 10	-	248	Quenched & tempered and nitriding steel for wear parts subject to high stress up to approx. 100 mm wall thickness
	1.8514	WL 1.8514							

Refractory steels

Designation	Material no.	Standard	Typical heat treatment state	Mechanical and technological characteristics				Notched-bar impact work (ISO-V)	Thermal expansion between 20 and 300°C	Intended use/ Particular application examples
				0.2% proof stress		Tensile strength Rm (MPa)	Percent elongation at failure A_5 (%)	(J)	α (10-6 K-1)	
				20°C	590°C					
G X 20 CrCoMoV 12 21	1.4912	-	Quenched and tempered	-	≥ 340	780-980	≥ 10	-	-	Heat-resisting castings resistant to pressurized hydrogen for the chemical industry; $Rp_{0.2}$ at least 340 MPa at 500°C
GS C 25	1.0619	DIN 17245 EN 10213	Quenched and tempered	≥ 245	-	440-590	≥ 22	≥ 27	13.4	Fittings
G X 22 CrMoV 12 1	1.4931	EN 10213 EN 10293	Quenched and tempered	≥ 590	≥ 340	740-880	≥ 15	≥ 21	11.5	Turbine construction; components that are exposed to rapid temperature changes (temperature shock)
G X 15 CrNiCo 21 20 20	1.4957	WL 1.4957	Raw casting	-	≥ 250	650-850	≥ 10	-	15.8	Aeronautics; turbines/air blades, combustion chambers, valves; up to approx. 730°C; for further data, see supplement 1 to 1.4957; non-scaling up to approx. 980°C; high-temperature; stainless
	1.4971	ASTM A567	Or annealed							
GS 16 CrMo 4	1.7242	-	Quenched and tempered	≥ 345	-	540-690	≥ 15	-	-	For castings up to max. 530°C application temperature can also be used as case-hardening steel
GS 17 CrMo 55	1.7357	EN 10213 EN 10293	Quenched and tempered	≥ 315	≥ 180	490-640	≥ 20	≥ 27	13.4	Turbine construction, pressure vessels, steam boiler construction
GS 17 CrMoV 5 11	1.7706	EN 10213	Quenched and tempered	≥ 440	≥ 300	590-780	≥ 15	≥ 27	13.4	

Stainless and corrosion-resistant steels, ferritic/austenitic

Designation	Material no.	Standard	Typical heat treatment state	Mechanical and technological characteristics			Notched-bar impact work (ISO-V)	Thermal expansion between 20 and 300°C	Intended use/ Particular application examples
				0.2% proof stress $Rp_{0.2}$	Tensile strength Rm (MPa)	Percent elongation at failure A_5 (%)	(J)	α (10-6 K-1)	
G X 6 Cr NiN 26 7	1.4347	EN 10283	Solution heat treated and quenched	≥ 420	590-790	≥ 20	≥ 30	14.5	Parts that require toughness with higher proof stress compared to austenitic steels with partially identical or better corrosion resistance, suitable filler material 1.4462, pump housing
G X 2 CrNiMoN 26 7 4	1.4469 J93404	EN 10213 EN 10283 ASTM A 995	Solution heat treated and quenched	≥ 480	≥ 650	≥ 22	≥ 50		For heavy exposure to corrosion, sea or brackish water, operating temperature up to 300°C
G X 2 CrNiMoN 22 5 3	1.4470 J92205	SEW 400 EN 10283 ASTM A 995	Solution heat treated and quenched	≥ 420	≥ 600	≥ 20	≥ 30	13	Chemical and petro-chemical industry, high resistance to stress-crack corrosion in media containing chlorine; similar to 1.4462
G X 2 CrNiMoCuN 25 6 3 3	1.4517	EN 10283	Solution heat treated and quenched	≥ 480	650-850	≥ 22	≥ 50	14.9	Chemical and petro-chemical industry, flue gas desulfurization; resistant to non-oxidizing acids, e.g. sulphuric acid

Stainless and corrosion-resistant steels, ferritic/martensitic

Designation	Material no.	Standard	Typical heat treatment state	Mechanical and technological characteristics			Notched-bar impact work (ISO-V)	Annealing hardness	Intended use/ Particular application examples
				0.2% proof stress $Rp_{0.2}$	Tensile strength Rm (MPa)	Percent elongation at failure A_5 (%)	(J)	(HB)	
G X 12 Cr 13 G X 12 Cr 12	1.4006 1.4011 J91150	DIN 17440 EN 10283 ASTM A743	Quenched and tempered	≥ 420	600-800	-	-	170-210	As 1.4008 but with slightly higher strength; suitable welding filler 1.4009
G X 8 CrNi 13 G X 7 CrNiMo 12 1	1.4008	DIN 17445 EN 10283	Quenched and tempered	≥ 44	590-790	≈15	27	170-240	Resistant to humidity, water, steam; pump parts, running wheels, running wheel blades; suitable welding filler 1.4009
X 6 Cr 17	1.4016	DIN 17440	Quenched and tempered	≥ 270	450-600	≈15	-	-	Castings with higher corrosion resistance compared to 1.4008; suitable welding filler 1.4302; good polishing properties
G X 20 Cr 14	1.4027	DIN 17445 SEW 410	Quenched and tempered	≥ 440	590-790	≈12	-	170-240	For parts that must be resistant to humidity, steam, water and frequent handling. Suitable welding filler 1.4009
X 46 Cr 13	1.4034	DIN 17440	Quenched and tempered	-	-	-	-	(55 HRC)	Heat-treatable cast steel for cutting tools, measuring tools, wear parts
G X 22 CrNi 17	1.4059	DIN 17445 SEW 410	Quenched and tempered	≥ 590	780-980	≈4	-	230-300	Corrosion-resistant, heat-treatable cast steel, e.g. for tow bars
X 14 CrMoS 17	1.4104	DIN 17440 SEW 310	Quenched and tempered	≥ 550	750-950	-	-	225-275	As 1.4016. For castings that require elaborate, mechanical finishing. Welding not recommendable
X 90 CrMoV 18	1.4112	SEW 400	Quenched and tempered	-	-	-	-	(57 HRC)	Wear parts, scale pans and cutting
X 20 CrMo 13	1.4120	DIN 17442 SEW 400	Annealed or quenched and tempered	≥ 500	750-850	≈10	-	220-280	Turbine blades, valve cones, superheated steam distributors for temperatures up to 500°C, suitable welding filler 1.4302 as well as for medical instruments
G X 35 CrMo 17	1.4122	DIN 17442 SEW 400	Annealed or quenched and tempered	≥ 500	750-850	≈10	-	220-280	Parts for optical devices, medical instruments and measuring devices
G X 5 CrNi 13 4	1.4313	DIN 17445	Quenched and tempered Stage 1	≥ 550	760-960	≈15	≥ 50	240-300	Water turbines and pump parts, suitable filler material 1.4351
G X 4 CrNi 13 4	1.4317 J91540	EN 10283 ASTM A743	Stage 2	≥ 830	900-1100	≈12	≤ 35	280-350	
G X 5 CrNiMo 16 5 1	1.4405	SEW 410 EN 10283	Quenched and tempered	≥ 540	760-960	≈15	≥ 60	-	For parts with increased corrosion resistance compared to 1.4313; suitable welding filler 1.4405
X 90 CrCoMoV 17	1.4535	-	Hardened	-	-	-	-	(59 HRC)	Blades with high cutting hardness and chemical resistance
17/4 PH	1.4549	WL 1.4549	Precipitation-hardened .4 .6	≥ 830-1100	≥ 900-1240	≈8	-	(30 HRC)	Precipitation-hardened, stainless cast steel of high strength; aeronautical material
G X 4 CrNiCuNb 16 4	1.4540	AMS 5342				≈6		(40 HRC)	
15/5 PH	1.4524	AMS 5346 WL 1.4524	Precipitation-hardened .4 .6	≥ 830-1100	≥ 900-1200	≈8 ≈6	-	(30 HRC) (38 HRC)	Precipitation-hardened, stainless cast steel of high strength; aeronautical material

Stainless and corrosion-resistant steels, austenitic

Designation	Material no.	Standard	Typical heat treatment state	Mechanical and technological characteristics			Notched-bar impact work (ISO-V)	Annealing hardness	Intended use/ Particular application examples
				0.2% proof stress $Rp_{0.2}$	Tensile strength Rm (MPa)	Percent elongation at failure A_5 (%)	(J)	(HB)	
X 8 CrNiS 18 9	1.4305	DIN 17440 EN 10088	Solution heat treated and quenched	≥ 175	440-640	≈20	-	130-200	As 1.4308. For castings with extensive mechanical machining, primarily thread cutting; welding not recommendable
G X 2 CrNiN 18 9 X 2 CrNi 19 11	1.4306	SEW 410 EN 10088	Solution heat treated and quenched	≥ 205	440-640	≈30	80	130-200	Fittings and parts for pumps, centrifuges, etc.; suitable welding filler 1.4302, 1.4551, 1.4316; food processing industry, dairies, beverage industry; similar to 1.4309 and 304 L
G X 6 CrNi 18 9 G X 5 CrNi 19 10	1.4308	DIN 17445 EN 10283	Solution heat treated and quenched	≥ 175	440-640	≈30	60	130-200	Frequently used "V2A" quality; similar forging quality to 1.4301 and 304; fittings, pumps, food processing industry, dairies
X 5 CrNiMo 17 12 2	1.4401	DIN 17440	Solution heat treated and quenched	≥ 185	440-640	≈20	60	130-200	Castings with identical corrosion resistance and forging quality, but lower strength; as a casting material standardised under 1.4408; similar to 316 L
G X 2 CrNiMoN 18 10 X 2 CrNiMo 17 12 2	1.4404	SEW 410 EN 10088	Solution heat treated and quenched	≥ 205	440-640	≈30	80	130-200	Castings for which resistance to intergranular corrosion is paramount. After welding, no renewed heat treatment required; suitable welding filler 1.4430, 1.4576; similar to 1.4409 and 316 L
G X 2 CrNiMo 19 11 2	1.4409	EN 10283	Solution heat treated and quenched	≥ 195	440-640	≈30	80	130-200	Similar to 316 L; castings with increased resistance to intergranular corrosion after welding without further processing
G X 6 CrNiMo 18 10 G X 5 CrNiMo 19 11 2	1.4408	EN 10213 EN 10283	Solution heat treated and quenched	≥ 185	440-640	≈20	60	130-200	Castings for the pulp, textile and chemical industry; fittings, pumps; suitable welding filler 1.4403
X 2 CrNiMoN17 13 5	1.4439	DIN 17445 EN 10088	Solution heat treated and quenched	≥ 210	490-630	≈20	50	130-200	Good intergranular corrosion resistance, resistant in high chlorine concentrations and temperatures, good pitting resistance, chemical industry
X 2 CrNiMo 18 14 3	1.4435 S31603 CF3M	DIN 17440 MR 0175 ASTM A 743	Solution heat treated and quenched	≥ 200	500-700	≈30	50	≤ 215	Material in accordance with NACE MR 0175. Similar to 1.4439, 316 L
G X 6 CrNiMo 17 13	1.4448	DIN 17445 EN 10283	Solution heat treated and quenched	≥ 185	440-640	≈20	60	130-200	Higher chemical resistance, good pitting resistance in the presence of chlorine ions; fittings and apparatus construction
X 1 NiCrMoCuN 25 20 5	1.4539	SEW 400	Solution heat treated and quenched	-220	-	(≈35)	(80)	-	Good resistance to pitting and stress-crack corrosion; full austenite; especially suitable for use in seawater; similar to 1.4584/1.4529
G X 1NiCrMoCuN 25 20 5	1.4538			≥ 185	≥ 450	≈30	60		
G X 5 CrNiNb 18 9 G X 5 CrNiNb 19 11	1.4552	EN 10213 EN 10283	Solution heat treated and quenched	≥ 175	440-640	≈20	35	130-200	Castings in the food processing, film, photo, paint, soap, paper, textile and saltpetre industry; suitable welding filler 1.4551
G X 5 CrNiMoNb 18 10 G X 5 CrNiMoNb 19 11 2	1.4581	WL 1.4581 EN 10283	Solution heat treated and quenched	≥ 185	440-640	≈20	35	130-200	As 1.4552; suitable welding filler 1.4576
X 45 CrNiW 18 9	1.4873	DIN 17480	Solution heat treated and quenched	-	-	-	-	-	For thin-walled castings with good heat resistance; as a forging material standardised in DIN 17 480
G X 6 CrNi 18 10	1.6902	SEW 685	Solution heat treated and quenched	≥ 180	440-640	≈20	80	130-200	Cryogenic cast steel in accordance with SEW 685; notched-bar impact work at –196°C at least 50 J.; (Iso-V) –253°C at least 27 J.

Refractory steels

Designation	Material no.	Standard	Typical heat treatment state	Mechanical and technological characteristics			Notched-bar impact work (ISO-V)	Annealing hardness	Intended use/ Particular application examples
				0.2% proof stress $Rp_{0.2}$	Tensile strength Rm (MPa)	Percent elongation at failure A_5 (%)	(J)	(HB)	
G X 40 CrSi 13	1.4729	DIN 17465 / EN 10295	Annealed	-	490-750	≈4	-	200-300	For parts in industrial furnace construction
G X 25 CrNiSi 18 9	1.4825	DIN 17465 / EN 10295	Raw casting or annealed	≥ 230	≥ 450	≥ 15	-	130-200	For parts in industrial furnace construction
G X 15 CrNiSi 25 20	1.4840	SEW 595	Raw casting or annealed	205	440-640	15	-	≤ 230	For parts in furnace and apparatus construction up to 1100°C in oxidizing atmospheres
G X 40 CrNiSi 25 20	1.4848	SEW 595 / EN 10295	Raw casting or annealed	≥ 220	≥ 450	≥ 8	-	150-220	For parts subject to minimal mechanical stress up to approx. 900°C
G X 40 NiCrSi 38 18	1.4865	DIN 17465 / EN 10295	Raw casting or annealed	≥ 220	≥ 420	≥ 8	-	150-220	For parts in industrial furnace construction

Special materials, non-magnetizable

Designation	Material no.	Standard	Typical heat treatment state	Mechanical and technological characteristics			Notched-bar impact work (ISO-V)	Annealing hardness	Intended use/ Particular application examples
				0.2% proof stress $Rp_{0.2}$	Tensile strength Rm (MPa)	Percent elongation at failure A_5 (%)	(J)	(HB)	
G X2 CrNiMoN 18 14	1.3952	SEW 395 / WL 1.3952	Solution heat treated and quenched	≥ 240	490-690	≥ 30	≥ 80	130-200	Non-magnetic casting material (VG 81236); resistant to intergranular corrosion; can be welded
G X12 CrNi 18 11	1.3955	SEW 395 / WL 1.3955	Solution heat treated and quenched	≥ 195	440-590	≥ 20	≥ 80	150-190	Non-magnetic casting material (VG 81236), can be welded
G X2 CrNiMnMoN Nb 21 16 5 3	1.3964	SEW 395 / WL 1.3964	Solution heat treated and quenched	≥ 315	570-800	≥ 20	≥ 65	130-200	Non-magnetic casting material (VG 81236); very good corrosion resistance; particularly resistant to intergranular corrosion; can be welded, subsequent heat treatment not required

Cobalt and nickel-based alloy

Designation	Material no.	Standard	Typical heat treatment state	Mechanical and technological characteristics			Notched-bar impact work (ISO-V)	Hardness	Intended use/ Particular application examples
				0.2% proof stress $Rp_{0.2}$	Tensile strength Rm (MPa)	Percent elongation at failure A_5 (%)	(J)		
G X 55 CoCrNiW 55 25 (G CoCr 25 NiW)	2.4682	WL 2.4682	Raw casting	≥ 440	590-790	≥ 5	-	≥ 330 HV -	High-temperature casting material, non-scaling up to approx. 1150°C, corrosion-resistant, suitable for welding; for further details, see WL 2.4682
G CoCr 26 Ni 9 Mo 5 W	2.4681	-	Raw casting	-	-	-	-	-	Highly wear-resistant cobalt-based alloy; good resistance to aggressive, oxidizing and reducing media, even at increased temperatures
G X 25 CoCrNiW 55 25 (X 45)	-	-	Raw casting or heat-treated	-	At 820°C ≥ 210	At 820°C ≥ 16	-	-	Modification of material 2.4682 with reduced cobalt content, better weldability
G NiCr 15 Fe (Inconel 600)	2.4816	DIN 17742	Raw casting or solution heat treated and quenched	≥ 175	490-640	≥ 15	-	-	Nickel-based material for corrosive media; resistant to oxidation even at higher solution heat treated temperatures (1100°C)
G NiCr 22 Mo 9 Nb (Inconel 625) ASTM A 494	2.4856 N26625	DIN 17744 ASTM A494	Raw casting or solution heat treated and quenched	≥ 275	≥ 485	≥ 25	-	-	Good oxidation and corrosion resistance; relatively high strength and toughness from low temperatures up to 1100°C; non-magnetic µr 1.0006

Maraging steels and special materials (on request)

Designation	Material no.	Standard	Typical heat treatment state	Mechanical and technological characteristics		
				0.2% proof stress $Rp_{0.2}$	Tensile strength Rm (MPa)	Elongation at break A_5 (%)
G-X2 NiCoMoTi 17 10 Aeronautical material (LW)	1.6351	WL 1.6351	Solution heat treated and age-hardened	≥ 1450	≥ 1600	≥ 4
G-X2 NiCoMo 18 95	1.6358		Solution heat treated and age-hardened	≈ 1500	≈ 1600	≥ 4
G-X2 NiCoMo 18 85 Aeronautical material (LW)	1.6359	WL 1.6359	Solution heat treated and age-hardened	≈ 1500	≈ 1600	≥ 4

High corrosion-resistant alloys (Hastelloy)

Designation	Material no.	Standard	Typical heat treatment state	Mechanical and technological characteristics			Notched-bar impact work (ISO-V)	Hardness	Intended use/ Particular application examples
				0.2% proof stress $Rp_{0.2}$	Tensile strength Rm (MPa)	Percent elongation at failure A_5 (%)	(J)		
G NiMo 16 Cr 16 Ti HASTELLOY C4	2.4610	ASTM A494 VDTÜV 424	Cast state or solution heat treated and quenched	280	550	≈35	-	≤ 200	Good intergranular corrosion resistance; very good resistance to crevice, pitting and stress-crack corrosion and quenched very good resistance to mineral acids
G NiCr 22 Fe 18 Mo HASTELLOY X	2.4665	ASTM A 567 WL 2.4665	Cast state or solution heat treated and quenched	At 20°C -250	20°C - 550 820°C - 240	20°C - ≈30 820°C - ≈12	-	≤ 250	High-temperature nickel alloy; very good resistance to oxidizing, carburizing and nitriding gases. Non-scaling in air up to approx. 1200°C. Castings for heat treatment systems and stationary gas turbines
G CoCr 26 Ni 9 Mo 5 W	(2.4681)	-	Cast state	-	-	-	-	-	Highly wear-resistant cobalt-based alloy; good resistance to aggressive, oxidizing and reducing media even at increased temperatures
G NiCr 20 Mo 15 C22	2.4697		Cast state or solution heat treated	280	500	≈12	-	140-200	Corrosion resistance, nickel-chromium-molybdenum alloy. Particularly resistant to flue gas and sulphuric acid, even at increased temperatures
G NiMo 16 Cr 15 W HASTELLOY C 276	2.4819	VDTÜV WB 400 DIN 17744	Cast state or solution heat treated and quenched	250	600	≈20	-	-	Outstanding resistance to crevice, pitting and stress-crack corrosion. Very good resistance to oxidizing and reducing media. Castings for chemical engineering, flue gas desulfurization systems
G NiMo 16 Cr HASTELLOY C	2.4883	ASTM A494	Cast state	20°C -275	20°C -500 820°C -340	20°C -≈4 820°C -≈10		≤ 230	Highly corrosion-resistant nickel-based material. Resistant to oxidizing and reducing atmospheres up to 1100°C. Very good seawater resistance
G CoCr 20 Ni 20 W	2.4989	ASTM A567	Cast state	-	-	-	-	-	Cobalt-based material with good corrosion resistance up to approx. 900°C. Used in gas turbines and other components with exposure to corrosion at higher temperatures

Soft magnetic materials

Designation	Material no.	Standard	Typical heat treatment state	Properties				Annealing hardness	Intended use/ Particular application examples
				ρ g/cm³	Curie temp.	BS T	ρE µΩ · cm	(HB)	
5 Si 2	-		Annealed	7.6	750°C	2.0	50	130-200	Pole shoes, back network parts, pole cores in electromagnets, components for magnetic circuits in electrical engineering
Fe Si 3	1.0884	DIN 17405	Annealed	7.6	750°C	2.0	45	130-200	

High-temperature alloys

Designation	Material no.	International designation	Typical heat tre-atment state	Mechanical and technological characteristics			Strength properties at higher temperatures in MPa				
				0.2% proof stress $Rp_{0.2}$	Tensile strength Rm (MPa)	Percent elongation at failure A_5 (%)	Temperature in °C		700	800	900
Inconel 718	2.4668	IN 718	Solution heat treated and age-hardened	≥ 760	≥ 860	≥ 5					
Inconel 713 LC	WL 2.4670	IN 713 LC	Raw casting	≥ 780	≥ 830	≥ 4	0.2% limit		670	620	400
							Creep rupture strength	1000 h		440	225
								10,000 h	430	170	85
Inconel 713 C	WL 2.4671	IN 713	Raw casting	≥ 690	≥ 760	≥ 3	0.2% limit		670	620	400
							0.2% creep strain limit in tensile test	100 h	500	300	140
								1000 h	400	230	90
								10,000 h	280	120	45
							1% creep strain limit in tensile test	100 h	590	360	190
								1000 h	490	280	125
								10,000 h	350	180	70
							Creep rupture strength	100 h	550	430	225
								1000 h	550	320	155
								10,000 h	400	220	90
Inconel 601	2.4851	IN 601	Raw casting								
C 263	WL 2.4671	C 263	Solution heat treated and age-hardened	≥ 430	≥ 620	≥ 12					
Udimet 500	2.4983	Udimet 500	Solution heat treated and age-hardened	≥ 750	≥ 900	≥ 3	0.2% limit		670	640	420
							Creep rupture strength	100 h	590	370	190
								10,000 h	330	160	70
Inconel 738 LC		IN 738 LC	Solution heat treated and age-hardened	≥ 830	≥ 930	≥ 3	0.2% limit		700	420	250
							Creep rupture strength	100 h	600	260	130
								1000 h	490	190	90
								10,000 h	360	180	50
Inconel 100	WL 2.4674	IN 100	Raw casting	≥ 660	≥ 790	≥ 5	0.2% limit			620	450
							Creep rupture strength	100 h		510	300
								10,000 h		405	200
GMR 235		GMR 235	Raw casting	≥ 620	≥ 700	≥ 5	Creep rupture strength at 870°C (60h) Hardness 30–40 HRC RT)				190 N/mm²; ≥ 10% elongation
MAR M246	WL 2.4676	MAR M246 2.4676	Raw casting	≥ 620	≥ 780	≥ 2	0.2% limit				
							Creep rupture strength	100 h	685	590	340
								1000 h	615	490	230

Tool steels

Designation	Material no.	Standard	Typical heat treatment state	Chemical composition (approximate values %)								Properties		Intended use/Particular application examples
				C	Si	Mn	Cr	Mo	V	W	Other	Hardness (HRC)	Annealing hardness (HB)	
Zollern Super V + Co			Hardened	1.4	0.3	0.4	4.0	3.0	5.1	6.0	Co 7.0	65	300	High-speed steel specially developed for investment casting with 3% VC, high heat resistance
Zollern Super V			Hardened	1.5	0.3	0.4	4.0	3.0	5.1	6.0	-	65	300	High-speed steel specially developed for investment casting with 3% VC
145 Cr 6	1.2063		Hardened	1.5	0.2	0.6	1.4	-	-	-	-	64	230	As 1.2067, but higher wear resistance; reamers, dies
100 Cr 6	1.2067	DIN EN ISO 4957	Hardened	1.0	0.2	0.3	1.5	-	-	-	-	64	230	Wear-resistant tool steel, also for parts with high Hertzian contact stress, telescopic type ball bearing travellers, etc.
X 210 Cr 12	1.2080	DIN EN ISO 4957	Hardened	2.1	0.3	0.2	11.5	-	-	-	-	63	250	High-performance cutting and punching tools, high wear resistance
115 CrV 3	1.2210	DIN EN ISO 4957	Hardened	1.2	0.3	0.3	0.7		0.1	-	-	64	220	Wear-resistant tool steel, similar to 1.2067
40 CrMnMoS 8-6	1.2312	DIN EN ISO 4957	Quenched and tempered	0.4	0.4	1.5	1.9	0.2		-	-	-	230	Tools for plastics processing; tool steel with good machining properties and of high strength and toughness; usually supplied in quenched and tempered state with a height of approx. 300 HB
G X 38 CrMoV 5 1	1.2343	DIN EN ISO 4957	Hardened	0.4	1.0	0.4	5.2	1.3	0.4	-	-	50	235	High-temperature tool steel for all non-cutting functions; working hardness 1180–1770 N/mm²
G X 40 CrMoV 5 1	1.2344	DIN EN ISO 4957	Hardened	0.4	1.0	0.4	5.2	1.3	1.0	-	-	51	230	High-temperature and wear-resistant tool steel; working hardness 1180–1770 N/mm²
G X 100 CrMoV 5 1	1.2363		Hardened	1	0.3	0.5	5.1	1.0	0.2	-	-	63	230	Cutting and punching tools for average material thicknesses, cutting dies
G X 155 CrVMo 12 1	1.2379	DIN EN ISO 4957	Hardened	1.5	0.3	0.2	11.5	0.7	1.0	-	-	64	250	Dimensionally stable, super-speed steel for higher toughness stress
105 WCr 6	1.2419	DIN EN ISO 4957	Hardened	1.1	0.3	0.9	1.0	-	-	1.2	-	65	230	Knife steel for cutting textiles, paper and plastics; measuring tools
X 210 CrW 12	1.2436	DIN EN ISO 4957	Hardened	2.1	0.3	0.3	11.5	-	-	0.7	-	64	250	As 2080, but even higher wear resistance
45 WCrV 7	1.2542		Hardened	0.5	1.0	0.3	1.1	-	0.2	2.0	-	57	225	As 1.2542, but higher toughness yet slightly lower wear resistance
60 WCrV 7	1.2550	DIN EN ISO 4957	Hardened	0.6	0.6	0.3	1.1	-	0.2	2.0	-	66	265	Components and tools with good resistance to wear, impact and pressure; hand tools, bodies and shafts of progression tools
142 WV 13	1.2562		Hardened	1.4	0.2	0.3	0.3	-	0.3	3.0	-	66	265	Highly wear-resistant tool steel, similar to 1.2067
X 165 CrMoV 12	1.2601		Hardened	1.7	0.3	0.3	11.5	0.6	0.3	0.5	-	63	250	Steel resistant to corrosion to a limited extent for plate, wire, punching and cutting tools. Tools for moulding ceramic shells
G X 19 NiCrMo 4	1.2764	DIN EN ISO 4957	Case-hardened	0.2	0.3	0.3	1.3	0.2	-	-	Ni 4.0	61	250	Case-hardening steel for maximum requirements in terms of through hardenability; heat-resisting, very wear-resistant
X 45 NiCrMo 4	1.2767	DIN EN ISO 4957	Hardened	0.5	0.3	0.3	1.3	0.3	-	-	Ni 4.0	56	260	Tool steel with maximum toughness. Only for parts with minimal straightening work; without mechanical finishing
90 MnCrV 8	1.2842	DIN EN ISO 4957	Hardened	0.9	0.3	2	0.3	-	0.1	-	-	64	220	Cutting and punching tool, small shear blades, higher toughness compared to 1.2060, 1.2067, 1.2419, 1.2210, yet slightly reduced wear resistance
X 210 CrCoW 12	1.2884		Hardened	2.1	0.3	0.3	12	0.4	-	0.7	Co 1.0	65	260	As 1.2080, but higher heat and wear resistance
X 79 WCo 18 5 HS 18 1 2 5	1.3255	DIN EN ISO 4957	Hardened	0.8	0.4	0.2	4.1	0.7	1.5	18.0	Co 4.9	65	300	Outstanding cutting power and toughness for heavy-duty workshop activities
X 85 WMo 7 5 HS 6 5 2	1.3343	DIN EN ISO 4957	Hardened	0.9	0.4	0.2	4.1	5.0	1.9	6.5	-	64	280	High-speed steel for chip breakers, push-type keyway broaches, heads of barrel extruders, etc.

Stellite and other high wear-resistant materials

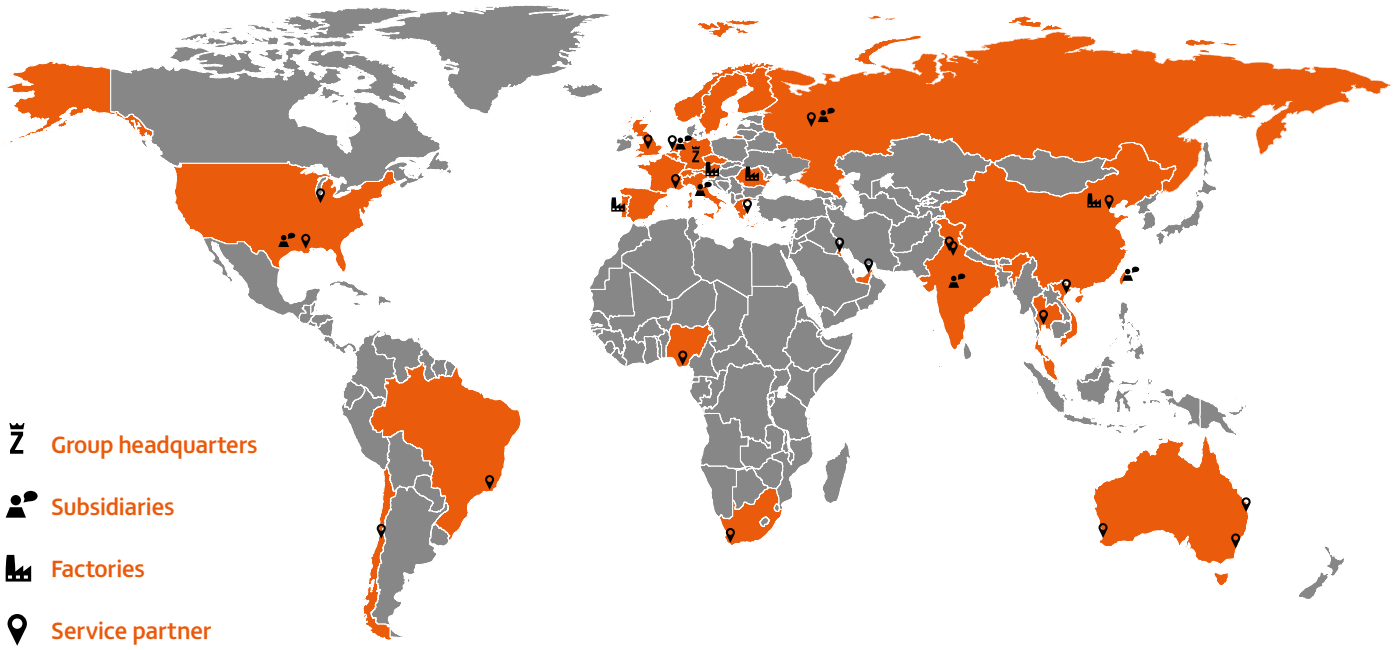
Designation	Material no.	Standard	Typical heat treatment state	Chemical composition (approximate values %)										Hardness	Intended use/Particular application examples
				C	Si	Mn	Cr	Ni	Mo	Co	W	Fe	V	(HRC)	
G X 170 CoCrW 35 25	-	-	Raw casting	1.7	2.5	0.5	25.0	-	-	33.0	6.0	Base			Wear-resistant material similar to stellite no. 156
G X 175 CoCrW 57 29	-	-	Raw casting	1.6	0.8	0.6	30.0	-	-	Base	11.0	≤			Wear-resistant material similar to stellite no. 19
G X 250 CoCrW 48 33 Stellite 1	-	-	Raw casting	2.5	1.2	0.3	33.0	-	-	Base	14.5	≤		54–60	High wear-resistant material; for hot press dies. Hot hardness at 700°C approx. 36 HRC
SCo 65	-	-	Raw casting	1.0	≤ 2.2	≤ 1.3	26.0	≤ 1.4	≤ 2.2	Base	5.0	≤			The alloys mentioned here can be openly smelted and solidify with as-rolled hardness. Their structure must not be affected or modified by heat treatment. With only minimal toughness values, this material group features a number of favourable properties. As cobalt-based alloys, they are non-magnetizable, high corrosion-resistant and high wear-resistant; cobalt-based hard alloys have a relatively low hardness, which is caused by the austenitic matrix. The high wear resistance is based on the strain hardening of the matrix and on the very hard carbides embedded in it. This provides them with a higer wear resistance than hardened tool steels. Cobalt-based hard alloys can be brazed, but welding is not recommended
Stellite 4	-	-	Raw casting	1.1	≤ 1.0	≤ 0.2	33.0	-	-	Base	13.0	≤		45–50	
G CoCr 30 W 4 Stellite 6	-	-	Raw casting	1.1	≤ 1.5	≤ 1.0	30.0	≤ 3.0	≤ 1.5	Base	4.5	≤		39–43	
Stellite 7	-	-	Raw casting	0.4	≤ 1.0	≤ 1.0	26.5	-	-	Base	6.0	≤		30–35	
Stellite 3	-	-	Raw casting	2.3	≤ 1.5	≤ 1.0	30.0	≤ 3.0	≤ 1.5	Base	12.5	≤		51–58	

Alloys for medical implants

Designation	Material no.	Chemical composition (approximate values %)							As-delivered state Heat treatment	Mechanical and technological properties		
		C	Cr	Mo	Ni	Co	N_2	Fe		Rp 0.2 (MPa)	Rm (MPa)	A5 (%)
ZOLLERN "Super N"		0.20	29.0	6.5	0.5	Base	0.2	≤ 0.70	Solution heat treated and quenched	530-600	900-1000	18-27
F 75 Co-Cr-Mo	UNS R30075 ASTM F75	0.35	27-30	5-7	1	Remainder	0.25	0.75	Solution heat treated and quenched	450 - 840	660 - 1280	8-20

Aluminium

Designation	Material no.	Standard	Typical heat treatment state	Mechanical and technological characteristics			Hardness	Resistance to		Remark
				0.2% proof stress $Rp_{0.2}$	Tensile strength Rm (MPa)	Percent elongation at failure A_5 (%)	(HB)	Atmospheric influences	Seawater	
GF-AlSi7Mg0.6 A 357	3.2384.6 Part 3	AMS-A-21180 A-S7G06 EN AC-42200 EN 1706	T6	200-230	260-290	2-4	75	Excellent	Good	Very good castability, can be welded, corrosion-resistant
GF-AlSi7Mg0.6 A 357 (SOPHIA)	3.2384.6 Part 4	AMS-A-21180 A-S7G06 EN AC-42200 EN 1706	T6	240-270	310-330	2-4	> 80	Excellent	Good	Higher strengths, very good castability, can be welded, corrosion-resistant
GF-AlCu4Ag1MgTi K 01 A 201	-	AMS 4228	T6 T7	345 390	410 430	5 3	115 115	-	Not suitable	Difficult to cast
GF-AlMg5	3.3561	DIN 1725 EN1706	T0	90	130	2	55	Excellent	Excellent	Satisfactory castability, corrosion-resistant
GF-AlSi5Cu1.3Mg C 355	3.2134.6	-	-	240-290	280-300	0 - 1	>75	-	-	Higher strength values than typical Sophia values Difficult to weld (copper content)
GF-AlSi7Cu1Mg0.6 RR 350	WL 3.1754 Part 1	-	-	160	185	0.5	-	-	Not suitable	Difficult to weld Difficult to cast Heat-resisting up to approx. 300°C



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