DELCROME 316

DELCROME™ 316/316L Alloy

TECHNICAL DATA

CASTING I ADDITIVE MANUFACTURING I HVOF & PLASMA SPRAY DEPOSITION I PTA & LASER WELD DEPOSITION

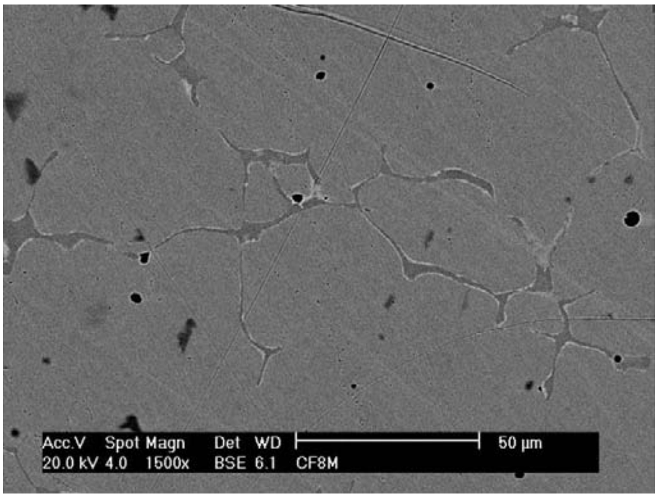
NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Alloy	Fe	C	Cr	Ni	Others	Hardness	Density	Melting Range
DELCROME 316	Base	Max 0.08	17	12.5	Mo, Si, Mn	260–316 DPH	7.87 g/cm³ 0.284 lb/in³	1375–1400°C 2507–2552°F
DELCROME 316L	Base	Max 0.03	18	13	Mo, Si, Mn	~180 DPH	8.00 g/cm³ 0.288 lb/in³	1390–1440°C 2534–2625°F

DELCROME ALLOYS are iron-based alloys with grades ranging from 316 and 410 stainless steels to much harder, wear-resistant, white cast irons. Delcrome alloy grades can be suitable for addressing general-purpose wear applications, with the harder grades typically used where abrasive wear is the primary concern.

DELCROME 316 is an austenitic general-purpose stainless steel. It offers corrosion and oxidation resistance up to 750ºC (1380ºF). It is often used in component restoration and is easily machined. **DELCROME 316L** is used more often where susceptibility to corrosion is a concern, particularly if the method of application is welding.

DELCROME 316/316L can both be cast and are useful for material build-up and in PTA applications as a buttering layer. Typical applications include pump sleeves, tank linings, exhaust fans and blowers, compressor rods, plungers, hydraulic rams, paper mill rolls, pump impellers, cylinder bores, mixer blades, drive shafts, and furnace equipment.



Delcrome 316 (As-Cast) Microstructure at 1500X

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)
µm/m K	16.0	16.5	17.0	17.5	18.0	18.3	18.6	19.0
µ-inch/inch °F	28.8	29.7	30.6	31.5	32.4	32.9	33.5	34.2

KENNAMETAL STELLITE

www.stellite.com

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress		Elongation	Elastic Modulus	
As-Cast	**ksi**	**MPa**	**ksi**	**MPa**	**A(%)**	**ksi**	**GPa**
316/316L	70	517	30	207	30	29,000	200

THERMAL AND ELECTRICAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal Conductivity	14.6 W/m K	101 BTU-in/hr/ft²/°F
Electrical Resistivity	74 μ-ohm cm	29.1 μ-ohm inch

AVAILABLE PRODUCT FORMS

DELCROME 316/316L is available as a powder, finished castings, and additively manufactured components.

DESIGNATIONS
AISI 316 CF8M
AISI 316L CF3M
Delcrome 316L AM

Kennametal Stellite™ manufactures sophisticated alloys in the form of castings, powders, coatings, consumables, and machined parts that resist wear, corrosion, and abrasion. Information provided in this document is intended only for general guidance about Kennametal Stellite products and is the best information in our possession at the time. Product users may request information about their individual use of our products, but Kennametal Stellite does not warrant or guarantee this information in any way. Selection and purchase of Kennametal Stellite products is the sole responsibility of the product user based on the suitability of each use. Individual applications must be fully evaluated by the user, including compliance with applicable laws, regulations, and non-infringement. Kennametal Stellite cannot know or anticipate the many variables that affect individual product use, and individual performance results may vary. For these reasons, Kennametal Stellite does not warrant or guarantee advice or information in this document, assumes no liability regarding the same, and expressly disclaims any warranty of any kind, including any warranty of fitness for a particular purpose, regarding the same.

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

DELCROME 90

DELCROME™ 90 Alloy

TECHNICAL DATA

CASTING | MIG WELD DEPOSITION | PTA AND LASER WELD DEPOSITION | HVOF & PLASMA SPRAY DEPOSITION

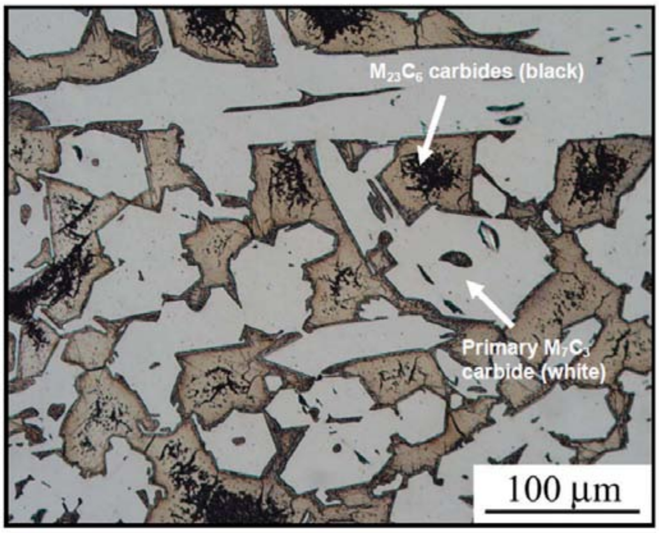
NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Fe	C	Cr	Si	Others	Hardness	Density	Melting Range
Base	2.8	27	1	Mn, V	50–64 HRC*	7.92 g/cm³ 0.286 lb/in³	1255–1307°C 2290–2385°F

*Higher hardness is obtained with heat treatment.

DELCROME ALLOYS are iron-based alloys with grades ranging from 316 and 410 stainless steels to much harder, wear-resistant, white cast irons. Delcrome alloy grades can be suitable for addressing general-purpose wear applications, with the harder grades typically used where abrasive wear is the primary concern.

DELCROME 90 is a specialty white cast iron with exceptional properties for components that must resist abrasive wear. It is generally not suitable for corrosive applications and, due to its brittleness, should be avoided when impact and shock are factors. Carbide modifiers in this iron provide refined microstructure and improved erosion resistance. Delcrome 90 can be annealed to enable economic machining operations and subsequently hardened to develop high compressive strength and wear properties. The corrosion resistance of this alloy is generally superior to mild steel, but less than 410 stainless steel.



Delcrome 90 microstructure at 500X

DELCROME 90 is often used in applications where strong abrasive wear is prevalent, such as mineral processing and mining industries. Mill liners, impellers, and wear plates are a few of the common applications.

WEAR

DELCROME 90 is developed specifically to resist strong abrasive wear and can be cast into net shape components or applied as a hard surface overlay.

ASTM G-65 Abrasive Wear Data	
Alloy	**Volume Loss (mm³)**
Delcrome 90	5–34
Delcrome 316	80–160
AISI 440C	32

Lower values indicate improved abrasive wear properties.

KENNAMETAL™ STELLITE

www.stellite.com

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)
µm/m K	10.98	11.61	12.67	13.36	13.72	14.90	15.86
µ-inch/inch °F	6.10	6.45	7.04	7.42	7.62	8.28	8.81

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp (0.2%)		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	psi	GPa
As-Cast	95	655	near UTS		<1%	32,600	224.5

NOMINAL HOT HARDNESS (BRINELL) AS-CAST

22°C (72°F)	600°C (1112°F)	900°C (1652°F)
476	247	70

IMPACT PROPERTIES AS-CAST

Izod Impact
3.00 ft.-lb. (4.07 Joules)

THERMAL AND ELECTRICAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal Conductivity	15 W/m K	104 BTU-in./hr./ft.^{2}/°F
Electrical Resistivity	85 µ-ohm cm	33.5 µ-ohm inch

AVAILABLE PRODUCT FORMS:

Delcrome 90 is available as finished castings, wire, and powder.

Kennametal Stellite™ manufactures sophisticated alloys in the form of castings, powders, coatings, consumables, and machined parts that resist wear, corrosion, and abrasion. Information provided in this document is intended only for general guidance about Kennametal Stellite products and is the best information in our possession at the time. Product users may request information about their individual use of our products, but Kennametal Stellite does not warrant or guarantee this information in any way. Selection and purchase of Kennametal Stellite products is the sole responsibility of the product user based on the suitability of each use. Individual applications must be fully evaluated by the user, including compliance with applicable laws, regulations, and non-infringement. Kennametal Stellite cannot know or anticipate the many variables that affect individual product use, and individual performance results may vary. For these reasons, Kennametal Stellite does not warrant or guarantee advice or information in this document, assumes no liability regarding the same, and expressly disclaims any warranty of any kind, including any warranty of fitness for a particular purpose, regarding the same.

SALES OFFICE - COMPONENTS
Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES
Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

DELORO™ 22S

TECHNICAL DATA

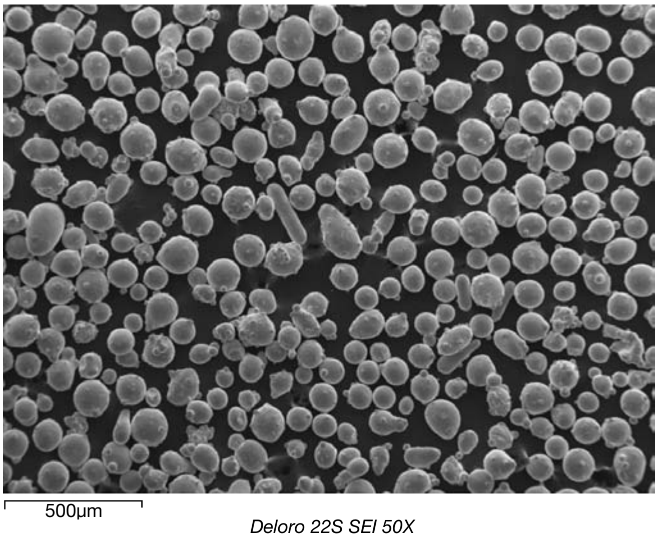
PTA & LASER WELD DEPOSITION

NOMINAL COMPOSITION AND PHYSICAL PROPERTIES

Chemical Composition (Weight %)					Scott Density	Pyc Density	Hall Flow Rate	Melting Range
Ni	Si	B	Fe	C				
Bal	3	1.5	1.0 max.	0.05	4.45g/cm^3	8.41g/cm^3	14.5 sec./50g	1080–1100°C

DESCRIPTION

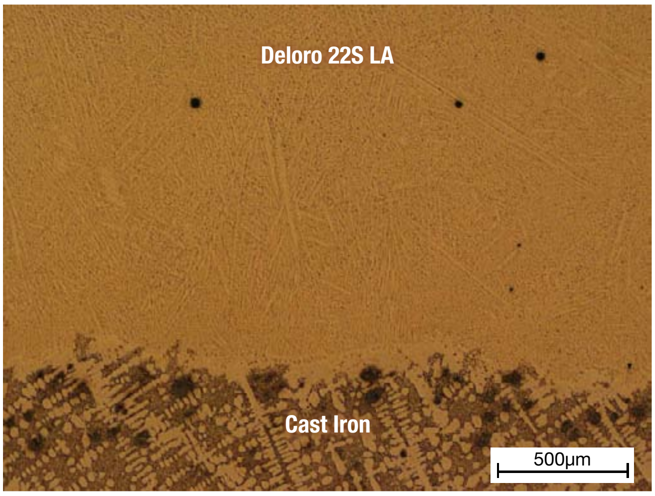
Deloro™ 22S cladding grade is a Ni-Si-B-based, gas-atomized alloy powder, specially developed for hardfacing glass molding products. Deloro 22S gives excellent resistances to high temperature oxidation, corrosion, erosion, and abrasion, which are mainly attributed to the borides and silicides dispersed uniformly in the primary phase. The cladding layer is dense and friendly to machine, giving great surface finish.



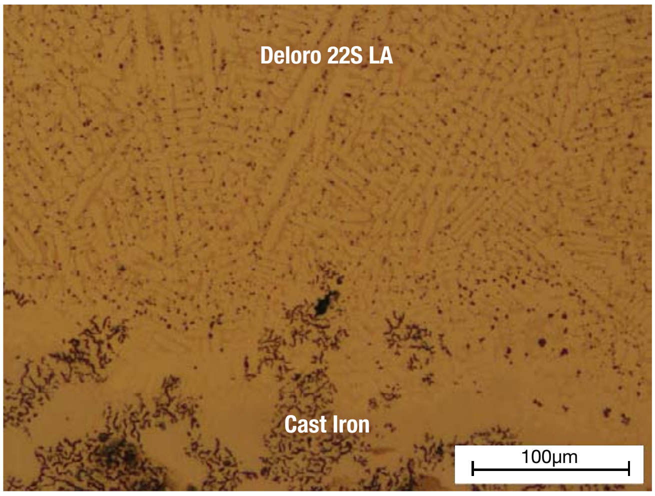
Deloro 22S SEI 50X

MICROSTRUCTURE AND PROPERTIES OF DELORO 22S DEPOSIT ON CAST IRON SUBSTRATE BY LASER CLADDING (REFERENCE ONLY)

	Density, g/cm^3	HRC
Deloro 22S-LA	8.20	32



Deloro 22S LA 50X



Deloro 22S LA 300X

KENNAMETAL STELLITE

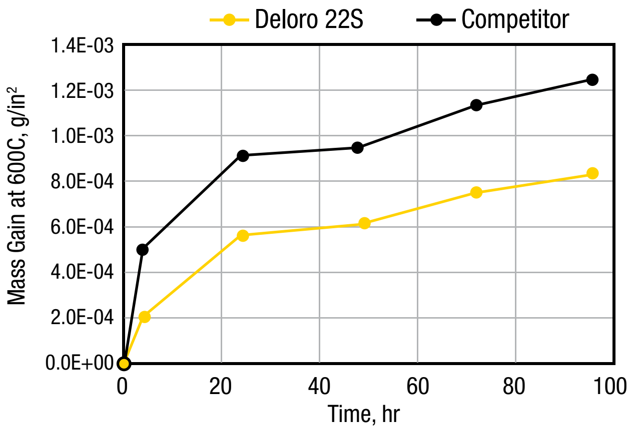
www.stellite.com

600C OXIDATION TEST IN AIR

Sample size

Dimension	Competitor	Deloro 22S
L (in)	0.975	0.913
W (in)	0.737	0.635
Th (in)	0.380	0.527
Area (in²)	2.737	2.789

Time, hr	Mass gain–Competitor, g/in²	Mass gain–Deloro 22S, g/in²
0	0	0
4	5.12E-04	2.15E-04
24	9.13E-04	5.74E-04
48	9.50E-04	6.10E-04
72	1.13E-03	7.53E-04
96	1.24E-03	8.25E-04

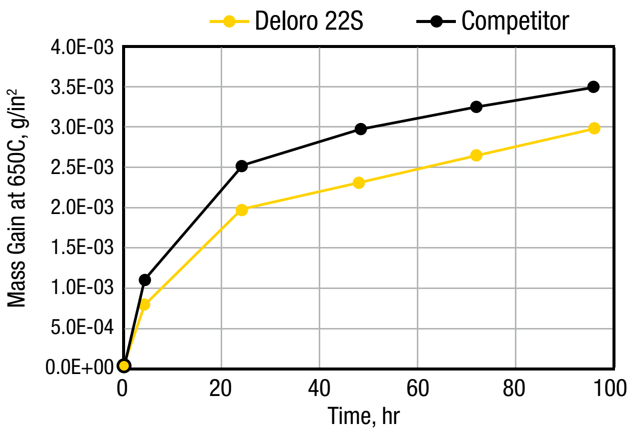


650C OXIDATION TEST IN AIR

Sample size

Dimension	Competitor	Deloro 22S
L (in)	0.970	0.957
W (in)	0.738	0.545
Th (in)	0.032	0.042
Area (in²)	1.541	1.168

Time, hr	Mass gain–Competitor, g/in²	Mass gain–Deloro 22S, g/in²
0	0	0
4	1.10E-03	7.71E-04
24	2.53E-03	1.97E-03
48	2.99E-03	2.31E-03
72	3.24E-03	2.65E-03
96	3.50E-03	3.00E-03



APPLICATIONS

Deloro™ 22S is mainly used for hardfacing protection of the joint line and two poles of the initial molds in the glass mold industry. It can also be used for repairing and hardfacing the molds, cast iron parts, and guide rails of machining tools in the plastic molding industry.

AVAILABLE FORMS/RECOMMENDED PROCESSES

PSD	100/325 Meshes or Customized
Standard Package	5kg Plastic Bottle
Recommended Process	Laser Cladding, PTA

Note: If the alloy powder has moisture absorption, or the storage period exceeds 3 months, it should be dried before use (120°C for 2 hours).

Sales Offices

Americas Welding Consumables
Kennametal Stellite
1201 Eisenhower Drive North
Goshen, Indiana 46526
USA
Tel: 1 574 534 2585
Fax: 1 574 534 3417
k-gshn.service@Kennametal.com

China
Kennametal Stellite
1799 Jialuo Road
Jiading, Shanghai 201800
China
Tel: +86 21 39523845
k-shnj.information@kennametal.com

KENNAMETAL STELLITE
www.stellite.com

DELORO 22

DELORO™ **22 Alloy**

TECHNICAL DATA

SPRAY-FUSE & POWDER WELDING | PTA & LASER WELD DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

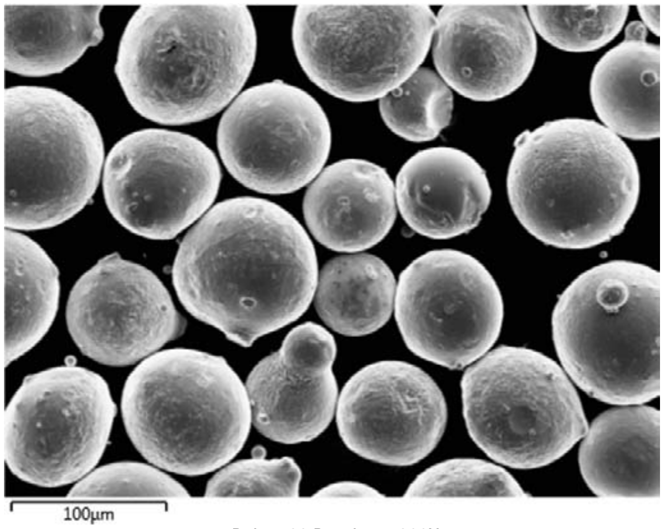
Ni	Si	C	Fe	B	Others	Hardness	Density (deposit)	Melting Range
Base	2.5	<0.05	<1.0	1.5	Cr	18–24 HRC 200–260 HV	8.5 g/cm³ 0.307 lb/in³	1070–1160°C 1960–2120°F

DELORO ALLOYS are nickel-based with additions of typically Cr, C, B, Fe, and Si. They cover a very wide range of hardness, from soft, tough, build-up alloys that are easily machined to exceptionally hard, wear-resistant alloys. The high hardness comes from the very complex microstructure consisting of Ni-solid solution, Ni_3B, Cr_5B_3, Cr_2B, CrB hard phases, and various Cr carbides. They can be selected for hardnesses of between 15 and 60 HRC and above depending on the application. Si and B make the alloys self fluxing and their low melting point makes powders ideal for spray/fuse or powder and rod/wire welding applications. They maintain their properties up to temperatures of about 315ºC (600ºF) and also offer good oxidation resistance.

DELORO 22 is a pre-alloyed, gas-atomized, nickel-based powder which is used primarily for the local repair and hardfacing of glass-forming molds. It can also be used as a tough build-up alloy for the edges of cast-iron and steel components.

DELORO 22 is typically deposited as a machinable, non-magnetic spray-fuse (SF) or powder weld deposited overlay. It is similar to **DELORO 25**, but is slightly softer, and is easily finished by hand.

Like the other Deloro nickel-base alloys, its wear resistance is mainly due to the presence of hard boride and silicide phases, and it retains its properties up to about 315ºC (600ºF). Because of its relatively low melting point, it is easily fused to form a smooth, hard-wearing surface.



Deloro 22 Powder at 300X

CORROSION RESISTANCE

A deposit of **DELORO 22** has high oxidation resistance and resists molten glass corrosion. Such repair work is done extensively by glass container manufacturers on bottle molds and other cast-iron parts that come in contact with hot glass.

KENNAMETAL™
STELLITE

www.stellite.com

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)
µm/m K	**9.8**	**9.9**	**10.4**	**11.1**	**12.4**	**12.9**	**13.2**	**14.1**
µ-inch/inch °F	5.44	5.5	5.78	6.17	6.88	7.17	7.33	7.83

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp (0.2%)		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	psi	GPa
Hardface Deposit	95	655	65	445	10	29,820	205

AVAILABLE PRODUCT FORMS

DELORO 22 is available as a powder and welding rods.

Deloro™ is a trademark of Madison Industries.

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

DELORO 40

DELORO™ 40 Alloy

TECHNICAL DATA

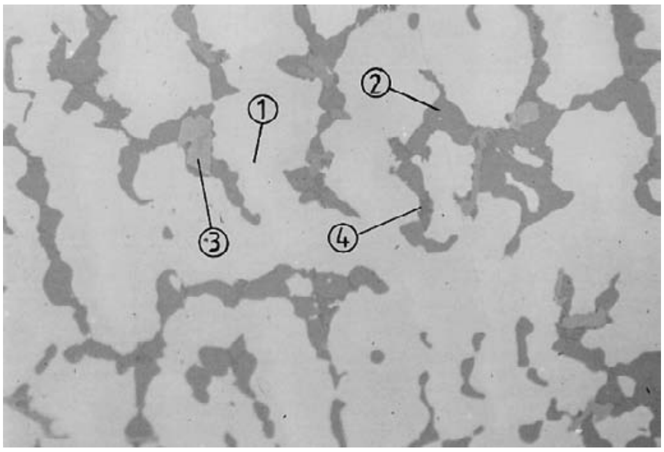
CASTING | TIG & OXY-ACETYLENE WELDING | SPRAY-FUSE & POWDER WELDING | PTA & LASER WELD DEPOSITION | HVOF & PLASMA SPRAY DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Ni	Cr	Si	Fe	C	B	Hardness	Density (deposit)	Melting Range
Base	7.5	3.5	2.5	0.3	2.0	35–45 HRC	8.14 g/cm³ 0.294 lb/in³	960–1107°C 1760–2025°F

DELORO ALLOYS are nickel-based with additions of typically Cr, C, B, Fe, and Si. They cover a very wide range of hardness, from soft, tough, build-up alloys that are easily machined to exceptionally hard, wear-resistant alloys. The high hardness comes from the very complex microstructure consisting of Ni-solid solution, Ni_3B, Cr_5B_3, Cr_2B, CrB hard phases, and various Cr carbides. They can be selected for hardnesses of between 15 and 60 HRC and above depending on the application. Si and B make the alloys self fluxing and their low melting point makes powders ideal for spray/fuse or powder and rod/wire welding applications. They maintain their properties up to temperatures of about 315°C (600°F) and also offer good oxidation resistance.

DELORO 40 is a NiCrSiB alloy developed primarily for the surfacing of steels and is also available as a casting. The alloy contains complex carbides, borides, and nitrides in a tough nickel matrix and provides protection from corrosion and both abrasive and sliding wear. **DELORO 40** offers a good combination of impact resistance and wear resistance and should be considered where impact could be a factor with harder Deloro grades.



Deloro 40 (As-Cast) Microstructure at 500X
1) Ni-Solid Solution
2) Ni_3B Hard-Phase
3) Cr_5B_3 Hard-Phase
4) CrB

CORROSION RESISTANCE

DELORO 40 is resistant to atmospheric, salt water, and salt spray corrosion, and has excellent oxidation resistance up to its melting range. It retains satisfactory performance in many organic acids, but high corrosion rates are observed in hot, strong inorganic acids. **DELORO 40** is highly resistant to semi-molten glass. It is normally used in the as-cast condition.

KENNAMETAL STELLITE

www.stellite.com

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)
µm/m K	10.64	11.81	12.33	12.91	13.41	13.90	14.35	14.67
µ-inch/inch °F	5.91	6.56	6.85	7.17	7.45	7.72	7.97	8.15

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	ksi	GPa
Hardface Deposit	100	689	Near UTS		—	32,000	220

NOMINAL HOT HARDNESS (DPH)

	22°C (72°F)	427°C (800°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)
TIG/GTA Weld	525	440	355	215	90

PRODUCT FORMS AND CROSS-REFERENCE SPECIFICATIONS

DELORO 40 is available as finished castings, rod, and powder.

SPECIFICATION	PRODUCT FORMS
AWS A5.21 ERNiCr-A	Rod
UNS N99644	Rod, Powder

Deloro™ is a trademark of Madison Industries.

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

DELORO™ 50 Alloy

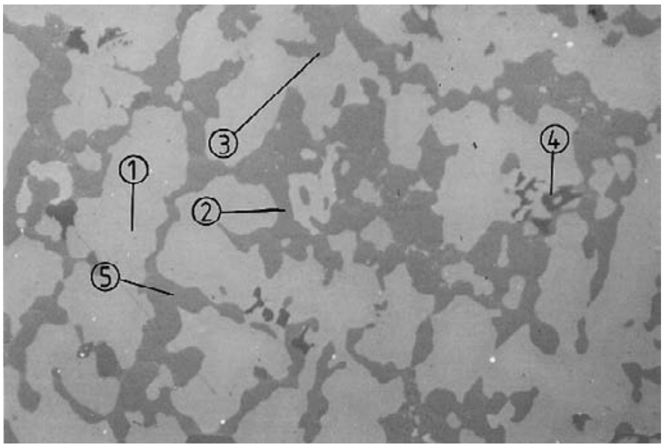
TECHNICAL DATA

CASTING | TIG & OXY-ACETYLENE WELDING | SPRAY-FUSE & POWDER WELDING | PTA & LASER WELD DEPOSITION | HVOF & PLASMA SPRAY DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Ni	Cr	Si	Fe	C	B	Hardness	Density (deposit)	Melting Range
Base	10-16	3-5	3-5	0.5	2.0	45–55 HRC 446–595 HV	8.16 g/cm³ 0.295 lb/in³	980–1060ºC 1796–1940ºF

DELORO ALLOYS are nickel-based with additions of typically Cr, C, B, Fe, and Si. They cover a very wide range of hardness, from soft, tough, build-up alloys that are easily machined to exceptionally hard, wear-resistant alloys. The high hardness comes from the very complex microstructure consisting of Ni-solid solution, Ni_3B, Cr_5B_3, Cr_2B, CrB hard phases, and various Cr carbides. They can be selected for hardnesses of between 15 and 60 HRC and above depending on the application. Si and B make the alloys self fluxing and their low melting point makes powders ideal for spray/fuse or powder and rod/wire welding applications. They maintain their properties up to temperatures of about 315ºC (600ºF) and also offer good oxidation resistance.



Deloro 50 (As-Cast) Microstructure at 500X
1) Ni-Solid Solution
2) Ni_3B Hard-Phase
3) Cr_5B_3 Hard-Phase
4) Cr_2B
5) CrB

DELORO 50 is primarily a hardfacing alloy for welding, spray-fuse, and powder-weld processes but is also available as a casting. It is machineable, and produces very hard, dense, and corrosion-resistant coatings with superior fusing characteristics. **DELORO 50** should be considered where mild impact is possible, as it has lower crack sensitivity than **DELORO 60**. This is necessarily achieved by loss of some abrasion resistance. Hot hardness maintained to approximately 400ºC (750ºF).

DELORO 50 applications include extruder screw flights, wear rings, bearings, camshafts, and diesel engine valve facings. It is also used to spray and fuse glass-forming plungers when high hardness is required.

KENNAMETAL STELLITE

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)
µm/m K	9.65	11.09	11.70	12.11	12.55	12.92	13.21	13.64
µ-inch/inch °F	5.36	6.16	6.50	6.73	6.97	7.18	7.34	7.58

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp (0.2%)		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	ksi	GPa
Hardface Deposit	95	655	near UTS		–	32,000	220

NOMINAL HOT HARDNESS (DPH)

	22°C (72°F)	427°C (800°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)
TIG/GTA Weld	530	440	400	375	95

THERMAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal Conductivity	10.5 W/m K	72.8 BTU-in./hr./ft.²/°F

Deloro™ is a trademark of Madison Industries.

AVAILABLE PRODUCT FORMS

DELORO 50 is available as finished castings, rod and powder.

SPECIFICATION	PRODUCT FORMS
AWS A5.21 ERNiCr-B	Rod
UNS N99645	Rod, Powder

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

DELORO™ 60 Alloy

TECHNICAL DATA

TIG & OXY-ACETYLENE WELDING | SPRAY-FUSE & POWDER WELDING | PTA & LASER WELD DEPOSITION | HVOF & PLASMA SPRAY DEPOSITION

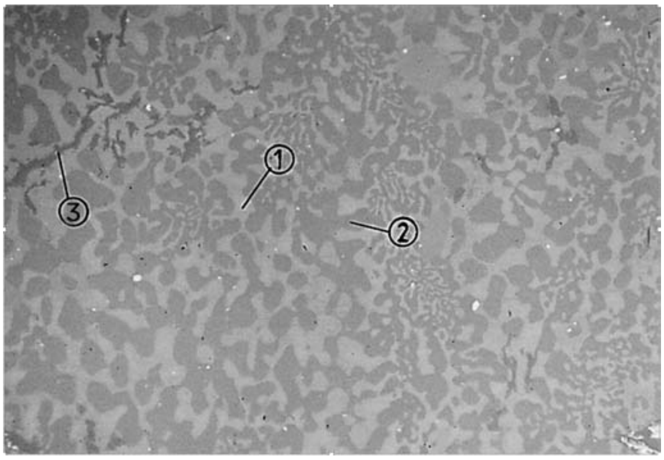
NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Ni	Cr	Si	Fe	C	B	Hardness	Density (deposit)	Melting Range
Base	14-15	2.0-4.5	3-5	0.7	3.2	56-64 HRC	7.8 g/cm³ 0.282 lb/in³	906-1081°C 1663-1978°F

DELORO ALLOYS are nickel-based with additions of typically Cr, C, B, Fe, and Si. They cover a very wide range of hardness, from soft, tough, build-up alloys that are easily machined to exceptionally hard, wear-resistant alloys. The high hardness comes from the very complex microstructure consisting of Ni-solid solution, Ni_3B, Cr_5B_3, Cr_2B, CrB hard phases, and various Cr carbides. They can be selected for hardnesses of between 15 and 60 HRC and above depending on the application. Si and B make the alloys self fluxing and their low melting point makes powders ideal for spray/fuse or powder and rod/wire welding applications. They maintain their properties up to temperatures of about 315ºC (600ºF) and also offer good oxidation resistance.

DELORO 60 is a hard nickel base alloy with excellent wear resistance, high hardness, and corrosion resistance. It can be ground, but is not machinable. **DELORO 60** coatings have superior fusing characteristics. Fusion of the coating may be achieved by oxy-fuel torch, induction heating or by furnace fusion. **DELORO 60** is harder and more wear resistant than other Deloro grades but gives up impact resistance in exchange.

DELORO 60 applications include hardfacing of wire drawing capstans, pump parts (such as casings, impellers, plungers, sleeves and shafts), mechanical seal faces, feed screws, centrifuge screws, bushings, plastic and glass molding equipment parts, and chemical processing and petroleum industry valves.



Deloro 60 (As-Cast) Microstructure, 500x
1) Ni-Solid Solution
2) Ni_3B Hard-Phase
3) CrB

KENNAMETAL STELLITE

www.stellite.com

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)
µm/m K	10.01	10.60	11.50	11.77	12.15	12.60	12.74	12.94
µ-inch/inch °F	5.56	5.89	6.39	6.54	6.75	7.00	7.08	7.19

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	ksi	GPa
Hardface Deposit	30	207	Near UTS		-	32,000	220

NOMINAL HOT HARDNESS (DPH)

	22°C (72°F)	427°C (800°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)
TIG/GTA Weld	585	555	440	250	115

THERMAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal Conductivity	15.01 W/m K	104 BTU-in/hr/ft²/°F

Deloro™ is a trademark of Madison Industries.

AVAILABLE PRODUCT FORMS

DELORO 60 is available as Rod and Powder.

SPECIFICATIONS	PRODUCT FORMS
AWS A5.21 ERNiCr-C	Rod
UNS N99646	Rod, Powder

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

NISTELLE 625

NISTELLE™ 625 Alloy

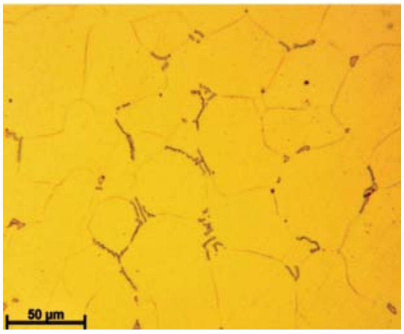
TECHNICAL DATA

CASTING I PTA & LASER WELD DEPOSITION I HVOF & PLASMA SPRAY DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Ni	Cr	Mo	C	Nb+Ta	Fe	Others	Hardness	Density	Melting Range
Base	21.5	9	0.1 max	3.7	5 max	Si, Mn, Al, Ti	25 HRC max	8.42 g/cm³ 0.304 lb./in.³	1290–1350°C 2354–2462°F

NISTELLE NICKEL-BASED ALLOYS are designed primarily for high corrosion resistance. They have excellent high-temperature strength, resistance to oxidizing and/or reducing acids (depending on the grade), and are readily machinable.



Vacuum-Cast Nistelle 625

NISTELLE 625 is a nickel-chromium-molybdenum alloy with an addition of niobium that acts with the molybdenum to stiffen the alloy's matrix, thereby providing high strength without a strengthening heat treatment. The alloy resists a wide range of severely corrosive environments and is especially resistant to pitting and crevice corrosion. It has excellent high-temperature oxidation and corrosion properties. **NISTELLE 625** is readily manufactured and fabricated by common industrial practices and has excellent weld qualities.

NISTELLE 625 has been widely used in a range of high-temperature aerospace, chemical process, and power industry applications. As a low-temperature corrosion-resistant material, it has been used in the chemical industry, marine industry, and in pollution-control equipment. It is widely specified for use in seawater and contaminated seawater environments.

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	93°C (200°F)	204°C (400°F)	316°C (600°F)	427°C (800°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)	871°C (1600°F)	982°C (1800°F)
µm/m K	12.8	13.1	13.3	13.6	14.0	14.7	15.3	15.8	16.6
µ-inch/inch °F	7.1	7.3	7.4	7.6	7.8	8.2	8.5	8.8	9.2

KENNAMETAL™
STELLITE

www.stellite.com

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength		Yield Stress		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	ksi	GPa
Casting (AMS 5402)	76	525	40	275	16	29,750	205
Casting (AMS 5401)	85	590	45	310	25	30,000	207

AQUEOUS CORROSION RESISTANCE

	NISTELLE 625
Sulfuric Acid	••
Hydrochloric Acid	••
Hydrofluoric Acid	••
Phosphoric Acid	••
Nitric Acid	••
Organic Acids	••
Alkalines and Salts	••
Seawater	••

Recommended	••
Acceptable	•
Not Recommended	–

THERMAL AND ELECTRICAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal Conductivity	9.8 W/m K	68 BTU-in./hr./ft.^{2}/°F
Electrical Resistivity	126 μ-ohm cm	49.6 μ-ohm in.

PRODUCT FORMS AND CROSS-REFERENCE SPECIFICATIONS

NISTELLE 625 is available as finished castings and powders.

SPECIFICATION	PRODUCT FORM
AWS 5.14 ASTM A494 CW6MC UNS N26625	Powder, Casting
AMS 5401	Casting (Vacuum)
AMS 5402	Casting (Air Melt)

Kennametal Stellite™ manufactures sophisticated alloys in the form of castings, powders, coatings, consumables, and machined parts that resist wear, corrosion, and abrasion. Information provided in this document is intended only for general guidance about Kennametal Stellite products and is the best information in our possession at the time. Product users may request information about their individual use of our products, but Kennametal Stellite does not warrant or guarantee this information in any way. Selection and purchase of Kennametal Stellite products is the sole responsibility of the product user based on the suitability of each use. Individual applications must be fully evaluated by the user, including compliance with applicable laws, regulations, and non-infringement. Kennametal Stellite cannot know or anticipate the many variables that affect individual product use, and individual performance results may vary. For these reasons, Kennametal Stellite does not warrant or guarantee advice or information in this document, assumes no liability regarding the same, and expressly disclaims any warranty of any kind, including any warranty of fitness for a particular purpose, regarding the same.

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

NISTELLE 718

NISTELLE™ 718 Alloy

TECHNICAL DATA

CASTING I PTA & LASER WELD DEPOSITION I HVOF & PLASMA SPRAY DEPOSITION

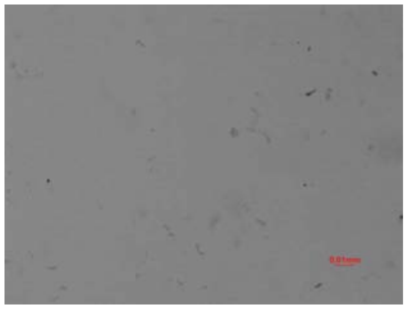
NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Ni	Cr	Fe	Mo	Nb+Ta	C	Others	Hardness	Density	Melting Range
Base	19	19	3	5	0.05	Ti, Al	34–44 HRC*	8.22 g/cm³ 0.297 lb./in.³	1204–1343°C 2200–2450°F

*Hardness depends on heat treat condition.

NISTELLE NICKEL-BASED ALLOYS are designed primarily for high corrosion resistance. They have excellent high-temperature strength, resistance to oxidizing and/or reducing acids (depending on the grade), and are readily machinable.

NISTELLE 718 is a nickel-chromium-iron vacuum alloy that is typically used for structural parts requiring strength up to 1300°F (704°C) and oxidation resistance up to 1800°F (982°C). This age-hardenable alloy can be readily cast and fabricated into complex parts and its welding characteristics, especially its resistance to postweld cracking, are outstanding. The ease and economy with which **NISTELLE 718** can be fabricated — combined with excellent tensile, fatigue, and creep and rupture strength — have resulted in its use in a wide range of applications.



Nistelle 718 Vacuum Casting 500X

NISTELLE 718 was initially developed for the aerospace industry and is still considered the material of choice for many aircraft engine components. Its excellent strength and corrosion resistance have been recognized by the oil industry and it is now widely used in this field.

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	93°C (200°F)	204°C (400°F)	316°C (600°F)	427°C (800°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)	871°C (1600°F)	982°C (1800°F)
µm/m K	13.16	13.55	13.93	14.45	14.53	15.10	16.04	16.29	16.85
µ-inch/inch °F	7.31	7.53	7.74	7.97	8.07	8.39	8.91	9.05	9.36

KENNAMETAL™
STELLITE

www.stellite.com

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength		Yield Stress		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	ksi	GPa
Vacuum Casting (AMS 5383)	125	862	110	758	5	29,600	204

AQUEOUS CORROSION RESISTANCE

	NISTELLE 718
Sulfuric Acid	•
Hydrochloric Acid	•
Hydrofluoric Acid	•
Phosphoric Acid	•
Nitric Acid	•
Organic Acids	••
Alkalines and Salts	••
Seawater	••

Recommended	••
Acceptable	•
Not Recommended	–

THERMAL AND ELECTRICAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal Conductivity	11.4 W/m K	79 BTU-in./hr./ft.^{2}/°F
Electrical Resistivity	120 μ-ohm cm	47.2 μ-ohm in.

PRODUCT FORMS AND CROSS-REFERENCE SPECIFICATIONS

NISTELLE 718 is available as finished castings and powders.

SPECIFICATION	PRODUCT FORM
UNS N07718	Powder, Casting
AMS 5383	Casting (Vacuum)

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

NISTELLE™ C-22 Alloy

TECHNICAL DATA

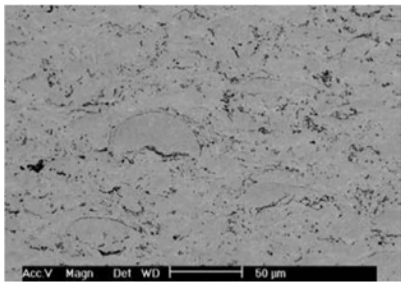
CASTING | PTA & LASER WELD DEPOSITION | HVOF & PLASMA SPRAY DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Ni	Cr	Mo	C	W	Fe	Others	Hardness	Density	Melting Range
Base	22	13	0.01	3	3	Co, Mn, Cu, V	83–98 HRB	8.69 g/cm^3 0.314 lb./in.^{3}	1355–1400°C 2471–2552°F

NISTELLE NICKEL-BASED ALLOYS are designed primarily for high corrosion resistance. They have excellent high-temperature strength, resistance to oxidizing and/or reducing acids (depending on the grade), and are readily machinable.

NISTELLE C-22 is a nickel-chromium-molybdenum-tungsten alloy with the versatility to be used in corrosive environments where both oxidizing and reducing chemicals are present. It was the first low C and Si Ni-Cr-Mo series alloy with higher Cr content. The high chromium content provides good resistance to oxidizing media while the molybdenum and tungsten content gives good resistance to reducing media. It also excels at protecting against pitting, crevice attack, and stress-corrosion cracking. The exceptional resistance of **NISTELLE C-22** to a broad range of corrosive environments, including mixed chemicals, makes it a strong candidate for use in industrial situations where "upset" conditions are likely to occur.



HVOF Nistelle C-22

NISTELLE C-22 has been used in a variety of corrosive environments in the pulp and paper, petrochemical, chemical, and power generation industries, and in marine service. **NISTELLE C-22** has been applied to a wide variety of parts, including boiler tube walls, large diameter shafts, and pulp and paper digesters.

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	93°C (200°F)	204°C (400°F)	316°C (600°F)	427°C (800°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)	871°C (1600°F)	982°C (1800°F)
µm/m K	12.42	12.42	12.60	13.32	13.86	14.58	15.30	15.84	16.20
µ-inch/inch °F	6.90	6.90	7.00	7.40	7.70	8.10	8.50	8.80	9.00

KENNAMETAL™ STELLITE

www.stellite.com

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength		Yield Stress		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	ksi	GPa
Casting	80	550	45	310	30%	29,750	205

CORROSION RESISTANCE

C-22 and **C-276** provide similar corrosion protection in reducing environments. In non-reducing and oxidizing environments, due to its higher chromium content, **C-22** provides better resistance to general corrosion and much better resistance to localized corrosion in the presence of chlorides.

THERMAL AND ELECTRICAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal Conductivity	9.8 W/m K	69.4 BTU-in./hr./ft.^{2}/°F
Electrical Resistivity	113.8 µ-ohm cm	44.8 µ-ohm in.

PRODUCT FORMS AND CROSS-REFERENCE SPECIFICATIONS

NISTELLE C-22 is available as a casting and powder.

SPECIFICATION	PRODUCT FORM
UNS N06022	Powders
ASTM A494 CX2MW	Casting
UNS N26022	Casting

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

NISTELLE C-276

NISTELLE™ C-276 Alloy

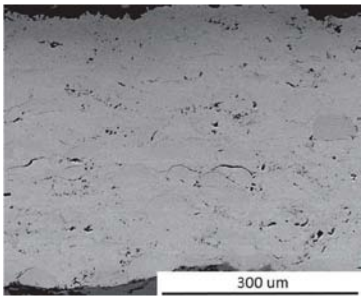
TECHNICAL DATA

CASTING | PTA & LASER WELD DEPOSITION | HVOF & PLASMA SPRAY DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Ni	Cr	Mo	Fe	W	Co	Others	Hardness	Density	Melting Range
Base	16	16	5	4	<2.5	Mn, V, Cu	85–98 HRB	8.89 g/cm^3 0.321 lb./in.^{3}	1270–1305°C 2318–2381°F

NISTELLE NICKEL-BASED ALLOYS are designed primarily for high corrosion resistance. They have excellent high-temperature strength, resistance to oxidizing and/or reducing acids (depending on the grade), and are readily machinable.



HVOF Nistelle C-276

NISTELLE C-276 is a nickel-chromium-molybdenum alloy with a long history of performance in corrosive applications. It was the first low C and Si alloy variation of the original Ni-Cr-Mo **NISTELLE C** alloy. It is ductile, easy to weld, and possesses exceptional resistance to stress-corrosion cracking in chloride-bearing solutions. Its high chromium and molybdenum content allows it to withstand both oxidizing and non-oxidizing acids and exhibits outstanding resistance to pitting and crevice attack in the presence of chlorides and other halides. It is very resistant to sulfide stress cracking and stress-corrosion cracking in sour oilfield environments.

NISTELLE C-276 has been used in sour gas recovery and handling equipment, sulfuric acid environments (heat exchangers, filters, and mixers), flue gas desulphurization equipments (scrubbers and ducting), pulp and paper production equipment (digesters and bleaching equipment), and in waste treatment facilities.

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	93°C (200°F)	538°C (1000°F)	649°C (1200°F)	732°C (1350°F)	816°C (1500F)	899°C (1650°F)	982°C (1800°F)
µm/m K	11.41	13.57	14.11	14.54	14.92	15.33	15.73
µ-inch/inch °F	6.34	7.54	7.84	8.07	8.29	8.52	8.74

KENNAMETAL STELLITE

www.stellite.com

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength		Yield Stress		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	ksi	GPa
Casting	72	495	40	275	4	29,750	205

THERMAL AND ELECTRICAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal Conductivity	10.2 W/m K	72.2 BTU-in./hr./ft.²/°F
Electrical Resistivity	123 μ-ohm cm	48.4 μ-ohm in.

PRODUCT FORMS AND CROSS-REFERENCE SPECIFICATIONS

NISTELLE C-276 is available as a casting and powder.

SPECIFICATION	PRODUCT FORM
UNS N10276	Powder
ASTM A494 CW12MW	Casting
UNS N30002	Casting

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

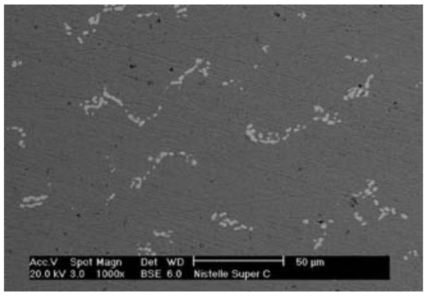
NISTELLE™ SUPER C Alloy

TECHNICAL DATA

CASTING | PTA & LASER WELD DEPOSITION | HVOF & PLASMA SPRAY DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Ni	Cr	Mo	C	Others	Hardness	Density	Melting Range
Base	23	18	.05	W, Si, Fe	30 HRC max	8.6 g/cm³ 0.311 lb./in.³	1280–1360ºC 2336–2480ºF



Cast Nistelle Super C

NISTELLE NICKEL-BASED ALLOYS are designed primarily for high corrosion resistance. They have excellent high-temperature strength, resistance to oxidizing and/or reducing acids (depending on the grade), and are readily machinable.

NISTELLE SUPER C is a proprietary welding and thermal spray alloy that exhibits much higher resistance to oxidizing and reducing acids than **NISTELLE C**, and offers significantly higher resistance to chloride-induced, localized attack. **NISTELLE SUPER C** is also castable. Unlike **NISTELLE C**, which has a chemical composition similar to the wrought version of the alloy, **NISTELLE SUPER C** is specifically formulated as a powder product. It is especially useful as a corrosion-resistant HVOF coating or PTA deposit. It can be used as a corrosion-resistant thermal spray bond coat. Compared to **NISTELLE C**, HVOF coatings of **NISTELLE SUPER C** are easier to grind to a smooth finish due to the alloy's lower tendency to work harden.

NISTELLE SUPER C coatings exhibit acceptable metal-on-metal wear and abrasion resistance and are well suited for most applications in the chemical and petrochemical industries for pumps and valve parts. **NISTELLE SUPER C** was originally developed to improve coating finishing and reduce corrosion in paper manufacturing on drying and calendaring rolls. It has been successfully used in coal-fired boiler tubes, paper mill digester boiler tubes, fans, and mixer blades.

The corrosion resistance and surface finishing characteristics make **NISTELLE SUPER C** an ideal alloy for HVOF spraying in printing, papermaking, oil refinery, and chemical processing industries.

NOMINAL HOT HARDNESS (DPH)

	22°C (72°F)	427°C (800°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400F)
TIG Weld	210	200	190	180	160

KENNAMETAL™ STELLITE

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

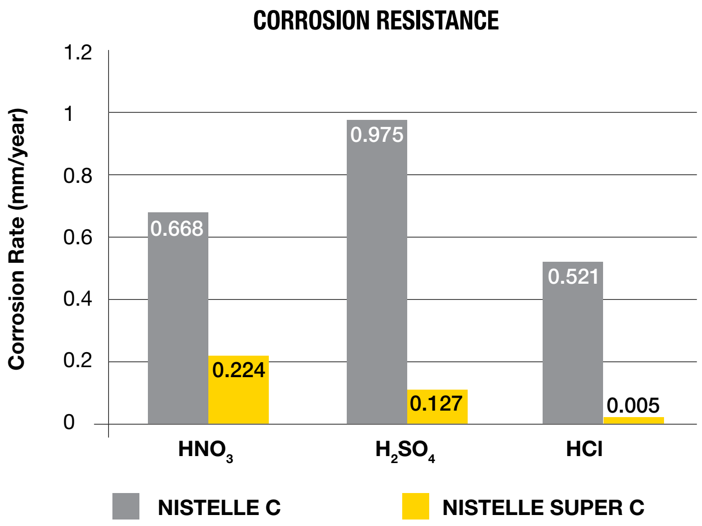
	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
µm/m K	10.78	11.05	11.20	11.58	12.20	12.61	12.91	13.44	13.92
µ-inch/inch °F	5.99	6.14	6.22	6.43	6.78	7.01	7.17	7.47	7.73

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength		Yield Stress		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	ksi	GPa
Casting	90	620	65	450	15	30,650	210

CORROSION RESISTANCE

The corrosion resistance of **NISTELLE C** and **NISTELLE SUPER C** was tested in oxidizing acid 65% HNO_3 at 66°C, reducing acids 10% H_2SO_4 at 102°C, and 5% HCI at 66°C, for 72 hrs. These conditions were selected based on industrial application conditions. **NISTELLE SUPER C** exhibits superior corrosion resistance to **NISTELLE C**.



PRODUCT FORMS

NISTELLE SUPER C is available as a powder and casting.

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

NISTELLE™ X ALLOY

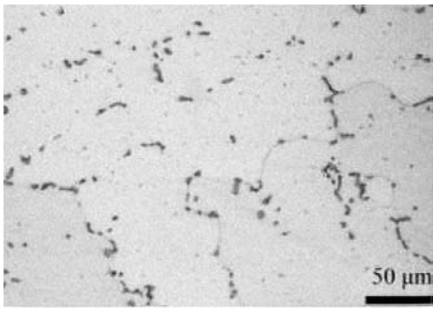
TECHNICAL DATA

CASTING | PTA & LASER WELD DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Ni	Cr	Fe	Mo	Co	C	Others	Hardness	Density	Melting Range
Base	22	18	9	1.5	0.1	W, Mn, Si, Nb, Al	90–98 HRB	8.22 g/cm³ 0.297 lb./in.³	1260–1355°C 2300–2470°F

NISTELLE NICKEL-BASED ALLOYS are designed primarily for high corrosion resistance. They have excellent high-temperature strength, resistance to oxidizing and/or reducing acids (depending on the grade), and are readily machinable.



Cast Nistelle X

NISTELLE X is a nickel-chromium-iron-molybdenum alloy having an exceptional combination of oxidation resistance and high-temperature strength. It has outstanding resistance to stress-corrosion cracking in petrochemical applications. **NISTELLE X** retains good ductility after prolonged exposure to high temperatures.

NISTELLE X has been used widely in gas turbines for hot gas path and combustion zone components such as transition ducts, combustor cans, flame holders, and afterburners. It is also used in industrial furnace applications due to its resistance to oxidizing, reducing, and neutral atmospheres, and in chemical industry processes.

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	93°C (200°F)	538°C (1000°F)	649°C (1200°F)	732°C (1350°F	816°C (1500°F)	899°C (1650°F)	982°C (1800°F)
µm/m K	13.86	15.12	15.48	15.84	16.02	16.38	16.56
µ-inch/inch F	7.70	8.40	8.60	8.80	8.90	9.10	9.20

KENNAMETAL STELLITE

www.stellite.com

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength		Yield Stress		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	ksi	GPa
Castings	55	380	35	240	8	29,000	200

OXIDATION RESISTANCE

Oxidation rate of **NISTELLE X** after 100 hours in air.

ϴ/°C	700°C	800°C	900°C	1000°C	1100°C
Oxidation rate/(g/[m^2•hr.])	0.0023	0.060	0.117	0.200	0.611

THERMAL AND ELECTRICAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal Conductivity	9.2 W/m K	63 BTU-in./hr./ft.^{2}/°F
Electrical Resistivity	118.4 µ-ohm cm	46.6 µ-ohm inch

PRODUCT FORMS AND CROSS-REFERENCE SPECIFICATIONS

NISTELLE X is available as a finished casting and powder.

SPECIFICATION	PRODUCT FORM
UNS N06002	Powder
AMS 5390	Casting
ASTM A567 Gr.5	Casting

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

STELLITE™ 1 ALLOY

TECHNICAL DATA

TIG WELD DEPOSITION | MMA WELD DEPOSITION | MIG WELD DEPOSITION | PTA & LASER WELD DEPOSITION | CASTINGS & POWDER METALLURGY

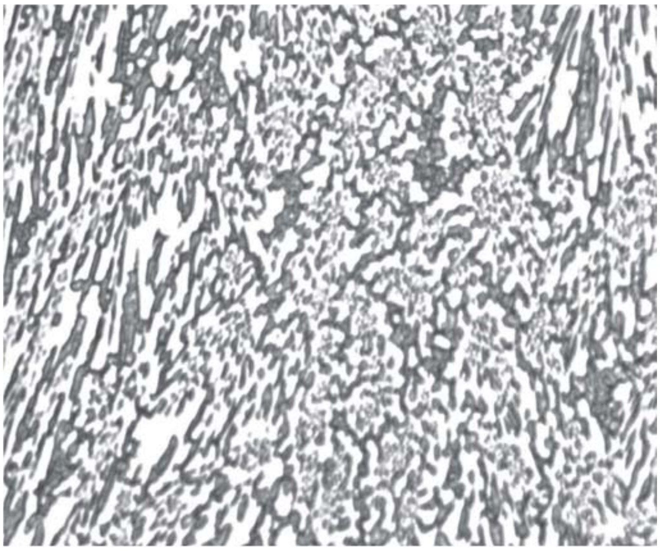
NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	W	C	Others	Hardness	Density	Melting Range
Base	28-32	11-13	2.0-3.0	Ni, Fe, Si, Mn, Mo	50-58 HRC 550-720 HV	8.69 g/cm³ 0.314 lb/in³	1248-1290°C 2278-2355°F

STELLITE COBALT-BASED ALLOYS consist of complex carbides in an alloy matrix. They are resistant to wear, galling, and corrosion and retain these properties at high temperatures. Their exceptional wear resistance is due mainly to the unique inherent characteristics of the hard carbide phase dispersed in a CoCr alloy matrix.

Stellite 1 possesses excellent abrasion and corrosion resistance for applications such as pump sleeves, rotary seal rings, wear pads, expeller screws, and bearing sleeves. It retains its hardness at temperatures in excess of 760°C (1400°F).

Stellite 1 contains a high proportion of hard, wear-resistant primary carbides. These render the alloy well suited to applications involving extreme low-angle erosion and severe abrasion, with some sacrifice in toughness. Compared to other **Stellite** alloys, it is more crack-sensitive, and care should be taken to minimize the cooling stresses experienced during casting and hardfacing processes. Due to its high hardness and wear resistance, **Stellite 1** should only be finished by grinding.



Optical micrograph of a Stellite 1 weld overlay

CORROSION RESISTANCE

Stellite 1 has good general corrosion resistance. The typical electrode potential in sea water at room temperature is approximately -0.4 V (SCE). **Stellite 1** corrodes primarily by a pitting mechanism and not by general mass loss in seawater and chloride solutions. More detailed information regarding corrosion resistance can be provided on request.

KENNAMETAL™ STELLITE

www.stellite.com

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
µm/m.K	10.5	11.3	11.8	12.1	12.5	12.8	13.5	13.9	14.4
µ-inch/inch.°F	5.8	6.3	6.5	6.7	6.9	7.1	7.5	7.7	8.0

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp(0.2%)		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	psi	GPa
Castings	79	550	-	-	<1	36.0x10^6	248

NOMINAL HOT HARDNESS (DPH) AS-CAST

20°C (68°F)	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
606	573	540	508	485	453	406	330	217	140

THERMAL AND ELECTRICAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal conductivity	14.5 W/m.K	100.5 Btu-in/hr/ft²/°F
Electrical resistivity	94.0 µ-ohm.cm	37.0 µ-ohm.inch

SPECIFICATION	PRODUCT FORM
UNS R30001	Rod, castings, powder for PTA or laser processing
UNS W73031	Wire
UNS W73001	Electrode

PRODUCT FORMS AND CROSS-REFERENCE SPECIFICATIONS

Stellite 1 is available as welding wire, rod, powder, electrodes, finished castings, and powder metallurgy components.

Stellite 1 can be supplied to the following specifications:

SPECIFICATION	PRODUCT FORM
AWS A5.21 / ASME BPVC IIC SFA 5.21 ERCoCr-C	Rod
AWS A5.21 / ASME BPVC IIC SFA 5.21 ERCCoCr-C	Wire
AWS A5.13 / ASME BPVC IIC SFA 5.13 ECoCr-C	Electrode

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

STELLITE 3

STELLITE™ 3 ALLOY

TECHNICAL DATA

Castings | Powder Metallurgy Components

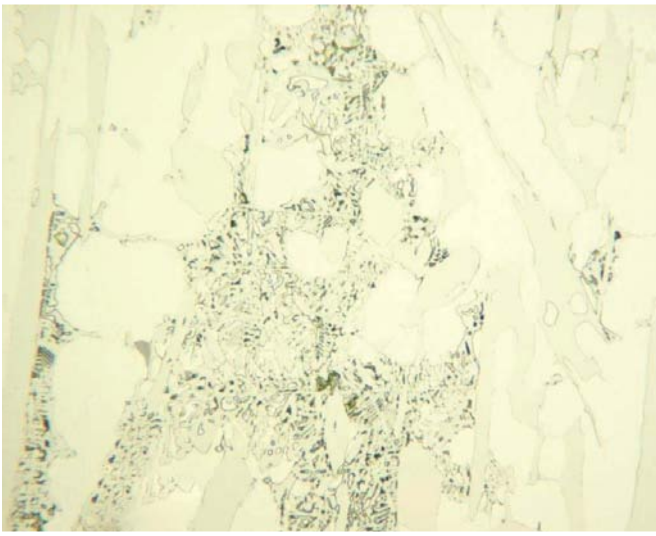
NOMINAL COMPOSITION (MASS%) AND PHYSICAL PROPERTIES

Co	Cr	W	C	Others	Hardness	Density	Melting Range
Base	30.5	12.5	2.3	Ni, Fe, Si	48-63 HRC	8.69 g/cm³ 0.314 lb/in³	1250-1290°C 2280-2355°F

STELLITE COBALT-BASED ALLOYS consist of complex carbides in an alloy matrix. They are resistant to wear, galling, and corrosion and retain these properties at high temperatures. Their exceptional wear resistance is due mainly to the unique inherent characteristics of the hard carbide phase dispersed in a CoCr alloy matrix.

The high carbon content of **STELLITE 3** increases the volume fraction of carbides and hence its abrasion and solid particle erosion resistance. The high tungsten content improves its high temperature properties. However, this results in an alloy that is nearly impossible to hardface crack-free and one that withstands very little impact. It has excellent metal-to-metal wear resistance and resists galling when mated with other Stellite alloys.

STELLITE 3 has been used for valve seat inserts, needle holders, steel mill guide rolls, seaming rolls, sleeves, bushings, bearing balls, wear pads, burner nozzles, palm guides, surgical scissor inserts, and in many other applications.



Stellite 3 cast microstructure at 1000x magnification

CORROSION RESISTANCE

Stellite alloys 6 and 12 are considered to have superior corrosion resistance over **STELLITE 3** in most environments. Like most Stellite alloys, it has excellent resistance to oxidation but is not recommended for reducing acids. **STELLITE 3** is resistant to nitric acid over a range of concentrations at room temperature. It also has excellent resistance to phosphoric acid below 150°F and formic acid at room temperature. It is highly resistant to sulfuric acid but only at room temperature. Since corrosion resistance varies with concentration, temperature, stress, and contaminants, it is best to use production exposure tests to determine the suitability for each application.

WEAR RESISTANCE

The higher carbon content results in an increase in volume fraction of carbides and higher abrasion resistance in low-stress abrasion tests. **STELLITE 3** is 3 to 4 times more resistant than **STELLITE 6** and twice as resistant as **STELLITE 12**. It is also superior to **DELCROME™ 90** and O7 tool steel. **STELLITE 3** has exceptional metal-on-metal wear properties, and this improved resistance increases as loads are increased or speeds are increased to 10 times to 25 times that of **STELLITE 12** or **STELLITE 6**. The material is also resistant to erosion and most combinations of heat and wear.

FINISHING

STELLITE 3 is more difficult to machine than **STELLITE 6**, but can be turned with carbide tip tools. If the hardness exceeds RC55, grinding is the preferred method. The material should be stress-relieved for machining.

KENNAMETAL STELLITE

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)	1000°C (1832°F)
µ-inch/inch.°F	5.83	6.28	6.56	6.72	6.94	7.11	7.5	7.72	8.0	8.2

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp (0.2%)		Elongation	Elastic Modulus	
	Ksi	MPa	ksi	MPa	A(%)	psi	MPa
Casting	80	551	–	–	<1	36,000	248,000

NOMINAL HOT HARDNESS (DPH)

	20°C (68°F)	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
Casting	606	573	540	508	485	453	406	330	217	140

THERMAL PROPERTIES

	Approximate Value at Room Temperature
Thermal conductivity	68 BTU-in/hr/ft²/°F

AVAILABLE PRODUCT FORMS:

STELLITE 3 is available as a finished casting and in powder metallurgy components.

DESIGNATION	PRODUCT FORM
UNS R30001	Castings
UNS R30103	Powder Metallurgy

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

STELLITE™ **4 Alloy**

TECHNICAL DATA

CASTING | PTA & LASER WELD DEPOSITION

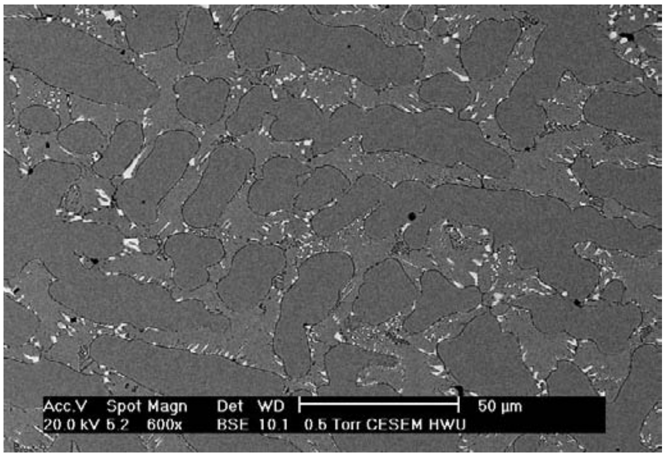
NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	W	C	Others	Hardness	Density	Melting Range
Base	30	14	1	Mn, Fe, Si, Ni	45-49 HRC	8.61 g/cm³ 0.311 lb/in³	1340–1395ºC 2245–2545ºF

STELLITE COBALT-BASED ALLOYS consist of complex carbides in an alloy matrix. They are resistant to wear, galling, and corrosion and retain these properties at high temperatures. Their exceptional wear resistance is due mainly to the unique inherent characteristics of the hard carbide phase dispersed in a CoCr alloy matrix.

STELLITE 4 is a cobalt-based alloy having greater wear resistance than **STELLITE 6** and is used for applications subject to only moderate mechanical shock. It is a machinable casting alloy having extremely good high temperature strength due to the higher tungsten and carbon contents. It has very good galling resistance at room and elevated temperatures. It exhibits a very low coefficient of friction when rubbed against itself and hard steels.

STELLITE 4 is often used for dies, hot pressing, and hot extrusion of copper base and aluminum alloys. It has also been used with success in pumps in corrosive and erosive conditions. **STELLITE 4** is also used for bushings and sleeves for Zn-Al hot dipping process.



Stellite 4 Microstructure at 600X

WEAR

The higher tungsten content of **STELLITE 4** gives improved high temperature properties and an increase in abrasive wear resistance over **STELLITE 6**. Adhesive wear is similar to **STELLITE 6**, but resistance improves as the load increases. Galling resistance is excellent. The alloy is brittle and withstands less impact than **STELLITE 6**. This material is suitable for high-temperature abrasion in corrosive environments.

CORROSION RESISTANCE

STELLITE 4 has higher corrosion resistance than **STELLITE 6** in oxidizing environments such as nitric and sulphuric acids. This improvement is due to the higher chromium content in the cobalt-rich matrix, making this material suitable for pump components. The alloy has excellent resistance to manganese di-oxide, carbon particles, and ammonium and zinc chlorides used in the manufacturing of dry batteries. Corrosion resistance will vary depending on acid concentration, temperature, stress, and contamination, thus production exposure tests are recommended.

KENNAMETAL™ STELLITE

www.stellite.com

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
μm/m K	9.50	10.01	10.62	11.00	11.61	12.01	12.42	12.80	13.50
μ-inch/inch °F	5.28	5.56	5.90	6.11	6.45	6.67	6.90	7.11	7.50

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp (0.2%)		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	ksi	MPa
Castings	110	757	80	550	<1%	34,100	235,010

NOMINAL HOT HARDNESS (DPH) AS-CAST

22°C (72°F)	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
505	490	479	438	409	387	333	244	183	124

THERMAL AND ELECTRICAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal Conductivity	15 W/m K	102 BTU-in./hr./ft.^{2}/°F
Electrical Resistivity	91.8 μ-ohm cm	36.1 μ-ohm inch

AVAILABLE PRODUCT FORMS

STELLITE 4 is available as a casting and powder.

DESIGNATION	PRODUCT FORMS
UNS R30404	Castings and Powder

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

STELLITE 6

STELLITE™ 6 ALLOY

TECHNICAL DATA

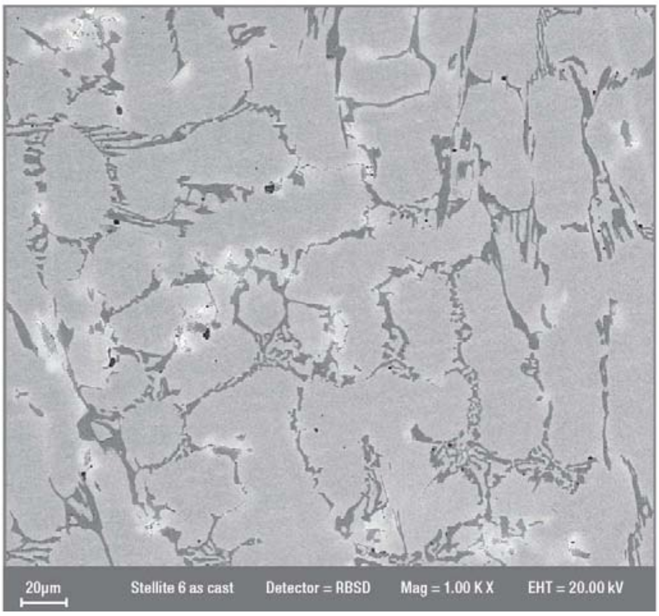
TIG WELD DEPOSITION | MMA WELD DEPOSITION | MIG WELD DEPOSITION | PTA & LASER WELD DEPOSITION | CASTINGS & POWDER METALLURGY | ADDITIVE MANUFACTURING

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	W	C	Others	Hardness	Density	Melting Range
Base	27-32	3-6	0.9-1.4	Ni, Fe, Si, Mn, Mo	36-45 HRC 380-490 HV	8.44 g/cm³ 0.305 lb/in³	1250-1360ºC 2282-2480ºF

STELLITE COBALT-BASED ALLOYS consist of complex carbides in an alloy matrix. They are resistant to wear, galling, and corrosion and retain these properties at high temperatures. Their exceptional wear resistance is due mainly to the unique inherent characteristics of the hard carbide phase dispersed in a CoCr alloy matrix.

STELLITE 6 is the most widely used of the wear-resistant cobalt-based alloys and exhibits good all-round performance. It is regarded as the industry standard for general-purpose wear-resistance applications, has excellent resistance to many forms of mechanical and chemical degradation over a wide temperature range, and retains a reasonable level of hardness up to 500°C (930°F). It also has good resistance to impact and cavitation erosion. **STELLITE 6** is ideally suited to a variety of hardfacing processes and can be turned with carbide tooling. Examples include valve seats and gates, pump shafts and bearings, erosion shields, and rolling couples. It is often used self-mated.



Scanning Electron Micrograph of Cast Stellite 6 at 1000X Magnification.

CORROSION RESISTANCE

The typical electrode potential in sea water at room temperature is -0.25V (SCE). Like stainless steels, **STELLITE 6** corrodes primarily by a pitting mechanism and not by general mass loss in seawater and chloride solutions. Its mass loss in sea water is below 0.05mm per year at 22°C. More information regarding corrosion resistance can be provided on request

KENNAMETAL™ STELLITE

www.stellite.com

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)	1000°C (1832°F)
µm/m K	11.35	12.95	13.6	13.9	14.2	14.5	14.7	15.05	15.5	17.5
µ-inch/inch °F	6.31	7.20	7.56	7.72	7.89	8.06	8.17	8.36	8.61	9.72

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp(0.2%)		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	psi	GPa
Castings	123	850	101.5	700	<1	30.3×10^6	209

NOMINAL HOT HARDNESS (DPH) AS-CAST

20°C (68°F)	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
410	390	356	345	334	301	235	155	138	95

THERMAL AND ELECTRICAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal conductivity	14.82 W/m.K	102.7 Btu-in/hr/ft²/°F
Electrical resistivity	106 µ-ohm.cm	41.7 µ-ohm.inch

SPECIFICATION	PRODUCT FORM
UNS R30006	Rod, Castings
UNS R30106	P/M Parts
UNS W73006	Electrode
UNS W73036	Wire
AMS 5387, AMS 5373	Castings
AMS 5788	Rod, Wire
AMS 7239	P/M Parts

PRODUCT FORMS AND CROSS-REFERENCE SPECIFICATIONS

STELLITE 6 is available as a spooled welding wire (solid and cored), rod, powder, electrodes, finished castings, powder metallurgy components, and additively manufactured components. A separate brochure is available for the wrought forms of this alloy, namely **STELLITE 6B** and **STELLITE 6K**.

STELLITE 6 can be supplied to the following specifications:

SPECIFICATION	PRODUCT FORM
AWS A5.21 / ASME BPVC IIC SFA 5.21 ERCoCr-A	Rod
AWS A5.21 / ASME BPVC IIC SFA 5.21 ERCCoCr-A	Wire
AWS A5.13 / ASME BPVC IIC SFA 5.13 ECoCr-A	Electrode

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

STELLITE 12

STELLITE™ 12 ALLOY

TECHNICAL DATA

TIG & OXY-ACETYLENE WELDING I MMA WELD DEPOSITION I MIG WELD DEPOSITION I PTA & LASER WELD DEPOSITION I CASTINGS & POWDER METALLURGY I CLADDING

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	W	C	Others	Hardness	Density	Melting Range
Base	27-32	7.5-9.5	1.4-2.0	Ni, Fe, Si, Mn	45-51 HRC 435-590 HV	8.53 g/cm³ 0.308 lb/in³	1225-1280°C 2240-2335°F

STELLITE COBALT-BASED ALLOYS consist of complex carbides in an alloy matrix. They are resistant to wear, galling, and corrosion and retain these properties at high temperatures. Their exceptional wear resistance is due mainly to the unique inherent characteristics of the hard carbide phase dispersed in a CoCr alloy matrix.

Stellite 12 could be considered an intermediate alloy between **Stellite 6** and **Stellite 1**. It contains a higher fraction of hard, brittle carbides than **Stellite 6**, and has increased resistance to low-angle erosion, abrasion, and severe sliding wear whilst retaining reasonable impact and cavitation resistance. **Stellite 12** is often used self-mated or running against **Stellite 6** or **Stellite 1**. The higher tungsten content provides better high temperature properties compared to **Stellite 6**, and it can be used at temperatures up to about 700°C.

Stellite 12 is typically used for cutting tools that need to withstand abrasion, heat, and corrosion. Examples include industrial knives for cutting carpets, plastics, paper and synthetic fibres; and saw tips in the timber industry. It is also used for control plates in the beverage industry, pump vanes, bearing bushes and narrowneck glass mold plungers; and for hardfacing of engine valves, pinch rollers in the metal-processing industries, and rotor blade edges.

Optical Micrograph of a Stellite 12 PTA Deposit at 500X.

CORROSION RESISTANCE

The typical electrode potential in sea water at room temperature is approximately -0.3 V (SCE). Like stainless steels, **Stellite 12** corrodes primarily by a pitting mechanism and not by general mass loss in seawater and chloride solutions. Information regarding corrosion resistance in other corrosive environments can be provided on request.

KENNAMETAL STELLITE

www.stellite.com

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)	1000°C (1472°F)
µm/m.K	11.5	12.1	12.6	12.9	13.3	13.8	14.3	14.8	15.2	15.6
µ-inch/inch.°F	6.4	6.7	7.0	7.2	7.4	7.7	7.95	8.2	8.45	8.7

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp(0.2%)		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	psi	GPa
Castings	107	740	84	580	<1	$32.8x10^6$	226

NOMINAL HOT HARDNESS (DPH) AS-CAST

20°C (68°F)	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
546	456	418	390	380	371	362	328	232	153

THERMAL AND ELECTRICAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal conductivity	14.6 W/m.K	100 Btu-in/hr/ft²/°F
Electrical resistivity	98 µ-ohm.cm	38.6 µ-ohm.inch

SPECIFICATION	PRODUCT FORM
UNS R30012	Rod, Castings
UNS W73012	Electrode
UNS W73042	Wire

PRODUCT FORMS AND CROSS-REFERENCE SPECIFICATIONS

Stellite 12 is available as welding wire, rod, powder, electrodes, finished castings, pressed and extruded powder metallurgy components, and claddings.

Stellite 12 can be supplied to the following specifications:

SPECIFICATION	PRODUCT FORM
AWS A5.21 / ASME BPVC IIC SF A 5.21 ERCoCr-B	Rod
AWS A5.21 / ASME BPVC IIC SF A 5.21 ERCCoCr-B	Wire
AWS A5.13 / ASME BPVC IIC SF A 5.13 ECoCr-B	Electrode

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

STELLITE™ 13 ALLOY

TECHNICAL DATA

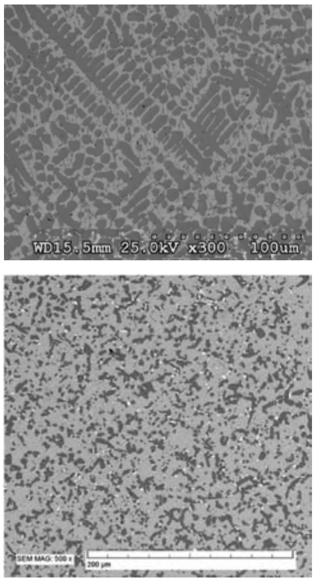
CASTINGS & POWDER METALLURGY | TIG WELD DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	W	Ni	C	Others	Hardness	Density	Melting Range
Base	28	20	5.0	0.9	V, Fe, Si, Mn	45–50HRC	9.02 g/cm³ 0.326 lb/in³	1230–1300°C 2246-2372°F

STELLITE COBALT-BASED ALLOYS consist of complex carbides in an alloy matrix. They are resistant to wear, galling, and corrosion and retain these properties at high temperatures. Their exceptional wear resistance is due mainly to the unique inherent characteristics of the hard carbide phase dispersed in a CoCr alloy matrix.

Stellite 13 was designed for good general resistance to wear, erosion, and oxidation. **Stellite 13** is used in a range of applications where a strong balance of wear and corrosion properties are required while also retaining good ductility and machinability. It has improved corrosion resistance relative to Stellite grades such as Stellite 6, Stellite 12, and Stellite 3.



Stellite 13 microstructure, Cast (top), P/M (bottom)

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Tensile Strength		Yield Strength		Elongation
	ksi	MPa	ksi	MPa	A(%)
Casting	115	790	90	620	1-3%

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 21C/70F TO STATED TEMPERATURE)

	204°C (400°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)	871°C (1600°F)	982°C (1800°F)
µ-inch/inch.F	7.0	7.8	8.1	8.4	8.9	9.7

NOMINAL HOT HARDNESS (DPH)

	21°C (70°F)	427°C (800°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)
Casting	440	355	320	310	220

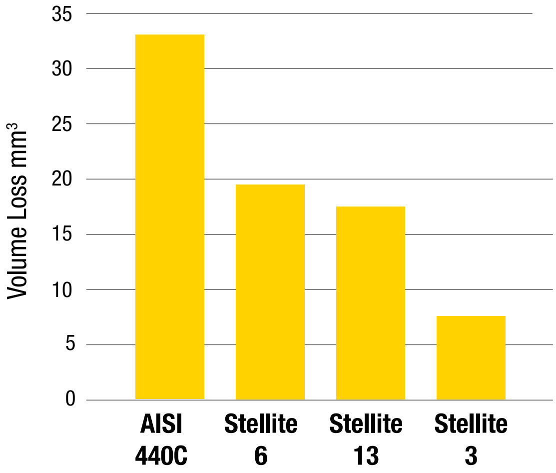
KENNAMETAL™ STELLITE

www.stellite.com

WEAR RESISTANCE

Like Stellite 6, **Stellite 13** exhibits good all-round performance and has excellent resistance to many forms of mechanical and chemical degradation over a wide temperature range. Stellite 13 has better abrasion wear resistance than Stellite 6 – the industry standard for general-purpose wear resistance and much better wear resistance than the hardest AISI 440C martensitic stainless steel.

DRY SAND ABRASION TEST (ASTM G65 PROC. B)

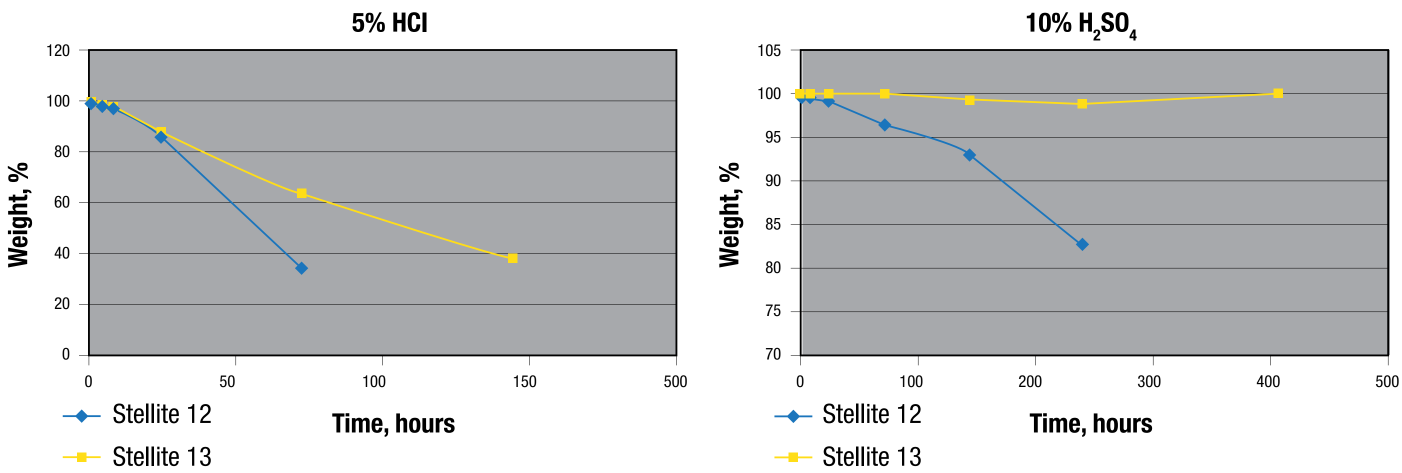


LOWER VALUES INDICATE IMPROVED ABRASION RESISTANCE

CORROSION RESISTANCE

The lower Carbon content in **Stellite 13** leaves more Chromium in the alloy matrix, enhancing the corrosion resistance. As a comparison, **Stellite 13** has significantly better corrosion resistance compared to Stellite 12 in HCl and H_2SO_4.

WEIGHT LOSS DURING IMMERSION CORROSION TEST (ROOM TEMPERATURE)



AVAILABLE PRODUCT FORMS:

Stellite 13 is available as a casting, powder metallurgy components, and solid welding wire.

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

STELLITE 19

STELLITE™ 19 ALLOY

TECHNICAL DATA

CASTINGS | POWDER METALLURGY

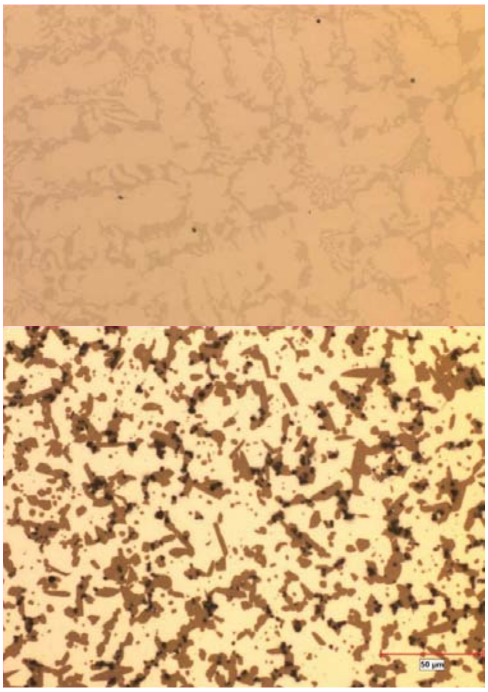
NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	W	C	Si	Others	Hardness	Density	Melting Range
Base	31	10.5	1.9	1.0	Ni, Fe	51-53 HRC	8.36 g/cm³ 0.302 lb/in³	1239-1299°C 2263-2370°F

STELLITE™ COBALT-BASED ALLOYS consist of complex carbides in an alloy matrix. They are resistant to wear, galling, and corrosion and retain these properties at high temperatures. Their exceptional wear resistance is due mainly to the unique inherent characteristics of the hard carbide phase dispersed in a CoCr alloy matrix.

STELLITE 19 is resistant to severe shock and has excellent red-hardness for applications such as cutting tools, machinery parts, high temperature bearing races, nozzle discs, and burnishing rollers.

One of the outstanding properties of **STELLITE 19** is its ability to remain hard at red heat. This denotes a range of temperatures from 932 to 1562°F. **STELLITE 19** has impact resistance that is comparable to high-speed steels but has much higher red hardness.
STELLITE 19 can be used at higher speeds than high-speed steels. Its excellent resistance to corrosion from many common chemicals combined with its abrasion-resistant qualities makes the use of this alloy economical for machining such materials as plastics and rubber, which liberate corrosives that are used in their manufacture.



Stellite 19 PM (top) & Cast (bottom) microstructure

KENNAMETAL STELLITE

www.stellite.com

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp (0.2%)		Elongation
	ksi	MPa	ksi	MPa	A(%)
Casting	105	725	near UTS		<1%
Powder Metallurgy	150	1035	near UTS		<1%

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)	1000°C (1832°F)
µm/m.K	12.78	12.96	13.68	13.86	14.22	14.22	14.76	15.12	15.66	16.92
µ-inch/inch.F	7.1	7.2	7.6	7.7	7.9	7.9	8.2	8.4	8.7	9.4

NOMINAL HOT HARDNESS (HRC)

	20°C (68°F)	93°C (200°F)	204°C (400°F)	316°C (600°F)	427°C (800°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)	871°C (1600°F)
Casting	58	56	54	52	50	47	45	39	27

AVAILABLE PRODUCT FORMS:

STELLITE 19 is available as a casting and powder metallurgy components.

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

STELLITE 20

STELLITE™ 20 ALLOY

TECHNICAL DATA

CASTINGS & POWDER METALLURGY | TIG & OXY-ACELYLENE WELDING | MMA WELD DEPOSITION | PTA WELD DEPOSITION | SPRAY & FUSE

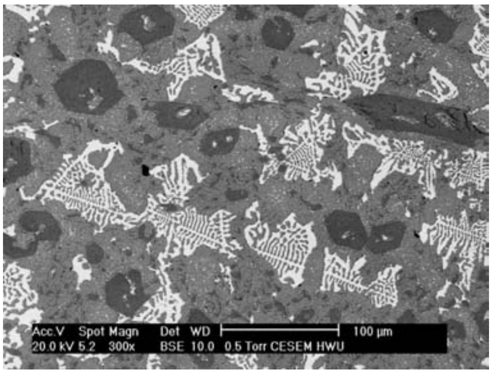
NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	W	C	Ni	Others	Hardness	Density	Melting Range
Base	32.5	17.5	2.5	<2.0	Mo, Fe, Si	53-62 HRC	8.77 g/cm^3 0.317 lb/in^3	1263-1301°C 2305-2374°F

STELLITE™ COBALT-BASED ALLOYS consist of complex carbides in an alloy matrix. They are resistant to wear, galling, and corrosion and retain these properties at high temperatures. Their exceptional wear resistance is due mainly to the unique inherent characteristics of the hard carbide phase dispersed in a CoCr alloy matrix.

STELLITE 20 is one of the most abrasion-resistant standard cobalt-base alloys. It also has good corrosion resistance. While it has low shock resistance, it is often the only answer for some environments where chemical resistance, in addition to abrasion resistance, is required.

STELLITE 20 has been used in slurry pumps, pump sleeves, rotary seal rings, wear pads, and bearing sleeves.



Stellite 20 microstructure at 300x magnification.

KENNAMETAL™ STELLITE

www.stellite.com

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp (0.2%)		Elongation
	ksi	MPa	ksi	MPa	A(%)
Casting	80	550	near UTS		<1%

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
µm/m.K	10.01	10.46	10.8	11.23	11.65	12.06	12.53	12.89	13.41
µ-inch/inch.F	5.56	5.81	6.00	6.24	6.47	6.7	6.96	7.16	7.45

NOMINAL HOT HARDNESS (DPH)

	20°C (68°F)	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
Casting	670	600	552	516	476	441	412	340	245	132

AVAILABLE PRODUCT FORMS:

STELLITE 20 is available as a casting, powder metallurgy components, rod, and powder.

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

STELLITE 21

STELLITE™ 21 ALLOY

TECHNICAL DATA

TIG WELD DEPOSITION | MMA WELD DEPOSITION | MIG WELD DEPOSITION | PTA & LASER WELD DEPOSITION | CASTINGS & POWDER METALLURGY | ADDITIVE MANUFACTURING

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	Mo	C	Ni	Others	Hardness**	Density	Melting Range
Base	26-29	4.5-6.0	<0.35	<3.0	Fe, Si, Mn	27-40 HRC** 290-430 HV**	8.33 g/cm³ 0.301 lb/in³	1295-1435ºC 2360-2615ºF

**Higher values indicate a typical work-hardened surface. Stellite 21 can work harden up to 550HV (48HRC).

STELLITE COBALT-BASED ALLOYS consist of complex carbides in an alloy matrix. They are resistant to wear, galling, and corrosion and retain these properties at high temperatures. Their exceptional wear resistance is due mainly to the unique inherent characteristics of the hard carbide phase dispersed in a CoCr alloy matrix.

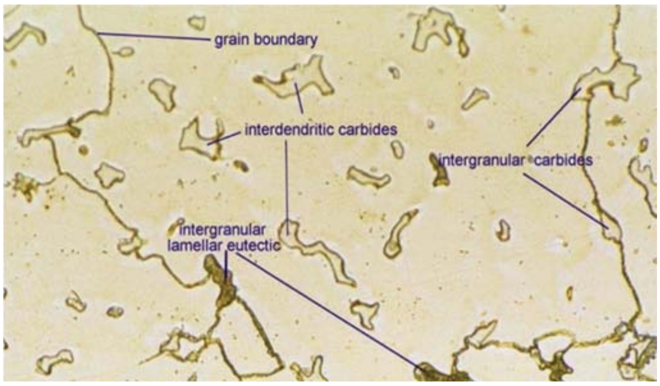
Stellite 21 (previously known as **Stellite 8**) was developed in the mid 1930s as a corrosion-resistant CoCr alloy, and rapidly found application as a biocompatible hip implant and denture alloy. Many of the alloys currently used in medical applications are variants of the original **Stellite 21** composition. It was also one of the first heat-resistant alloys trialed for use in jet engines.

Stellite 21 consists of a CoCrMo alloy matrix containing dispersed hard carbides which strengthen the alloy and increase its hardness, but also decrease the ductility. The type, shape, size, and distribution of the carbides is strongly influenced by the processing history of the alloy, and for this reason the mechanical properties of **Stellite 21** are very dependent upon the manufacturing route and any subsequent heat treatments.

Due to the low volume fraction of carbides, the Co-based alloy matrix dominates the wear and corrosion properties. **Stellite 21** has excellent cavitation, galling, and metal-to-metal sliding wear resistance, but is not recommended for severe hard particle abrasion. The surface can work harden considerably during wear or even during machining, and the use of correct machining tools and techniques is important to achieve optimal results.

Stellite 21 has excellent resistance to thermal and mechanical shock. Optimum high temperature strength is obtained by solution heat treatments at 1200–1240C (2190–2265F) followed by quenching, and aging in the temperature range 700–1150C (1290–2100F).

Stellite 21 can be cast, powder metallurgically processed, or applied as a weld hardfacing. It is recommended for applications involving cavitation, erosion, corrosion and/or high temperatures, such as valve trim for petrochemical and power generation. Due to its good impact resistance, it has been widely used in the building up of forging or hot stamping dies. The oxyacetylene weld deposition method is not recommended for this alloy.



Optical Micrograph of a Stellite 21 investment casting (as-cast, etched, 200X). The carbides in Stellite 21 are usually of the type $(Cr,Mo,Co)_{23}C_6$

CORROSION RESISTANCE

Stellite 21 is resistant to oxidizing and reducing gaseous atmospheres up to 1150°C (2100°F). Because its ternary alloying element is Mo and not W, it has higher resistance to reducing or complex environments (e.g. sulphuric acid, hydrochloric acid, and sour gas) than CoCrW alloys such as Stellite 6. The typical electrode potential in sea water at room temperature is approximately -0.3 V (SCE). Like stainless steels, **Stellite 21** corrodes primarily by a pitting mechanism and not by general mass loss in seawater and chloride solutions. More information regarding corrosion resistance can be provided on request.

KENNAMETAL™ STELLITE

www.stellite.com

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
µm/m.K	11.0	11.2	12.0	12.65	13.1	13.6	14.3	14.7	15.21
µ-inch/inch.°F	6.1	6.2	6.7	7.0	7.3	7.6	7.9	8.2	8.45

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

NOTE: The mechanical properties of Stellite 21 are dependent upon the manufacturing route and heat treatment.

	Ultimate Tensile Strength Rm		Yield Stress Rp(0.2%)		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	psi	GPa
Castings	103	710	82	565	9	36.2×10^6	250

NOMINAL HOT HARDNESS (DPH) OF UNDILUTED WELD DEPOSIT

20°C (68°F)	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
347	279	248	228	208	197	181	153	123	92

THERMAL AND ELECTRICAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal conductivity	14.5 W/m.K	100.5 Btu-in/hr/ft²/°F
Electrical resistivity	87.38 µ-ohm.cm	34.4 µ-ohm.inch

SPECIFICATION	PRODUCT FORM
UNS R30021	Rod, Castings
UNS W73041	Wire
UNS W73021	Electrode
AMS 5385	Castings
AMS 5819	Rod, Wire

PRODUCT FORMS AND CROSS-REFERENCE SPECIFICATIONS

Stellite 21 is available as welding wire, rod, powder, electrodes, finished castings, and powder-metallurgically produced (P/M) parts.

Stellite 21 can be supplied to the following specifications:

SPECIFICATION	PRODUCT FORM
AWS A5.21 / ASME BPVC IIC SFA 5.21 ERCoCr-E	Rod
AWS A5.21 / ASME BPVC IIC SFA 5.21 ERCCoCr-E	Wire
AWS A5.13 / ASME BPVC IIC SFA 5.13 ECoCr-E	Electrode

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

STELLITE 25

STELLITE™ 25 ALLOY

TECHNICAL DATA

CASTINGS I TIG & OXY-ACETYLENE WELDING I MMA WELD DEPOSITION I MIG WELD DEPOSITION I PTA & LASER WELD DEPOSITION I HVOF & PLASMA SPRAY DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	W	C	Others	Hardness	Density	Melting Range
Base	20	15	0.1	Ni, Fe, Si, Mo, Mn	20-45 HRC*	8.31 g/cm³ 0.300 lb/in³	1329-1410°C 2425-2573°F

**Hardness dependent on amount of work hardening.*

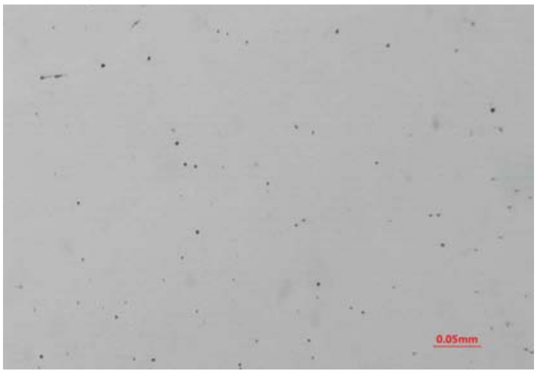
STELLITE™ COBALT-BASED ALLOYS consist of complex carbides in an alloy matrix. They are resistant to wear, galling, and corrosion and retain these properties at high temperatures. Their exceptional wear resistance is due mainly to the unique inherent characteristics of the hard carbide phase dispersed in a CoCr alloy matrix.

STELLITE 25 is a tungsten-strengthened cobalt-chromium alloy and is the cast version of the wrought alloy L605, and is also available in hardfacing wire, rod, and powder. This special low-carbon alloy has been found to have exceptional thermal fatigue resistance and is useful for tools to work hot steel. The alloy also resists hot metal-on-metal wear.

STELLITE 25 is often used for metal-working tools where a combination of metal-on-metal wear, thermal fatigue, and hot corrosion resistance are required, such as piercing points, forming tools, extrusion dies, and furnace hardware.

CORROSION RESISTANCE

STELLITE 25 is resistant to oxidation and carburization up to 1900°F. The alloy resists wet chlorine at ambient temperatures and is resistant to nitric and hydrochloric acids under certain conditions. Exposure testing is recommended to verify performance.



Stellite 25 cast microstructure at 200x magnification

WEAR

STELLITE 25 forms a protective oxide film during hot metal-on-metal wear, which prevents metal transfer and damage due to adhesion. The alloy is resistant to thermal cracking and surface fatigue. Since the microstructure is relatively free of carbide reinforcement, it is not recommended for low-stress or low-angle particle erosion service.

FINISHING

Carbide tools allow a variety of conventional machining operations. Use positive rake angle to avoid burnishing since the alloy work hardens readily. Sharp tools and coolant are recommended for drilling.

KENNAMETAL™ STELLITE

www.stellite.com

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	93°C (200°F)	204°C (400°F)	316°C (600°F)	427°C (800°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)	871°C (1600°F)	982°C (1800°F)
µm/m.K	12.24	12.96	13.68	14.04	14.4	14.76	15.48	16.38	16.92
µ-inch/inch.F	6.80	7.20	7.60	7.80	8.00	8.20	8.60	9.10	9.40

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp (0.2%)		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	ksi	GPa
Casting	134	925	130	895	5	30,000	207

NOMINAL HOT HARDNESS (BRINELL HARDNESS NUMBER)

	20°C (68°F)	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
Casting	350	–	–	–	–	280	–	–	–	130

THERMAL AND ELECTRICAL PROPERTIES

	Approximate Value at Room Temperature
Thermal conductivity	65 BTU-in/hr/ft²/°F
Electrical resistivity	34.9 µ-ohm.in

AVAILABLE FORMS

STELLITE 25 is available as welding wire, rod, powder, and electrodes as well as finished castings.

DESIGNATION	PRODUCT FORM
UNS R30605	Casting

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

STELLITE 31

STELLITE™ **31 ALLOY**

TECHNICAL DATA

CASTINGS & POWDER METALLURGY | HVOF & PLASMA SPRAY DEPOSITION | PTA WELD DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	W	C	Ni	Others	Hardness	Density	Melting Range
Base	26	7.5	0.5	10.5	Mo, Fe, Si	25-35 HRC *	8.61 g/cm³ 0.311 lb/in³	1340-1395°C 2245-2545°F

** Hardness dependent on amount of work hardening.*

STELLITE™ COBALT-BASED ALLOYS consist of complex carbides in an alloy matrix.They are resistant to wear, galling, and corrosion and retain these properties at high temperatures.Their exceptional wear resistance is due mainly to the unique inherent characteristics of the hard carbide phase dispersed in a CoCr alloy matrix.

STELLITE 31 is a cobalt-base, high-temperature superalloy having high tensile and creep properties.It is superior in stress-rupture properties to many alloys commercially available, especially at 1700°F (926°C) and 1800°F (980°C). **STELLITE 31** is resistant to oxidizing and reducing atmospheres up to 2100°F (1150°C).It has excellent resistance to thermal and mechanical shock. Due to its high temperature properties, **STELLITE 31** is often used in gas turbine engines in areas subject to hot gas erosion, as well as furnace working tools that require a combination of mechanical integrity and hot wear resistance.

CORROSION RESISTANCE

STELLITE 31 is resistant to both oxidizing and reducing gases up to 2100°F (1150°C) and hence prevents scaling of gas turbine components. This alloy has excellent resistance to nitric and phosphorus acids, and at room temperature to sulfuric acid. **STELLITE 31** is superior to **STELLITE 6** in hydrochloric acid. Exposure test coupons should be used to verify performance when possible due to variations resulting from temperature, pH concentrations, and contamination.

Stellite 31 cast microstructure

WEAR

During sliding, hot metal-on-metal wear, **STELLITE 31** forms an adherent oxide film which helps to prevent adhesive transfer. This has been used to advantage in jet engine spacer bushings and burner can retaining nuts. **STELLITE 31** is useful where thermal fatigue is combined with metal-on-metal wear and has been successfully used for metal-working tools, such as extrusion dies and drills used to tap metallurgical furnaces.

FINISHING

Due to the rate of work hardening in the solution annealed condition, it is best to machine this alloy in the aged condition. The alloy can be machined by all common methods using carbide tools. Low speeds and a positive cut will help to avoid burnishing.

KENNAMETAL™ STELLITE

www.stellite.com

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
µm/m.K	10.49	11.75	12.49	13.05	13.45	13.9	14.35	14.8	15.19
µ-inch/inch.F	5.83	6.53	6.94	7.25	7.47	7.72	7.97	8.22	8.44

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp (0.2%)		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	ksi	GPa
Casting	107	740	63	430	10	30,000	207

NOMINAL HOT HARDNESS (BRINELL HARDNESS NUMBER)

	20°C (68°F)	93°C (200°F)	204°C (400°F)	316°C (600°F)	427°C (800°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)	871°C (1600°F)	982°C (1800°F)
Casting	228	–	–	165	162	139	137	125	116	64

THERMAL AND ELECTRICAL PROPERTIES

	Approximate Value at Room Temperature
Thermal conductivity	102 BTU-in/hr/ft²/°F
Electrical resistivity	38.2 µ-ohm.inch

PRODUCT FORMS AND CROSS-REFERENCE SPECIFICATIONS

STELLITE 31 is available as a casting, powder metallurgy components, and powder.

SPECIFICATION	PRODUCT FORM
UNS R30031	Castings, P/M Components, Powder
AMS 5382	Castings
ASTM A732 Gr.31	Castings

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

STELLITE 190

STELLITE™ 190 ALLOY

TECHNICAL DATA

I TIG & OXY-ACETYLENE WELDING I PTA & LASER WELD DEPOSITION I

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	W	C	Fe	Others	Hardness	Density	Melting Range
Base	27	14	3.3	<3	Ni, Si, Mo, Mn	52-60 HRC 570-760 HV	8.66 g/cm³ 0.313 lb/in³	1200-1335°C 2192-2435°F

Stellite 190 is a highly abrasion-resistant alloy, primarily used for the hardfacing of bearing journals in tricone rotary rock bits used in the oil and gas industry. Tricone bits operate in hot and extremely abrasive downhole conditions. Due to the high proportion of carbides, which provide the abrasion resistance, care must be taken to minimize cooling stresses incurred during hardfacing and to avoid service conditions which involve severe mechanical or thermal shock.

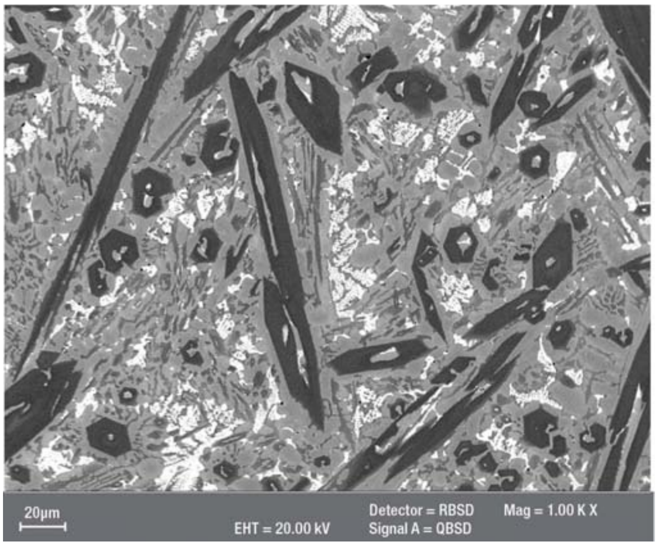
Stellite 190 can only be finished by grinding.

CORROSION RESISTANCE

Stellite 190 is not designed primarily as a corrosion-resistant alloy, although it may be expected to have reasonable corrosion resistance to brackish water and mildly oxidizing environments. The high carbide content reduces its corrosion resistance relative to other CoCrW alloys, such as Stellite 6.

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

Stellite 190 is not designed to be a casting alloy. For small components of simple geometry requiring extreme abrasion resistance and not subject to severe mechanical shock, HIP-consolidated parts can be manufactured. The Charpy Impact Energy (unnotched) of HIP-consolidated Stellite® HS-190 is lower (5-10 J) than that of cast Stellite 6 (typically 10-15 J).



Scanning Electron Micrograph of a Stellite 190 Oxy-Acetylene Weld Deposit at 1000X magnification.

The chrome-rich primary carbide which gives the alloy its exceptional abrasion resistance can be seen as a dark rod-like phase in longitudinal cross section, and also as a roughly hexagonal phase when sectioned transverse to its length. The small grey dispersed particles are a secondary (Cr,W) carbide and the white phase is a tungsten-rich complex carbide. All of these carbides are dispersed in a light grey CoCr alloy matrix, which is solid-solution strengthened with extra tungsten for excellent heat resistance.

KENNAMETAL™ STELLITE

www.stellite.com

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp(0.2%)		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	psi	GPa
Stellite HS-190 (*)	167	1155	137	950	0.2	32.2	223

*"HS" = HIP-consolidated from the powder form

NOMINAL HOT HARDNESS (DPH) AS-DEPOSITED

	22°C (72°F)	427°C (800°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)
GTAW (TIG) deposit	495	355	305	295	255
Oxy-acet. deposit	570	No hardness data is available for higher temperatures, but the hardness can be expected to be above that of a GTAW deposit at all temperatures.			

PRODUCT FORMS AND CROSS-REFERENCE SPECIFICATIONS

Stellite 190 is available as welding rod and powder. It can be supplied to the following specifications, as well as to individual customer specifications:

SPECIFICATION	PRODUCT FORM
UNS R30014	Rod, Powder
AWS A5.21 / ASME BPVC IIC SFA 5.21 ERCoCr-G	Rod

SALES OFFICE - COMPONENTS
Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES
Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

STELLITE 250

STELLITE™ 250 ALLOY

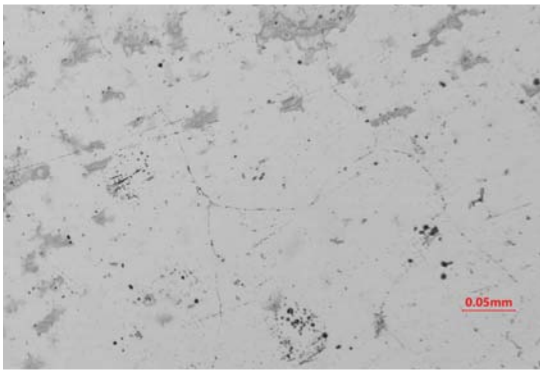
TECHNICAL DATA

CASTINGS | TIG & OXY-ACETYLENE WELDING | MMA WELD DEPOSITION | PTA & LASER WELD DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	Fe	C	Si	Others	Hardness	Density	Melting Range
Base	28	20	0.1	1.0	Mn	18-29 HRC	8.05 g/cm³ 0.291 lb/in³	1380-1395°C 2515-2540°F

STELLITE™ COBALT-BASED ALLOYS consist of complex carbides in an alloy matrix. They are resistant to wear, galling, and corrosion and retain these properties at high temperatures. Their exceptional wear resistance is due mainly to the unique inherent characteristics of the hard carbide phase dispersed in a CoCr alloy matrix.



Stellite 250 cast microstructure at 200x

STELLITE 250 is a cobalt-chromium-iron heat-resistant alloy with excellent resistance to thermal shock, oxidation, and hot corrosion. **STELLITE 250** is suitable for various uses in heat treatment furnaces or metallurgical industrial furnaces such as roasters and smelters. Potential applications include thermowells, tuyeres, lances, gaskets, grates, trays, skids for slab-reheat furnaces, gas and pulverized coal burners, discharge rolls and channels, radiant tube supports, and certain parts in contact with molten slags and ore. **STELLITE 250** is designed to resist carburization and sulphidization of furnace components, and is machinable.

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp (0.2%)		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	ksi	GPa
Casting	80	551	46	314	8	31,000	214

NOMINAL HOT HARDNESS (DPH)

	22°C (72°F)	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
Casting	250	245	235	222	210	195	180	163	107	75

Available Product Forms: STELLITE 250 is available in finished castings, rod, and powder.

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

STELLITE 694

STELLITE™ **694 ALLOY**

TECHNICAL DATA

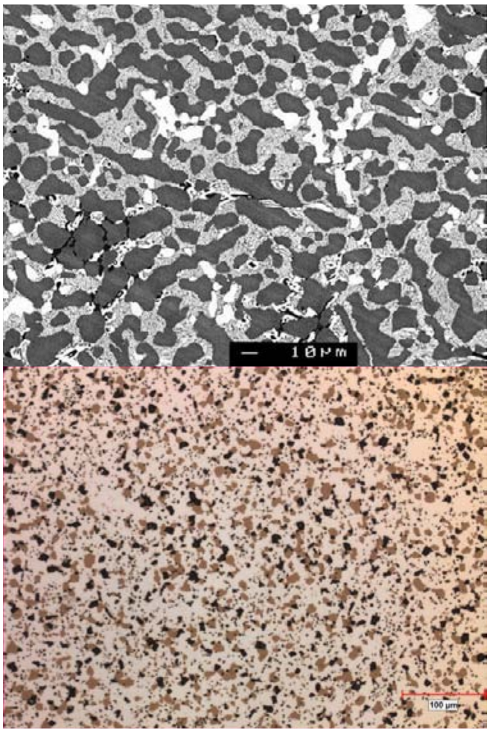
CASTINGS & POWDER METALLURGY I TIG WELDING I PTA & LASER WELD DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	W	Ni	C	Others	Hardness	Density	Melting Range
Base	28.5	19.5	5.0	0.9	V, Fe, Si, Mn	44-50HRC	9.02 g/cm^3 0.326 lb/in^3	1237-1296°C 2259-2365°F

STELLITE™ COBALT-BASED ALLOYS consist of complex carbides in an alloy matrix. They are resistant to wear, galling, and corrosion and retain these properties at high temperatures. Their exceptional wear resistance is due mainly to the unique inherent characteristics of the hard carbide phase dispersed in a CoCr alloy matrix.

STELLITE 694 is a cobalt-chromium alloy which has a high tungsten content to ensure high matrix strength at elevated temperatures (up to 1148ºC or 2100ºF). This alloy exhibits good resistance to wear, creep, erosion, thermal fatigue, and oxidation. The principal application is for hard-facing turbine blade interlock surfaces. Used in gas turbine parts where a higher hardness than **STELLITE 31** is required.



Stellite 694 microstructure, Cast (top), PM (bottom)

KENNAMETAL STELLITE

www.stellite.com

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength Rm		Yield Stress Rp (0.2%)		Elongation
	ksi	MPa	ksi	MPa	A(%)
Powder Metallurgy	120	830	90	620	3

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 21°C/70°F TO STATED TEMPERATURE)

	204°C (400°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)	871°C (1600°F)	982°C (1800°F)
µ-inch/inch.F	7.0	7.8	8.1	8.4	8.9	9.7

TYPICAL HOT HARDNESS (DPH)

21°C (70°F)	427°C (800°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)
440	355	320	310	220

AVAILABLE PRODUCT FORMS:

STELLITE 694 is available as a casting, powder metallurgy components, solid welding wire, and powder.

SPECIFICATION	PRODUCT FORM
B50TF55	Solid Wire

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

STELLITE 700

STELLITE™ 700 Series Alloys

TECHNICAL DATA

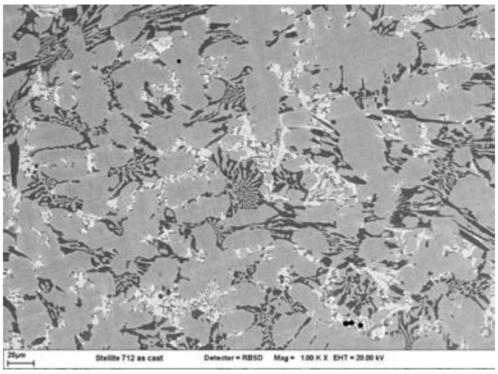
CASTINGS | TIG & OXY-ACETYLENE WELDING | MMA WELD DEPOSITION | MIG WELD DEPOSITION | PTA & LASER WELD DEPOSITION | ULTRAFLEX™ COATINGS | ADDITIVE MANUFACTURING | POWDER METALLURGY

STELLITE™ 700 ALLOYS raise the standards for wear and corrosion resistant alloys. They have the unusual combination of excellent wear resistance and exceptional corrosion resistance in environments that are either reducing or complex.

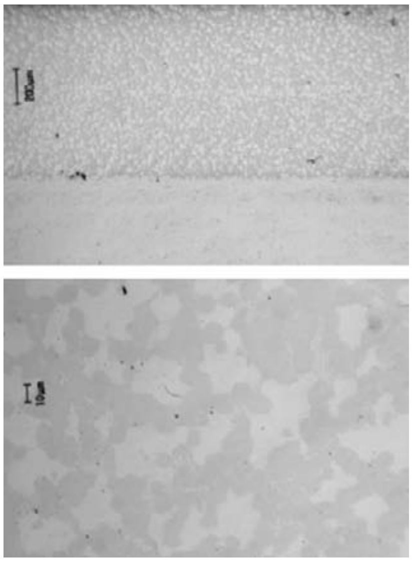
STELLITE 700 ALLOYS are cobalt based with chromium and molybdenum as major alloying elements. The unique combination of wear and corrosion properties result from the high-volume fraction of carbide particles and high degree of solid-solution strengthening from the addition of molybdenum. The **STELLITE 700** alloys have been particularly successful in petrochemical and refinery applications, such as delayed coker-fired heater return bends, catalyst withdrawl lines and conveyance, as well as FCC feed and regenerator air and grid nozzles. Valve seats, slides, and general flow-control applications where corrosion and wear are key considerations are also good candidates. The 700 series alloys have broad application wherever there is a combination of high wear with corrosion.

STELLITE 720 coatings are available with the proprietary UltraFlex™ process, which is able to deliver this extremely wear- and corrosion-resistant alloy to the surfaces of complex and non-line-of-sight components. **STELLITE 720** is also available as additively manufactured components.

STELLITE 700 ALLOYS are based on the traditional Stellite grades 6, 12, 3, and 20, but tungsten has been replaced with molybdenum. This allows them to retain their hardness and wear properties while substantially improving corrosion resistance in reducing environments. The 700 series alloys are more brittle compared to the equivalent traditional Stellite alloys.



Cast Stellite 712 microstructure



UltraFlex™ Stellite 720 coating on INCONEL® 625. Coating thickness of 0.035".

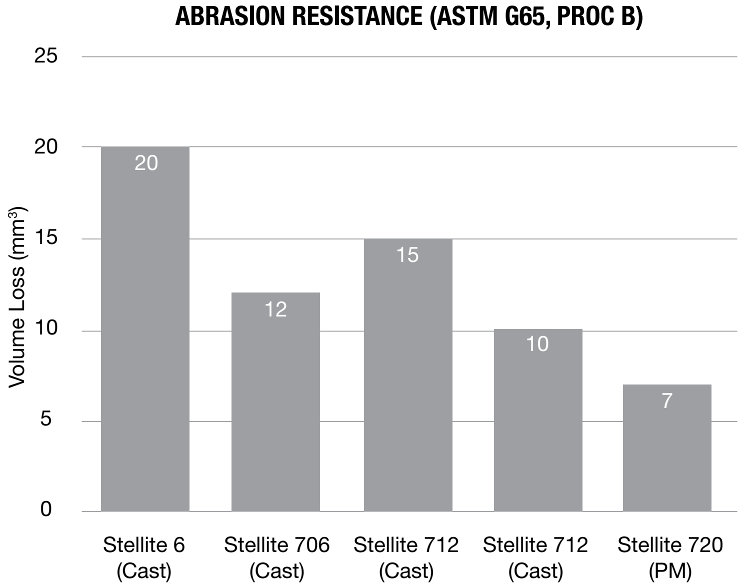
NOMINAL HARDNESS

700 Series Alloy	Hardness (HRC)	Traditional Alloy	Hardness (HRC)
Stellite 706 (5.5% Mo)	~41	Stellite 6 (5.5% W)	~40
Stellite 712 (8.5% Mo)	~51	Stellite 12 (8.5% W)	~48
Stellite 703 (13% Mo)	~53	Stellite 3 (13% W)	~52
Stellite 720 (17.5% Mo)	~60	Stellite 20 (17.5% W)	~58

KENNAMETAL™ STELLITE

www.stellite.com

WEAR PERFORMANCE DATA



CORROSION RESISTANCE*

Lower values indicate less volume loss and better relative corrosion resistance for acids shown.

Acid	Stellite 6	Stellite 706	Stellite 12	Stellite 712
5% HCl, RT	96	40	88	17
5% HCl, 40°C	660	54	540	120
10% H_2SO_4, 66°C	1700	380	2200	420
10% HNO_3, Boiling (oxidizing)	37	110	16	590

*MILS PER YEAR, MPY

AVAILABLE PRODUCT FORMS:

STELLITE 700 series alloys are available as powder metallurgy components, welding rod, wire, and powder.
STELLITE 706, **712**, and **703** are available as castings.
STELLITE 720 is available as an UltraFlex™ coating and additively manufactured components.

INCONEL® is a registered trademark of Huntington Alloys Corporation.

Kennametal Stellite manufactures sophisticated alloys in the form of castings, powders, coatings, consumables, and machined parts that resist wear, corrosion, and abrasion. Information provided in this document is intended only for general guidance about Kennametal Stellite products and is the best information in our possession at the time. Product users may request information about their individual use of our products, but Kennametal Stellite does not warrant or guarantee this information in any way. Selection and purchase of Kennametal Stellite products is the sole responsibility of the product user based on the suitability of each use. Individual applications must be fully evaluated by the user, including compliance with applicable laws, regulations, and non-infringement. Kennametal Stellite cannot know or anticipate the many variables that affect individual product use, and individual performance results may vary. For these reasons, Kennametal Stellite does not warrant or guarantee advice or information in this document, assumes no liability regarding the same, and expressly disclaims any warranty of any kind, including any warranty of fitness for a particular purpose, regarding the same.

SALES OFFICE -
COMPONENTS
Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

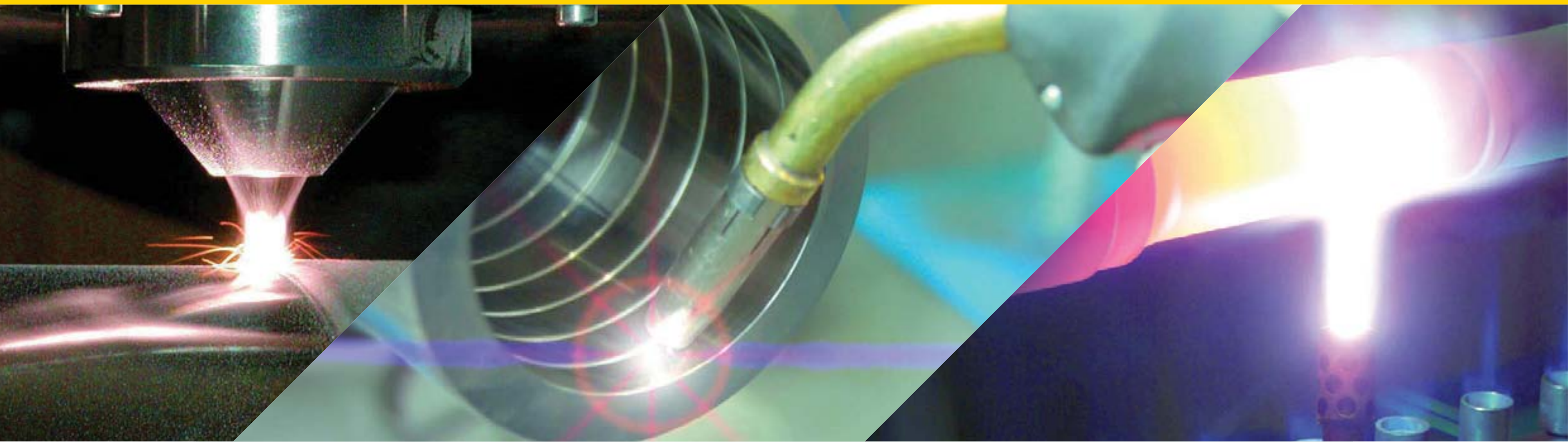
SALES OFFICE -
WELDING CONSUMABLES
Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

SALES OFFICE -
ULTRAFLEX COATINGS
Kennametal Conforma Clad
501 Park East Blvd.
New Albany, Indiana
47150
USA
T: 1 888 289 4590
E-mail: k-nalb.cs@kennametal.com

KENNAMETAL™ STELLITE

www.stellite.com

STELLITE ALLOYS



KENNAMETAL
STELLITE

Stellite Alloys

With over 100 years of proven performance, Kennametal's Stellite™ alloys have become known as the worldwide material solution in wear, heat and corrosion applications. These hardfacing alloys are offered in form of rod, wire, powder, & electrodes and can be tailored to meet individual customer needs.

In addition to welding consumables, Kennametal also offers its expertise

and experience in coating services and technologies such as HVOF, PTA, and spray fuse.

Industries Served

Kennametal utilizes its proven heat, wear, and corrosion experience to create cost effective solutions in some of the most hostile operating environments. As a result, the Stellite™ family of alloys have been become standardized solutions to a broad range of industries, including:

- Aerospace
- Oil & Gas
- Automotive
- Power Generation
- Steel
- Timber
- Glass
- Forging
- Dental
- Food Processing

Table of Contents

KENNAMETAL™
STELLITE

The Stellite Family

Stellite™ Alloys

The cobalt-based Stellite™ alloys are our most well-known and successful alloys, with the best "all-round" properties. They combine excellent mechanical wear resistance, especially at high temperatures, with very good corrosion resistance. The Stellite™ alloys are mostly cobalt based with additions of Cr, C, W, and/or Mo. They are resistant to cavitation, corrosion, erosion, abrasion, and galling. The lower carbon alloys are generally recommended for cavitation, sliding wear, or moderate galling. The higher carbon alloys are usually selected for abrasion, severe galling, or low-angle erosion. Stellite™ 6 is our most popular alloy as it provides a good balance of all of these properties. The Stellite™ alloys retain their properties at high temperatures where they also have excellent oxidation resistance. They are typically used in the temperature range 315 – 600° C (600 – 1112° F). They can be finished to exceptional levels of surface finish with a low coefficient of friction to give good sliding wear.

Deloro™ Alloys

The Deloro™ alloys are nickel based with additions of typically Cr, C, B, Fe, and Si. They cover a very wide range of hardness from soft, tough, build-up alloys that are easily machined or hand finished to exceptionally hard, wear-resistant alloys. They can be selected for hardnesses of between 20 and 62 HRC depending on the application. Their low melting point makes these powders ideal for spray/fuse or powder welding applications. The lower hardness Deloro™ alloys are typically used for glass forming molds. The higher hardness Deloro™ alloys are used in severe wear applications, such as rebuilding the flights of feeder screws, and they can be blended with carbides for an even harder deposit. They maintain their properties up to temperatures of about 315° C (600° F) and also offer good oxidation resistance.

Tribaloy™ Alloys

Tribaloy™ alloys, with either nickel or cobalt base, were developed for applications in which extreme wear is combined with high temperatures and corrosive media. Their high molybdenum content accounts for the excellent dry-running properties of Tribaloy™ alloys and makes them very suitable for use in adhesive (metal-to-metal) wear situations. Tribaloy™ alloys can be used up to 800–1000° C (1472–1832° F).

Nistelle™ Alloys

Nistelle™ alloys are designed for corrosion resistance rather than wear resistance, particularly in aggressive chemical environments where their high chromium and molybdenum contents provide excellent pitting resistance. As a class, they are also generally resistant to high-temperature oxidation and hot gas corrosion. Care should be taken to select the correct alloy for any given corrosive environment.

Stelcar™ Alloys

Stelcar™ alloys are mixtures of carbide particles and nickel- or cobalt-based powders. Due to their construction, Stelcar™ materials are available only in powder form, for application by thermal spraying or weld hardfacing.

Jet Kote™ Powders

Jet Kote™ powders feature a variety alloys developed specifically for HVOF operations. These powders are designed to produce well-bonded, high-density coatings through most HVOF systems.

The JetKote™ portfolio includes powders based on the Stellite™ family and an offering of unique carbide-metal (e.g., WC-Co or Cr3Cr2-NiCr) composite powders which provide exceptional wear resistance.

Delcrome™ Alloys

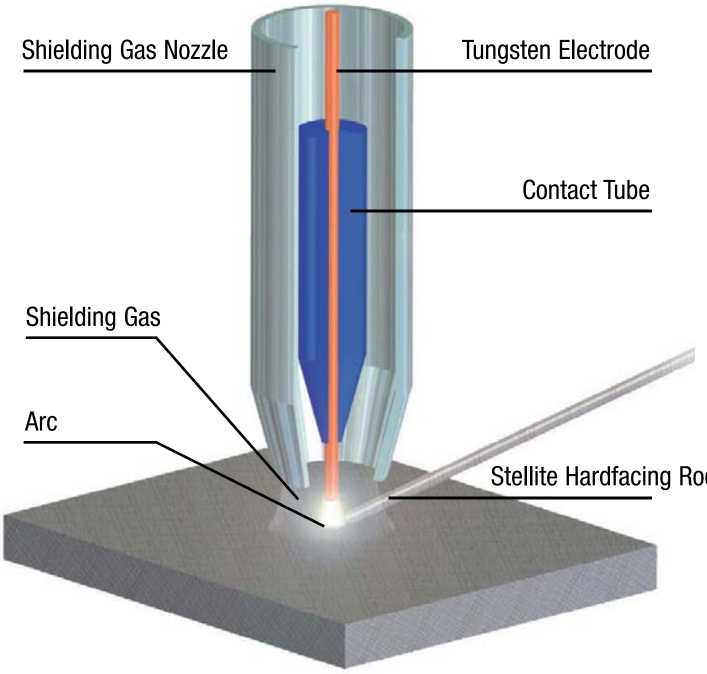
These iron-based alloys were developed to resist abrasive wear at lower temperatures, typically up to 200º C. When compared with our cobalt- and nickel-based alloys, their corrosion resistance is also comparatively low.

Selection Table

	ALLOY	MECHANICAL WEAR	CORROSION	HIGH OPERATING TEMPERATURE
Resistance	**Stellite™**	■■■	■■■	■■■■
■ Low	**Deloro™**	■■■	■■	■■
■■ Satisfactory	**Tribaloy™**	■■■	■■■	■■■■
■■■ Very Good	**Nistelle™**	■	■■■■	■■■
■■■■ Excellent	**Delcrome™**	■■■	■	■■
	Stelcar™	■■■■	■■	■■

TIG and Oxy-Acetylene Welding

In TIG (Tungsten Inert Gas), also known as Gas Tungsten Arc Welding (GTAW), an arc is drawn between a non-consumable tungsten electrode and the workpiece. The electrode, the arc, and the weld-pool are protected from the atmosphere with an inert shielding gas. The hardfacing material is in the form of a rod. Advantages of the TIG process include simple manual operation and good control of the welding arc. The process can also be mechanised, in which case a manipulator is used to move the workpiece in relation to the welding torch and the hardfacing rod or wire.



Welding rods used for TIG welding are also used for hardfacing with the oxy-acetylene welding process. With the correct operation, a very low level of iron dilution can be achieved in the overlay.

Rod is available in these standard diameters:

- 2.4mm
- 3.2mm (1/8")
- 4.0mm (5/32")
- 5.0mm (3/16")
- 6.4mm (1/4")
- 8.0mm (5/16")

Rod inventory held in North America is typically in 36" lengths. Other rod sizes may be available by special request.

Rod is typically packaged in 10kg (22lb) bundles. Other bundling available upon request.

TIG and Oxy-Acetylene Welding

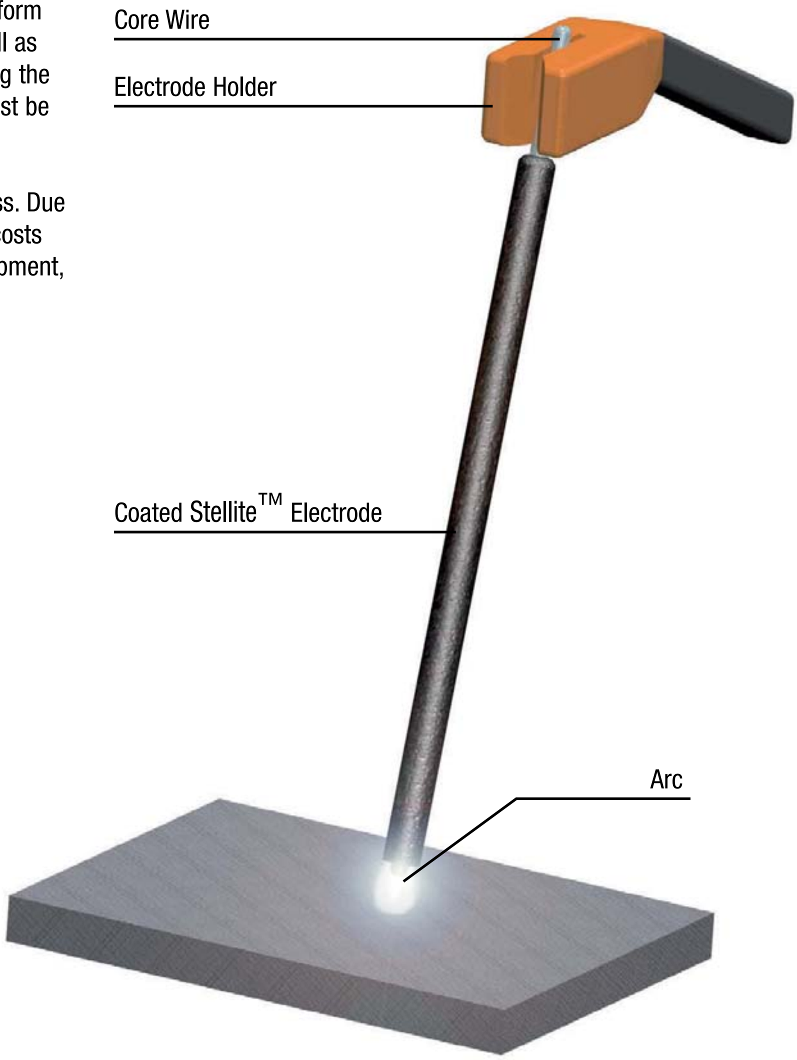
ALLOY	NOMINAL ANALYSIS OF WELDING ROD[1]								Others	UNS	ASME/ AWS[2]	Hardness (HRC)[3]
	Co	Cr	W	C	Ni	Mo	Fe	Si				
COBALT-BASED ALLOY BARE WELDING RODS												
Stellite™ alloy 1	Bal.	32	12	2.45	<3.0	<1.0	<3.0	<2.0	<0.5	R30001	(SF)A 5.21 ERCoCr-C	51–56
Stellite™ alloy 6	Bal.	30	4–5	1.2	<3.0	<1.0	<3.0	<2.0	<0.5	R30006	(SF)A 5.21 ERCoCr-A	40–45
Stellite™ alloy 12	Bal.	30	8	1.55	<3.0	<1.0	<3.0	<2.0	<0.5	R30012	(SF)A 5.21 ERCoCr-B	46–51
Stellite™ alloy 20	Bal.	33	16	2.45	<3.0	<1.0	<3.0	<2.0	<0.5	–	–	53–59
Stellite™ alloy 21	Bal.	28	–	0.25	3	5.2	<3.0	<1.5	<0.5	R30021	(SF)A 5.21 ERCoCr-E	28–40*
Stellite™ alloy 25	Bal.	20	14	0.1	10	<1.0	<3.0	<1.0	<0.5	–	–	20–45*
Stellite™ alloy F	Bal.	26	12	1.7	22	<1.0	<3.0	<2.0	<0.5	R30002	(SF)A 5.21 ERCoCr-F	40–45*
Stellite™ alloy 706	Bal.	31	–	1.2	<3.0	4	<3.0	<1.0	<1.0	–	–	39–44
Stellite™ alloy 712	Bal.	31	–	1.55	<3.0	8	<3.0	<2.0	<1.0	–	–	46–51
ULTIMET™ **	Bal.	26	2	0.06	9	5	3	–	<1.0	R31233	–	28–45*
NICKEL-BASED ALLOY BARE WELDING RODS												
Nistelle™ alloy C	–	17	5	0.1	Bal.	17	6	–	0.3%V	N30002	–	17–27*
Deloro™ alloy 40	–	12	–	0.4	Bal.	–	2–3	2.9	1.6% B	N99644	(SF)A 5.21 ERNiCr-A	36–42
Deloro™ alloy 50	–	12	–	0.5	Bal.	–	3–5	3.5	2.2% B	N99645	(SF)A 5.21 ERNiCr-B	48–55
Deloro™ alloy 55	–	12	–	0.6	Bal.	–	3–5	4.0	2.3% B	–	–	52–57
Deloro™ alloy 60	–	13	–	0.7	Bal.	–	3–5	4.3	3.0% B	N99646	(SF)A 5.21 ERNiCr-C	57–62
INTER-METALLIC LAVES PHASE ALLOY WELDING RODS (TRIBALOY™ ALLOYS)												
Tribaloy™ alloy T-400	Bal.	8.5	–	<0.08	<1.5	28	<1.5	2.5	<1.0	R30400	–	54–58
Tribaloy™ alloy T-400C	Bal.	14	–	<0.08	<1.5	27	<1.5	2.6	<1.0	–	–	54–59
Tribaloy™ alloy T-700 (Ni based)	<1.5	16	–	<0.08	Bal.	32	<1.5	3.4	<1.0	–	–	50–58
Tribaloy™ alloy T-800	Bal.	18	–	<0.08	<1.5	28	<1.5	3.4	<1.0	–	–	55–60
Tribaloy™ alloy T-900	Bal.	18	–	<0.08	16	22	–	2.7	<1.0	–	–	52–57

1 Nominal analysis is a guideline only for standard product. Does not include all incidental elements and may differ depending on the exact specification/standard used when ordering.
2 When written certification to a standard is required, please specify this when ordering. Certain products can also be certified to AMS, SAE, and other standards. Please contact us for more details.
3 Undiluted weld metal.
* Depending upon the degree of work hardening.
**ULTIMET™ is a registered trademark of Haynes International.

Manual Metal Arc (MMA) Weld Deposition

In this process, an arc is drawn between a coated consumable electrode and the workpiece. The metallic core is melted by the arc and is transferred to the weld pool as molten droplets. The electrode coating also melts to form a gas shield around the arc and the weld pool as well as a slag on the surface of the weld pool, thus protecting the cooling weld-pool from the atmosphere. The slag must be removed after each layer.

MMA welding is still a widely used hardfacing process. Due to the low cost of the equipment, the low operating costs of the process, and the ease of transporting the equipment, this flexible process is ideally suited to repair work.



MMA Weld Deposition

ALLOY	NOMINAL ANALYSIS OF UNDILUTED WELD METAL[4]								Others	UNS	ASME/ AWS[5]	Hardness (HRC)[6]
	Co	Cr	W	C	Ni	Mo	Fe	Si				
COBALT-BASED ALLOY ELECTRODES												
Stellite™ alloy 1	Bal.	31	12	2.45	<3.0	<1.0	<3.0	<2.0	<1.0	W73001	(SF)A 5.13 ECoCr-C	51–56
Stellite™ alloy 6	Bal.	29	4	1.2	<3.0	<1.0	<3.0	<2.0	<1.0	W73006	(SF)A 5.13 ECoCr-A	39–43
Stellite™ alloy 12	Bal.	30	8	1.55	<3.0	<1.0	<3.0	<2.0	<1.0	W73012	(SF)A 5.13 ECoCr-B	45–50
Stellite™ alloy 20	Bal.	32	16	2.45	<3.0	<1.0	<3.0	<2.0	<1.0	–	–	53–57
Stellite™ alloy 21	Bal.	28	–	0.25	3	5.5	<3.0	<1.5	<1.0	W73021	(SF)A 5.13 ECoCr-E	28–40*
Stellite™ alloy 25	Bal.	20	14	0.1	10	<1.0	<3.0	<1.0	<1.0	–	–	20–45*
Stellite™ alloy 706	Bal.	30	–	1.2	<3.0	4	<3.0	<1.0	<1.0	–	–	39–44
Stellite™ alloy 712	Bal.	30	–	1.55	<3.0	8	<3.0	<2.0	<1.0	–	–	46–51
ULTIMET™ **	Bal.	26	2	0.06	9	5	3	–	<1.0	–	–	28–45*
NICKEL-BASED ALLOY ELECTRODES												
Nistelle™ alloy C	–	17	5	0.1	Bal.	17	6	–	0.3%V	W80002	–	17–27*

4 Nominal analysis is a guideline only for standard product. Does not include all incidental elements and may differ depending on the exact specification/standard used when ordering.
5 When written certification to a standard is required, please specify this when ordering. Certain products can also be certified to AMS, SAE, and other standards. Please contact us for more details.
6 Undiluted weld metal.

Electrodes are available in these standard diameters:

- 2,6mm (3/32") (special order)
- 3,2mm (1/8")
- 4,0mm (5/32")
- 5,0mm (3/16")
- 6,4mm (1/4")

Electrodes are supplied in lengths of 350mm (14") and are boxed in 5.0 kg (11 lb) boxes.

Depending upon the process parameters, the hardness of the welded deposit can vary from the values provided in the table above.

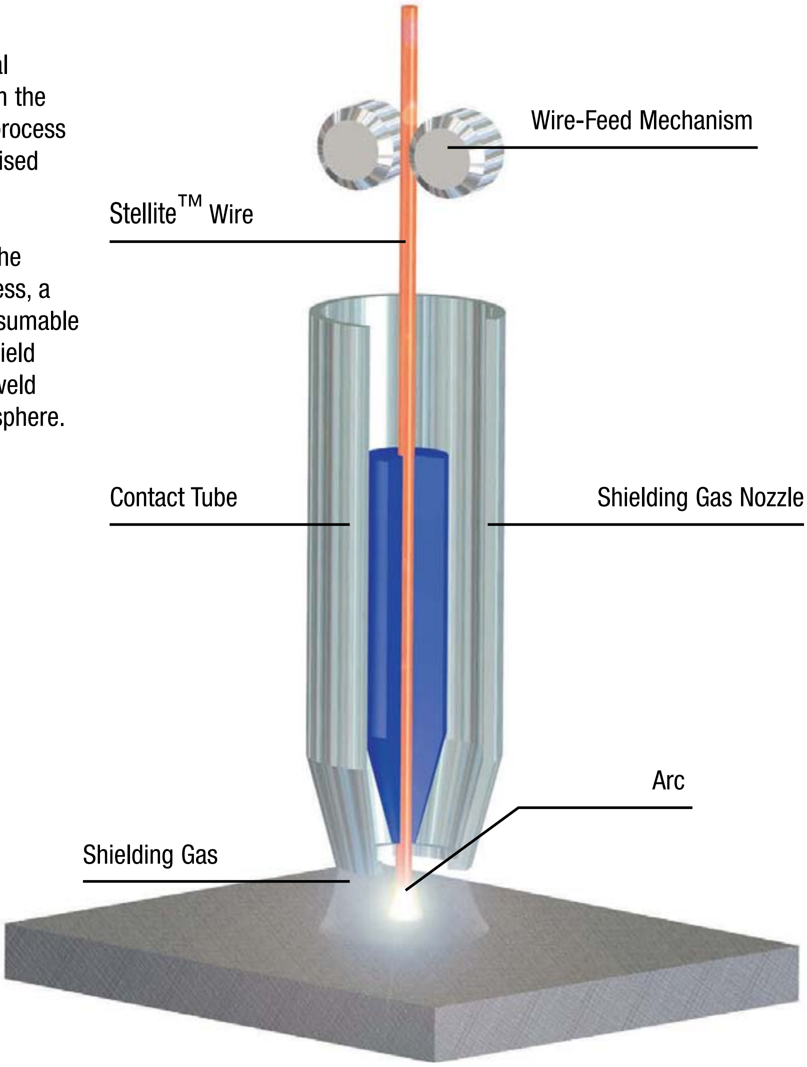
* Depending upon the degree of cold-working
**ULTIMET™ is a registered trademark of Haynes International.

MIG Weld Deposition, Submerged Arc Welding

In these arc welding processes, consumable hardfacing wire is fed continuously from a spool through the welding torch into the arc, where it is melted and transferred to the workpiece.

In the case of MIG welding, also known as Gas Metal Arc Welding (GMAW), the weld pool is protected from the atmosphere by a stream of shielding gas. The MIG process is very flexible — it can be partially or fully mechanised and is suitable for a wide range of applications.

Wire is also used as the hardfacing consumable in the Submerged Arc Welding (SAW) process. In this process, a mineral-based fluxing powder flows around the consumable wire and is melted by the arc. It forms a gaseous shield around the arc and also forms a slag on top of the weld pool, shielding the cooling weld pool from the atmosphere.



MIG Weld Deposition

ALLOY	NOMINAL ANALYSIS OF UNDILUTED WELD METAL[7]								Others	UNS	ASME/ AWS[8]	Hardness (HRC)[9]
	Co	Cr	W	C	Ni	Mo	Fe	Si				
COBALT-BASED ALLOY CORED WIRE												
Stellite™ alloy 1	Bal.	28	11.5	2.45	<3.0	<1.0	<5.0	<2.0	<1.0	W73031	(SF)A 5.21 ERCCoCr-C	50–55
Stellite™ alloy 6	Bal.	30	4.5	1.2	<3.0	<1.0	<5.0	<2.0	<1.0	W73036	(SF)A 5.21 ERCCoCr-A	38–44
Stellite™ alloy 12	Bal.	29	8	1.55	<3.0	<1.0	<5.0	<2.0	<1.0	W73042	(SF)A 5.21 ERCCoCr-B	45–50
Stellite™ alloy 21	Bal.	28	–	0.25	3	5.2	<5.0	<1.5	<1.0	W73041	(SF)A 5.21 ERCCoCr-E	28–40*
Stellite™ alloy 21 LC	Bal.	26	–	0.1	4	6.0	<5.0	<1.5	<1.5	Proprietary crack-resistant alloy specially developed for hardfacing of forging dies		25–40*
Stellite™ alloy 25	Bal.	20	14	0.1	10	<1.0	<3.0	<1.0	<1.0	–	–	20–45*
Stellite™ alloy 706	Bal.	31	–	1.2	<3.0	4	<3.0	<1.0	<1.0	–	–	39–44
Stellite™ alloy 712	Bal.	31	–	1.55	<3.0	8	<3.0	<2.0	<1.0	–	–	46–51
ULTIMET™ **	Bal.	26	2	0.06	9	5	3	–	<1.0	R31233	–	28–45*

7 Nominal analysis is a guideline only for standard product. Does not include all incidental elements and may differ depending on the exact specification/standard used when ordering.
8 When written certification to a standard is required, please specify this when ordering. Certain products can also be certified to AMS, SAE, and other standards. Please contact us for more details.

Electrodes are available in these standard diameters:

- 1,2mm (0.045") — supplied in 15 kg (33 lb) spools
- 1,6mm (0.062") — supplied in 15 kg (33 lb) spools
- 2,4mm (0.093") — supplied in 15 kg (33 lb) or 20kg (44lbs) spools
- 3,2mm (0.126") (special order) — supplied in 15 kg (33 lb) or 20kg (44lbs) spools

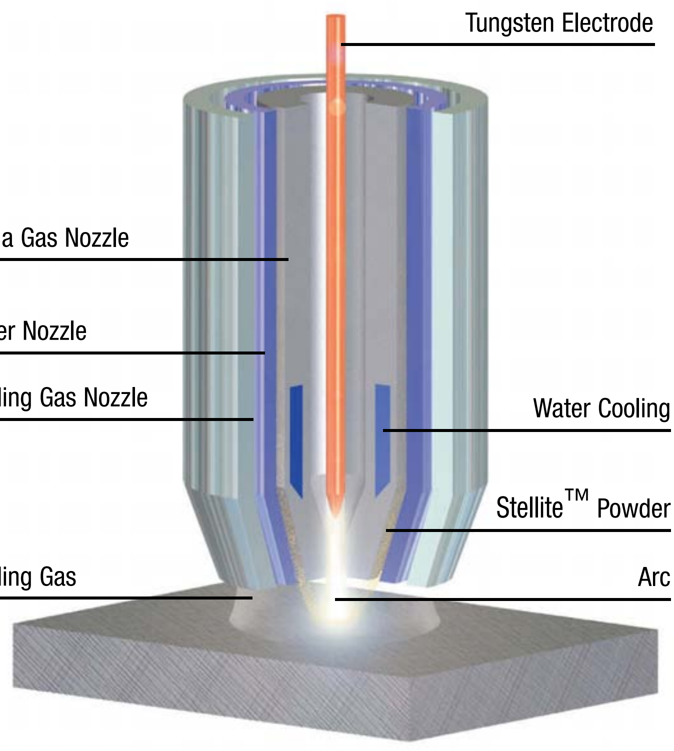
Depending upon the process parameters, the hardness of the welded deposit can vary from the values provided in the table above.

* Depending on the degree of_cold working.
**ULTIMET™ is a registered trademark of Haynes International.

Plasma Transferred Arc (PTA) Weld Deposition

The PTA process is easily automated, providing a high degree of reproducibility of the weld overlays. In addition, because of the highly concentrated heat source, this process benefits from high powder utilization and can achieve a very low level of iron dilution in the overlay.

Because the hardfacing materials are in powder form, it is possible to produce overlays from many different materials and combinations of materials with a wide range of hardness and other properties.

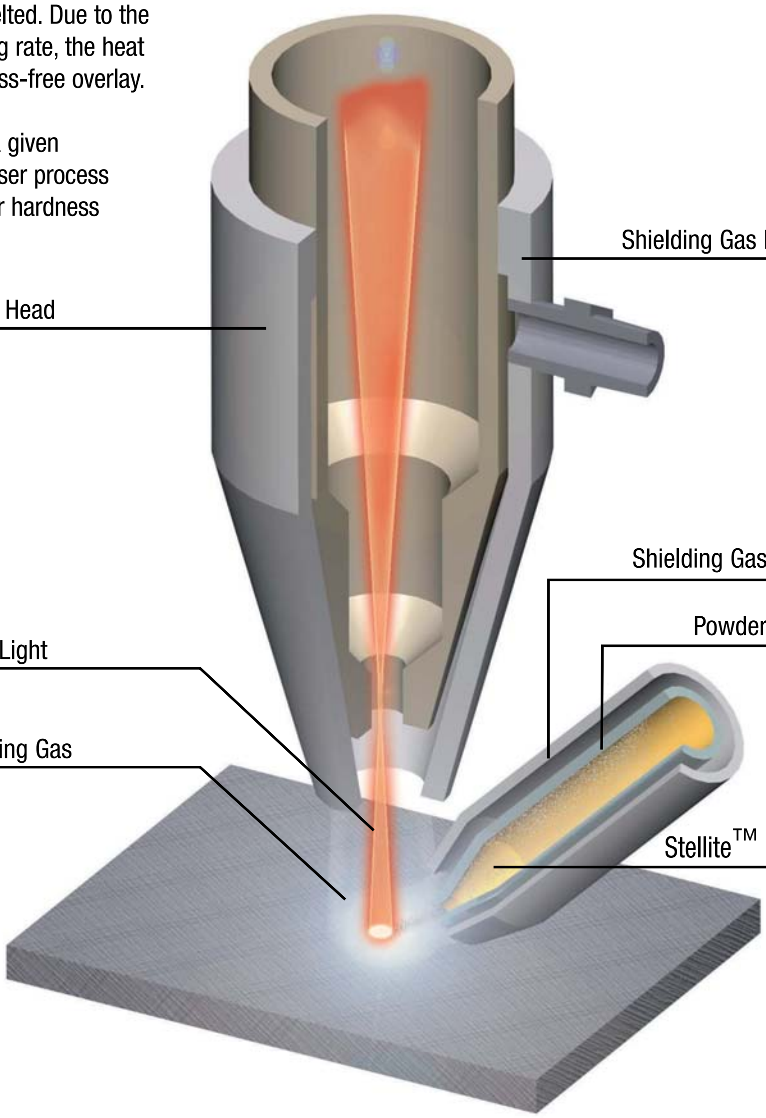


Kennametal manufactures fit-for-purpose PTA equipment packages.
Please see contact information on page 25 for any questions or requests.

Laser Weld Deposition

When overlaying with a laser, an optical arrangement is used to focus the laser beam on the workpiece and heat it. Simultaneously, hardfacing material in the form of powder or wire is introduced into the laser beam and melted. Due to the narrow heat-affected zone and the fast cooling rate, the heat input is low, thereby producing an almost stress-free overlay.

Compared with other welding processes, for a given hardfacing alloy, the fast cooling rate of the laser process produces an overlay with a significantly higher hardness and finer microstructure.



PTA Weld Deposition

ALLOY	NOMINAL ANALYSIS OF POWDER[1]								Others	UNS	Hardness (HRC)[2]
	Co	Cr	W	C	Ni	Mo	Fe	Si			
COBALT-BASED ALLOY (GAS-ATOMIZED POWDERS)											
Stellite™ alloy 1	Bal.	30	13	2.5	<2.0	<1.0	<2.0	<2.0	<1.0	R30001	51–60
Stellite™ alloy 4	Bal.	30	13.5	0.7	<2.5	<1.0	<2.5	<1.0	<1.0	R30404	40–50
Stellite™ alloy 6	Bal.	28.5	4.6	1.2	<2.0	<1.0	<2.0	<2.0	<1.0	R30106	40–46
Stellite™ alloy 6LC	Bal.	29	4.5	1.1	<2.0	<1.0	<2.0	<2.0	<1.0	–	38–44
Stellite™ alloy 6HC	Bal.	28.5	4.6	1.35	<2.0	<1.0	<2.0	<2.0	<1.0	–	43–53
Stellite™ alloy 156	Bal.	28	4	1.7	<2.0	<1.0	<0.5	<2.0	<1.0	–	46–54
Stellite™ alloy 12	Bal.	30	8.5	1.45	<2.0	<1.0	<2.0	<2.0	<1.0	R30012	43–53
Stellite™ alloy 20	Bal.	32.5	17.5	2.55	<2.0	<1.0	<2.0	<1.0	<1.0	–	52–62
Stellite™ alloy 21	Bal.	27.5	–	0.25	2.6	5.4	<2.0	<2.0	<1.0	R30021	27–40 *
Stellite™ alloy 22	Bal.	28	–	0.30	1.5	12	<3.0	<2.0	<0.5	–	41–49 *
Stellite™ alloy 25	Bal.	20	15	0.1	10	<1.0	2	<1.0	1.9%Mn	–	20–45 *
Stellite™ alloy 31	Bal.	26	7.5	0.5	10.5	<1.0	<2.0	<1.0	<0.5	R30031	20–35 *
Stellite™ alloy F[3]	Bal.	26	12.5	1.8	22	<1.0	<2.0	1.1	<0.5	R30002	40–45
Stellite™ alloy 190	Bal.	26	14	3.4	<2.0	<1.0	<2.0	<1.0	<1.0	R30014	55–60
Stellite™ alloy 694	Bal.	28.5	19.5	0.9	5	–	<3.0	<1.0	1%V	–	46–52
Stellite™ alloy 706	Bal.	29	–	1.25	<2.0	4.5	<2.0	<1.0	<1.0	–	39–44
Stellite™ alloy 712	Bal.	29	–	2.0	<2.0	8.5	<2.0	<1.0	<1.0	–	46–53
ULTIMET™ **	Bal.	26	2	0.07	9.4	5	3	<1.0	<1.0	R31233	20–45 *
COBALT-BASED TRIBALOY™ ALLOYS (GAS-ATOMIZED POWDERS)											
Tribaloy™ alloy T-400	Bal.	8.5	–	<0.08	<1.5	29	<1.5	2.8	<1.0	R30400	51–57
Tribaloy™ alloy T-400C	Bal.	14	–	<0.08	<1.5	27	<1.5	2.6	<1.0	–	51–57
Tribaloy™ alloy T-401	Bal.	17	–	0.2	<1.5	22	<1.5	1.3	<1.0	–	45–50
Tribaloy™ alloy T-800	Bal.	17	–	<0.08	<1.5	29	<1.5	3.7	<1.0	–	53–61
Tribaloy™ alloy T-900	Bal.	18	–	<0.08	16	23	<1.5	2.8	<1.0	–	48–55
NICKEL-BASED SUPERALLOYS (GAS-ATOMIZED POWDERS)											
Nistelle™ alloy C	–	17	4.5	0.1	Bal.	17	6	<1.0	0.3%V	–	17–27 *
Nistelle™ alloy C22	<2.0	21.5	3	–	Bal.	13.5	4	–	0.15%V	–	
Nistelle™ alloy C276	–	15.5	3.7	–	Bal.	16	5.5	<1.0	0.15%V	–	
Nistelle™ alloy 305	–	42	–	–	Bal.	–	–	0.5	<1.0%	–	
Nistelle™ alloy 2315	–	20	–	–	Bal.	–	–	<1.0	<1.0%	–	
Nistelle™ alloy 600	–	15.5	–	–	Bal.	–	8	<0.5	<1.0%	N06600	
Nistelle™ alloy 625	–	21.5	–	<1.0	Bal.	9	<1.0	<0.5	3.5% Nb	N06625	
Nistelle™ alloy 718	<2.0	21.5	3	–	Bal.	13.5	4	–	0.15%V	N07718	

[1] Nominal analysis is a guideline only for standard product. Does not include all incidental elements and may differ depending on the exact specification/standard used when ordering.
[2] Undiluted weld metal.
[3] Stellite™ Alloy F usually made to customer specification.
* Depending upon the degree of work hardening.
**ULTIMET™ is a registered trademark of Haynes International.

Laser Weld Deposition

ALLOY	NOMINAL ANALYSIS OF POWDER[1]								Others	UNS	Hardness (HRC)[2]
	Co	Cr	W	C	Ni	Mo	Fe	Si			
NICKEL-BASED ALLOY (GAS-ATOMIZED POWDERS)											
Deloro™ alloy 22	–	–	–	<0.05	Bal.	–	<1.0	2.5	1.4%B	–	20–22
Deloro™ alloy 30	–	9	–	0.2	Bal.	–	2.3	3.2	1.2%B	–	27–31
Deloro™ alloy 38	–	–	–	0.05	Bal.	–	0.5	3.0	2.1%B	–	35–39
Deloro™ alloy 40	–	7.5	–	0.3	Bal.	–	2.5	3.5	1.7%B	N99644	38–42
Deloro™ alloy 45	–	9	–	0.35	Bal.	–	2.5	3.7	1.9%B	–	44–47
Deloro™ alloy 46	–	–	–	0.05	Bal.	–	–	3.7	1.9%B	–	32–40
Deloro™ alloy 50	–	11	–	0.45	Bal.	–	3.3	3.9	2.3%B	N99645	48–52
Deloro™ alloy 55	–	12	–	0.6	Bal.	–	4.0	4.0	2.7%B	–	52–57
Deloro™ alloy 60	–	15	–	0.7	Bal.	–	4.0	4.4	3.1%B	N99646	57–62
Extrudalloy 50	15	21	–	1.3	Bal.	6	<1.0	3.0	2.3%B	–	–
NICKEL-BASED TRIBALOY® ALLOYS (GAS-ATOMIZED POWDERS)											
Tribaloy™ alloy T-700	<1.5	16	–	0.08	Bal.	32	<1.5	3.4	<1.0	–	45–52
IRON-BASED HARDFACING ALLOYS (GAS-ATOMIZED POWDERS)											
Delcrome™ 90	–	27	–	2.9	–	–	Bal.	<1.0	0.5%Mn	–	Depends on heat treatment
Delcrome™ 92	<0.5	<1.0	–	3.8	<1.0	10	Bal.	<1.0	<1%Mn	–	55–63
Delcrome™ 253	<0.5	28	–	1.9	16.5	4.5	Bal.	1.3	0.8%Mn	–	
Delcrome™ 316	<0.5	17	–	0.05	11	2.6	Bal.	2.5	0.4%Mn	–	<180 DPH
Delcrome™ 316L Delcrome™ 317	<0.5	18	–	<0.03	13	2.6	Bal.	1.8	0.7%Mn	–	<180 DPH
Delcrome™ 6272	<0.5	25	–	2.5	14	7	Bal.	1.8	<1.0%	–	
CARBIDES IN A CORROSION-RESISTANT HARD ALLOY MATRIX											
Super Stelcar™ alloy 9365	WC in an alloy matrix										
Super Stelcar™ alloy 50 plus	WC in a Deloro™ 50 alloy matrix										
Super Stelcar™ alloy 60 plus	WC in a Deloro™ 60 alloy matrix										

[1] Nominal analysis is a guideline only for standard product. Does not include all incidental elements and may differ depending on the exact specifications/standard used when ordering.
[2] Undiluted weld metal.

PTA and laser hardfacing powders are available in these standard powder particle size ranges and custom sizes upon request.

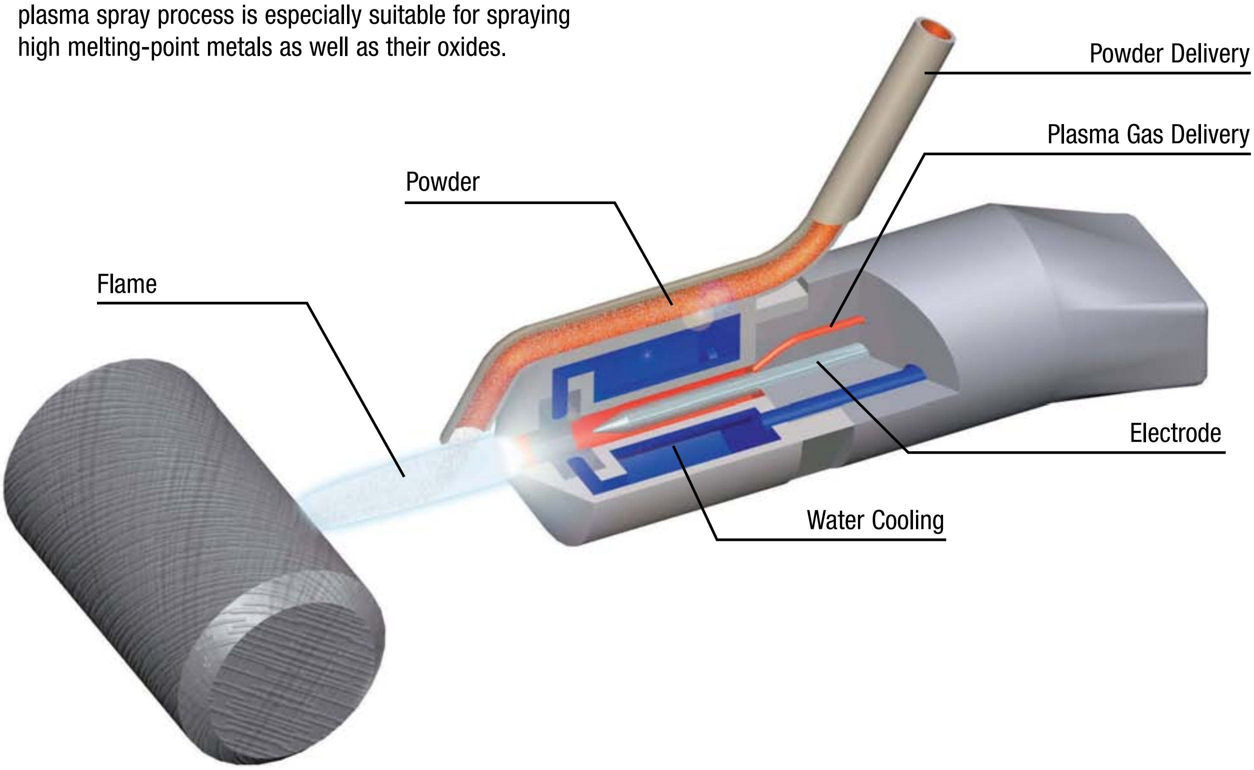
Depending upon the process parameters and extent of dilution, the hardness of the weld deposit may vary from that provided in the above table.

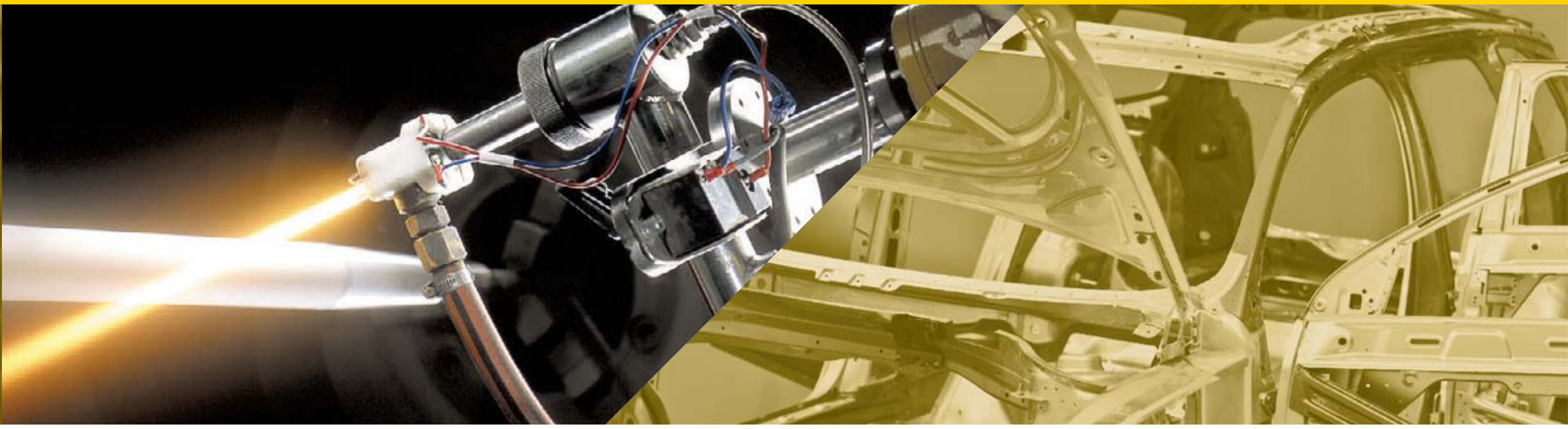
Plasma Spraying

In the Plasma Spraying process, powder is softened or melted in the plasma gas stream, which also transfers the particles to the workpiece.

The plasma arc is not transferred to the workpiece, it is contained within the plasma torch between an axial electrode and a water-cooled nozzle. The process is operated in normal atmosphere, in a shielding gas stream (e.g., argon), in a vacuum, or under water.

Due to the high temperature of the plasma gas stream, the plasma spray process is especially suitable for spraying high melting-point metals as well as their oxides.

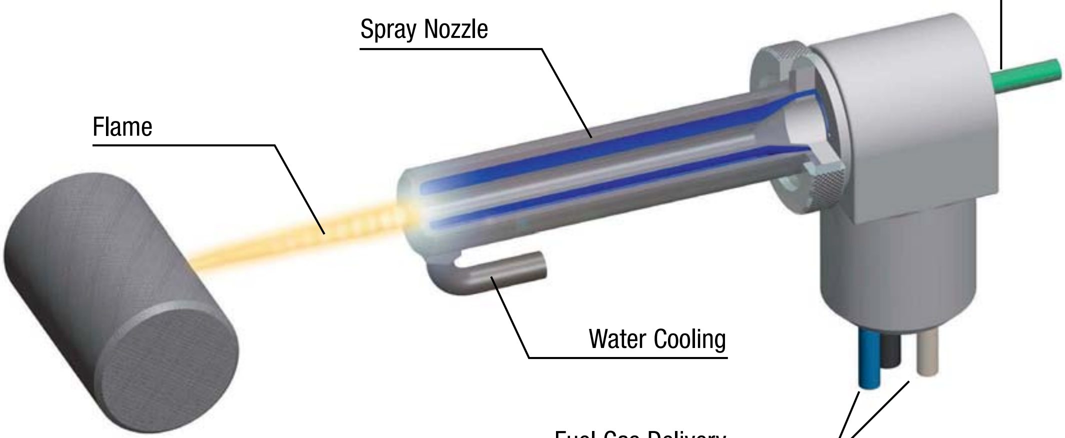




High-Velocity Oxy-Fuel Spray (HVOF)

In the HVOF process, powder is introduced axially into a chamber in which a gas flame is constantly burning under high pressure. The exhaust gas exits through an expansion nozzle which produces a high-velocity gas stream. The powder particles are heated in this gas stream and transferred by it with high kinetic energy to the surface of the workpiece, forming a dense coating with excellent bonding properties.

Due to the moderate transfer of heat to the powder particles and to the workpiece, which remains relatively cool, there is little metallurgical change to the sprayed material and the workpiece.



Kennametal manufactures fit-for-purpose Jet Kote™ HVOF equipment packages.
Please see contact information on page 25 for any questions or requests.

Tungsten Carbide HVOF Powders

PRODUCT	POWDER TYPE	NOMINAL COMPOSITION (mass %)					HARDNESS (depends on deposition method & parameters)	Nominal size (µm) and manufacturing method
		Co	Ni	Cr	W	C		
JK™ 112H	WC-12Co with fine carbides	12	–	–	Bal.	5.5	1140–1296 DPH 92.7–94.6 R15N	53/10 Agglomerated, sintered & densified.
JK™ 112P / JK™ 7112	WC-12Co with fine carbides	12	–	–	Bal.	5.5	960–1150 DPH 89–93 R15N (equiv. to HRC: ~67–71)	45/10 Agglomerated, sintered & densified.
JK™ 114 / JK™ 7114	WC-12Co with coarse carbides	12	–	–	Bal.	4	1000–1150 DPH 87–94 R15N (equiv. to HRC: ~68–71)	45/10 Agglomerated, sintered & crushed.
JK™ 117 / JK™ 7117	WC-17Co with intermediate carbides	17	–	–	Bal.	5.2	960–1240 DPH 90–95 R15N (equiv. to HRC: ~67–72)	53/15 Agglomerated & sintered.
JK™ 119	WC-9Co with coarse carbides	9	–	–	Bal.	4.2	860–1170 DPH 89–94 R15N (equiv. to HRC: ~65–71)	45/5 Sintered & crushed, blocky.
JK™ 120H / JK™ 7109	WC-10Co-4Cr	10	–	4	Bal.	5.4	1160–1370 DPH 93–95 R15N (equiv. to HRC: ~71–73)	45/5 Agglomerated, sintered & densified.
JK™ 120P / JK™ 7109	WC-10Co-4Cr	10	–	4	Bal.	5.4	825–1030 DPH 89–91 R15N (equiv. to HRC: ~65–71)	53/10 Agglomerated, sintered & densified.
JK™ 125 / JK™ 7178	A mixed carbide with nickel 70%(W, Cr)xCy 25%WC 6%Ni	–	6	20	Bal.	5	900–1100 DPH 89–92 R15N (equiv. to HRC: ~66–70)	53/10 Agglomerated sintered & densified.
JK™ 6189	WC 10Ni with large carbides	–	10	–	Bal.	3.7	Not available	53/10 Sintered & crushed.

Chromium Carbide HVOF Powders

PRODUCT	POWDER TYPE	NOMINAL COMPOSITION (mass %)			HARDNESS (depends on deposition method & parameters)	Nominal size (µm) and manufacturing method
		Ni	Cr	C		
JK™ 135 / JK™ 7184	75% Cr_3C_2 25% NiCr	20	Bal.	9.7	610–910 DPH 87.5–91.5 R15N (equiv. to HRC: ~58–65) (varies srongly depending on spray parameters)	53/10 Agglomerated, sintered & densified.

Gas-Atomized Stellite™ Cobalt-Based HVOF & Plasma Spray Powders

PRODUCT	STELLITE™ ALLOY NO.	NOMINAL COMPOSITION (mass %)							HARDNESS (depends on deposition method & parameters)	Nominal size (µm)
		Co	Ni	Cr	W	Mo	C	Others		
JK™ 571 / JK™ 7221	21	Bal.	2.5	28	–	5.5	0.25	Si 2	400–520 DPH 80.5–84.5 R15N (equiv. to HRC: ~40–50)	53/10
JK™ 572 / JK™ 7212	12	Bal.	–	29.5	8	–	1.4	Si 1.5	680–675 DPH 88.1–89.5 R15N	53/10
JK™ 573 / JK™ 7231	31	Bal.	10.5	25.5	7.5	–	0.5	–	32 HRC	45/10
JK™ 575 / JK™ 7201	1	Bal.	–	30	12	–	2.5	–	Not available	53/10
JK™ 576 / JK™ 7206	6	Bal.	–	28	4.5	–	1.1	Si 1.1	495–580 DPH 81.5–86.5 R15N (equiv. to HRC: ~43–54)	53/10
JK™ 577	SF6	Bal.	14.5	19	7.5	–	0.7	Si 2.5 B 1.6	635–790 DPH (505-525 when fused) ~ 85.5 R15N (equiv. to HRC: ~50–51)	53/10
JK™ 579 / JK™ 7225	25	Bal.	10	20	15	1	0.1	Si 1 Mn 1.5	450–490 DPH 82–85.5 R15N (equiv. to HRC: ~43–50) (varies strongly depending on spray parameters)	53/10

Gas-Atomized Tribaloy™ Cobalt-Based HVOF & Plasma Spray Powders

PRODUCT	TRIBALOY™ ALLOY NO.	NOMINAL COMPOSITION (mass %)							HARDNESS (depends on deposition method & parameters)	Nominal size (µm)
		Co	Ni	Cr	W	Mo	C	Others		
JK™ 554 / JK™ 7560	T-400	Bal.	–	8.5	–	29	<0.08	Si 2.6	450–600 DPH 86–87.5 R15N (equiv. to HRC: ~52–55)	53/10
JK™ 558H Typically used with hydrogen fuel	T-800	Bal.	–	18	–	28	<0.08	Si 3.4	670–780 DPH 89–92 R15N (equiv. to HRC: ~58–64)	45/5
JK™ 558P / JK™ 7580 Typically used with carbon fuel	T-800	Bal.	–	18	–	28	<0.08	Si 3.4	455–620 DPH 83.5–88.5 R15N (equiv. to HRC: ~46–56)	53/10
JK™ 559H (Special order)	T-900	Bal.	16	18	–	23	<0.08	Si 2.7	~ 700 DPH	45/5
JK™ 559P (Special order)	T-900	Bal.	16	18	–	23	<0.08	Si 2.7	~ 500 DPH	53/10
ULTIMET™ for JK™ and Plasma Spray	ULTIMET™	Bal.	9	26	2	5	0.06	Si 0.3	~ 500 DPH	53/20

*ULTIMET™ is a registered trademark of Haynes International.

Gas-Atomized Nickel-Based HVOF & Plasma Spray Powders

PRODUCT	ALLOY NAME	NOMINAL COMPOSITION (mass %)							HARDNESS (depends on deposition method & parameters)	Nominal size (µm)
		Ni	Fe	Cr	W	Mo	C	Others		
JK™ 347	Nistelle™ 2347	Bal.	–	–	–	5	–	Al 6	332–336 DPH 75.3–78.1 R15N	63/15
JK™ 350 / JK™ 7301	Nistelle™ 2350	Bal.	–	–	–	–	–	Al 5	285–335 DPH 71–76 R15N	63/15
JK™ 557 / JK™ 7570	Tribaloy™ T-700	Bal.	–	15.5	–	32.5	<0.08	Si 3.4	~ 700 DPH	45/10
JK™ 584 / JK™ 7640	Deloro™ 40	Bal.	2.5	7.5	–	–	0.25	Si 3.5 B 1.7	~ 40 HRC	53/10
JK™ 585 / JK™ 7650	Deloro™ 50	Bal.	2.9	11	–	–	0.45	Si 4 B 2.3	~ 50 HRC	53/10
JK™ 586 / JK™ 7660	Deloro™ 60	Bal.	4	15	–	–	0.7	Si 4.4 B 3.1	~ 60 HRC	53/10
JK™ 591H	Nistelle™ C	Bal.	5.5	16.5	4.5	17	–	–	400–440 DPH ~ 83 R15N (equiv. to HRC: ~44-45)	45/5
JK™ 591P / JK™ 7391	Nistelle™ C	Bal.	5.5	16.5	4.5	17	–	–	375–390 DPH ~ 80 R15N (equiv. to HRC: ~39-41)	63/15
Nistelle™ Super C (Jet Kote™)	Nistelle™ "Super C"	Bal.	–	23	–	18	–	–	410 DPH (equiv. to HRC: ~ 41)	P: 53/15 H: 45/10
JK™ 594 / JK™ 7392	Nistelle™ C-4C	Bal.	–	16	–	16.5	–	–	380–440 DPH ~ 81–83 R15N (equiv. to HRC: ~40-44)	53/15
JK™ 625 / JK™ 7342	Nistelle™ 625	Bal.	<5	21.5	–	9	–	(Nb+Ta) 3.7	385–460 DPH ~ 79–83 R15N (equiv. to HRC: ~37-46)	53/20
JK™ 718 / JK™ 7341	Nistelle™ 718	Bal.	18	19	–	3	0.06	(Nb+Ta) 5 Al 0.5, Ti 1	275–470 DPH 72.5–81.5 R15N (equiv. to HRC: ~25-45)	45/15

Gas-Atomized Iron-Based HVOF Powders

PRODUCT	POWDER TYPE	NOMINAL COMPOSITION (mass %)						HARDNESS (depends on deposition method & parameters)	Nominal size (µm)
		Co	Ni	Fe	Cr	C	Others		
JK™ 513 (Also sold as JK™ 7330)	316 Stainless Steel	–	13	Bal.	17	0.1	Mo 2.5 Si 1	260–315 DPH 69–75 R15N	53/10

Cobalt Based Plasma Spray Powders

PRODUCT	POWDER TYPE	NOMINAL COMPOSITION (mass %)							HARDNESS (depends on deposition method & parameters)	Nominal size (µm)
		Co	Ni	Cr	W	Mo	C	Others		
Stellite™ 157	–	Bal.	–	21	4.5	–	<0.2	B 2.4 Si 1.5	Not available	45/5
Tribaloy™ T-400 (Not Available)	T-400	Bal.	–	8.5	–	29	<0.08	Si 2.6	52 HRC	45/5
Tribaloy™ T-900 (Not Available)	T-900	Bal.	16	18	–	23	<0.08	Si2.7	52 HRC	75/D 53/10

Nickel-Based Plasma Spray Powders

PRODUCT	ALLOY NAME	NOMINAL COMPOSITION (mass %) Ni	Fe	Cr	W	Mo	C	Others	HARDNESS (depends on deposition method & parameters)	Nominal size (µm)
Deloro™ 55	Deloro™ 55	Bal.	4	12	–	–	0.6	Si 4.0 B 2.7	52-57 HRC	Various
Deloro™ 60	Deloro™ 60	Bal.	4	15	–	–	0.7	Si 4.4 B 3.1	58-62 HRC	Various
Nistelle™ C276	Nistelle™ C276	Bal.	5	15.5	3.8	16	–	–	Not Available	106/D 45/5
Nistelle™ 625	Nistelle™ 625	Bal.	<5	21.5	–	9	–	(Nb+Ta) 3.7	385-460 DPH 79-83 R15N (equiv. to HRC: ~37-46)	Various
Nistelle™ 2315	Nistelle™ 2315	Bal.	–	20	–	–	–	–	Not Available	106/D 75/45 45/5
Nistelle™ 2350	Nistelle™ 2350	Bal.	–	–	–	–	–	Al 5	~ 70 HRB	75/45

Gas-Atomized Iron-Based Plasma Spray Powders

PRODUCT	ALLOY NAME	NOMINAL COMPOSITION (mass %) Co	Ni	Fe	Cr	C	Others	HARDNESS (depends on deposition method & parameters)	Nominal size (µm)
Delcrome™ 90	Delcrome™ 90	–	–	Bal.	27	2.8	Si 0.5	Not Available	53/10
Delcrome™ 92	Delcrome™ 92	–	–	Bal.	–	3.7	Mo 10	Not Available	45/D
Delcrome™ 316L/317	316L Stainless Steel	–	13	Bal.	17	0.03	Mo 2.5 Si 1	~ 180 DPH	106/38 106/D 45/5
Tristelle™ TS-3	Tristelle™ TS-3	12	10	Bal.	35	3	Si 5	>55 HRC	45/5

Powders labelled "JK" are intended primarily for HVOF spraying with the Jet Kote™ or Diamond Jet™ torches but can also be used for plasma spraying. Some of these powders may be listed below in different nominal size ranges for other thermal spray processes.

*Diamond Jet™ is a registered trademark of Sulzer Metco.

Flame Spraying with Subsequent Fusing (Spray and Fuse)

Spray and fuse is a two-stage process, the powder alloy being deposited first by flame spraying and then fused. During fusing, the deposit is partially remelted and allowed to resolidify.

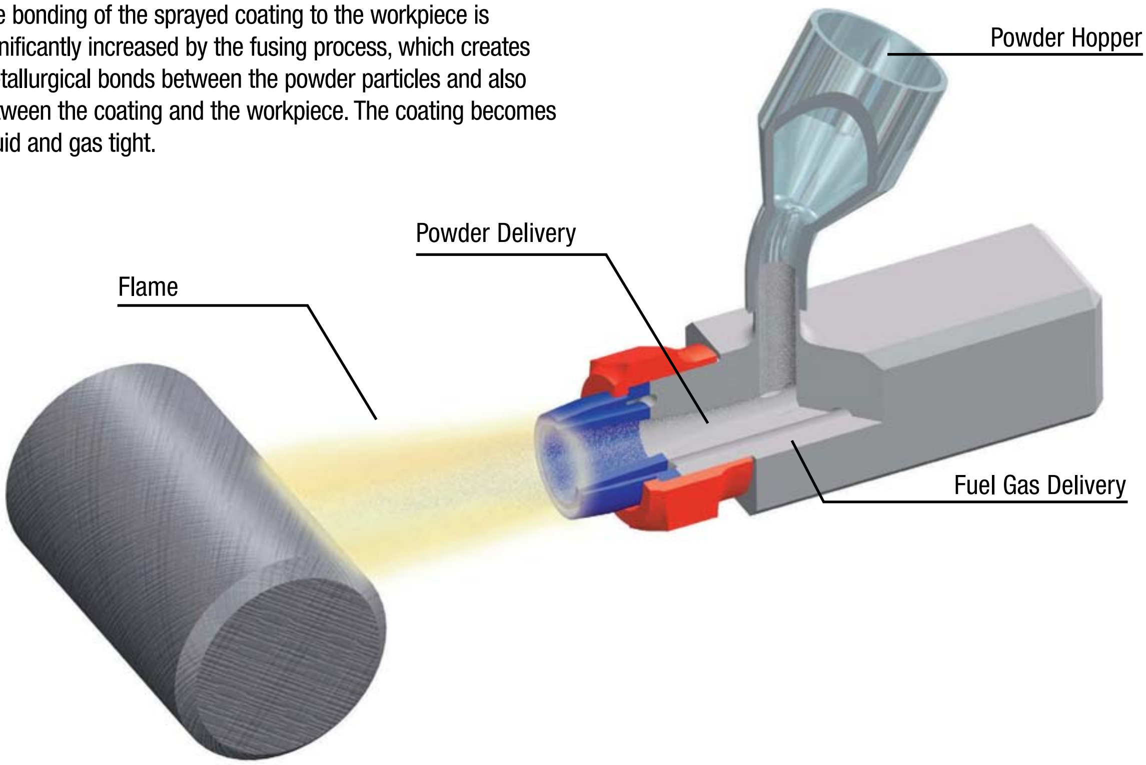
In flame-spraying, the powder particles are softened or melted in an oxyacetylene flame and transferred to a prepared workpiece by the expanding gases. An additional gas stream can be used to assist with powder particle transfer.

The second stage of the process, fusing the sprayed coating to the workpiece, is usually done with an oxyacetylene burner. Alternatively, for mass production, fusing can be carried out by induction heating or in a vacuum furnace.

The bonding of the sprayed coating to the workpiece is significantly increased by the fusing process, which creates metallurgical bonds between the powder particles and also between the coating and the workpiece. The coating becomes liquid and gas tight.

This process is used for the deposition of relatively thin (0.010" to 0.060" or 0,25 to 1,5 mm) layers, usually on the surface of small cylindrical objects such as pump shafts, packing gland sleeves and pistons, as an alternative to the greater deposit thickness obtained from oxy-acetylene and arc processes. The process can also be used for the facing of flat surfaces, but its possibilities for this type of work are limited.

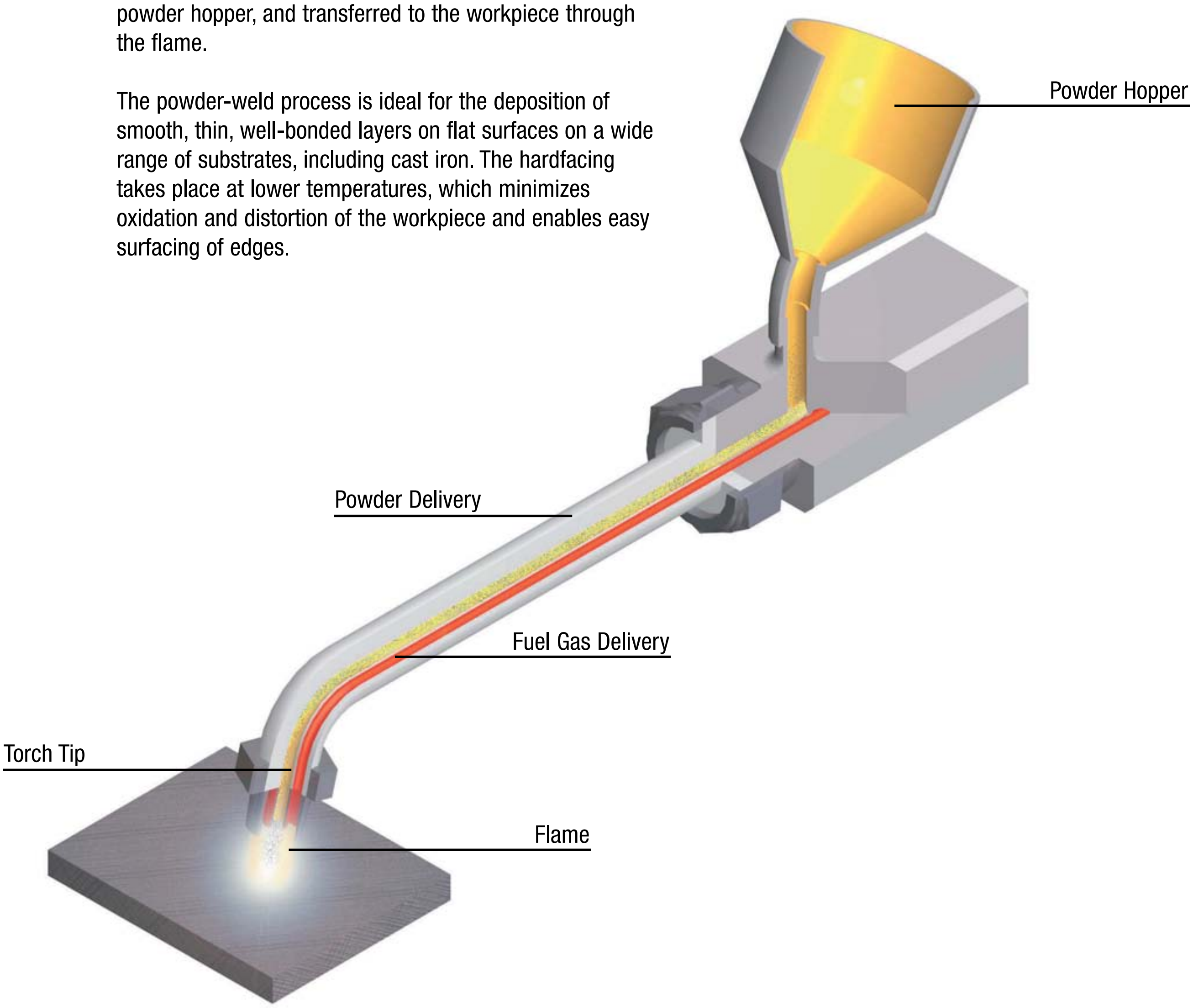
Since the deposit is thinner and more uniform than that obtained by other welding methods and the heat for fusion is applied uniformly and rapidly, shrinkage and distortion of the component is frequently very small. When the fusing operation is carried out correctly, dilution of the deposit by the base metal is negligible.



Powder Welding

A specially-designed oxy-acetylene torch is used for powder welding. The workpiece is heated with the torch, powder is introduced into the gas stream from the integral powder hopper, and transferred to the workpiece through the flame.

The powder-weld process is ideal for the deposition of smooth, thin, well-bonded layers on flat surfaces on a wide range of substrates, including cast iron. The hardfacing takes place at lower temperatures, which minimizes oxidation and distortion of the workpiece and enables easy surfacing of edges.



Spray and Fuse & Powder Welding

ALLOY	NOMINAL ANALYSIS OF WELDING ROD[1]								Others	Hardness (HRC)[2]
	Co	Cr	W	C	Ni	B	Fe	Si		
COBALT-BASED ALLOYS (GAS-ATOMIZED POWDERS)										
Stellite™ alloy SF1	Bal.	19	13	1.3	13.5	2.45	3	2.8	<0.5%Mn	50–60
Stellite™ alloy SF6	Bal.	19	7.5	0.8	14	1.7	3	2.6	<0.5%Mn	40–48
Stellite™ alloy SF12	Bal.	19	9	1.1	14	1.9	3	2.8	<0.5%Mn	42–52
Stellite™ alloy SF20	Bal.	19	15	1.6	14	2.9	3	3.2	<0.5%Mn	55–65
Stellite™ alloy 157	Bal.	21	4.5	0.1	<2.0	2.5	<2	1.6	<0.5%Mn	45–55
NICKEL-BASED ALLOYS (GAS-ATOMIZED POWDERS)										
Deloro™ alloy 15	–	–	–	<0.05	Bal.	1.1	0.5	2.0	20%Cu	180–230 DPH
Deloro™ alloy 21	–	3	–	<0.05	Bal.	0.8	<0.5	2.1	2.2%	240–280 DPH
Deloro™ alloy 22	–	–	–	<0.05	Bal.	1.4	<1.0	2.5	–	18–24
Deloro™ alloy 25	–	–	–	<0.06	Bal.	1.7	<1.0	2.7	–	22–28
Deloro™ alloy 29	–	3	–	<0.05	Bal.	0.9	<0.5	2.2	2.2%	27–30
Deloro™ alloy 30	–	9	–	0.2	Bal.	1.2	2.3	3.2	–	29–39
Deloro™ alloy 34	–	4.5	–	0.15	Bal.	1.2	0.3	2.8	2.5%Mo 2.2% Other	33–37
Deloro™ alloy 35	–	4	–	0.4	Bal.	1.6	1.5	3.4	–	32–42
Deloro™ alloy 36	–	7	–	0.3	Bal.	1.2	3	3.7	–	34–42
Deloro™ alloy 38	–	–	–	0.05	Bal.	2.1	0.5	3.0	–	35–42
Deloro™ alloy 40	–	7.5	–	0.3	Bal.	1.7	2.5	3.5	–	38–45
Deloro™ alloy 45	–	9	–	0.35	Bal.	1.9	2.5	3.7	–	42–50
Deloro™ alloy 50	–	11	–	0.45	Bal.	2.3	3.3	3.9	–	47–53
Deloro™ alloy 55	–	12	–	0.6	Bal.	2.7	4.0	4.0	–	52–60
Deloro™ alloy 60	–	15	–	0.7	Bal.	3.1	4.0	4.4	–	57–65
Deloro™ alloy 75	–	17	–	0.9	Bal.	3.5	4.5	4.5	2%Cu 3%Mo	53–63
Deloro™ alloy 6116	–	15.3	–	0.03	Bal.	4.0	–	–	–	–

Depending upon the process parameters and extent of dilution, the hardness of the weld deposit may vary from that provided in the above table.

KENNAMETAL

PRODUCTIVE
INNOVATIVE
ADVANCED

OUR MISSION

Kennametal delivers productivity to customers seeking peak performance in demanding environments by providing innovative customized and standard wear-resistant solutions, enabled through our advanced materials sciences, application knowledge, and commitment to a sustainable environment.

SUSTAINABLE ENGINEERING

With decades of experience, Kennametal offers you some of the most effective opportunities for sustainable manufacturing in the industry using the synergies of superior engineering, leading technology, and tailor-made solutions. Our comprehensive range of products, local support, and excellent customer service make Kennametal your complete supplier of sustainable tooling solutions.

Successful project engineering requires planning, teamwork, and disciplined execution. Through our extensive experience in developing and implementing new project engineering strategies, Kennametal has pioneered a proven methodology to help you manufacture new products and bring them to market quickly. Service deliverables are carefully outlined and jointly agreed to before the project begins. We formally evaluate progress and results with you throughout the project through our stage-gate management system.

Kennametal can provide your engineering teams and machine tool builders with process engineering support, advanced metalcutting technologies, and project management expertise to help you achieve your sustainability goals. With our best-in-class process, you'll experience accelerated time-to-market, lower overall costs, and reduced risks to implement new technologies.

STELLITE ALLOYS

For customer service or to place an order contact:

AMERICAS SALES OFFICE
Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana 46526
USA
Phone: +1 574 534 2585
Fax: +1 574 534 3417
Email: k-gshn.service@kennametal.com

kennametal.com/stellite

WORLD HEADQUARTERS
Kennametal Inc.
1600 Technology Way
Latrobe, PA 15650
USA
Tel: 1 800 446 7738
E-mail: ftmill.service@kennametal.com

EUROPEAN HEADQUARTERS
Kennametal Europe GmbH
Rheingoldstrasse 50
CH 8212 Neuhausen am Rheinfall
Switzerland
Tel: +41 52 6750 100
E-mail: neuhausen.info@kennametal.com

ASIA-PACIFIC HEADQUARTERS
Kennametal Singapore Pte. Ltd.
3A International Business Park
Unit #01-02/03/05, ICON@IBP
Singapore 609935
Tel: +65 6265 9222
E-mail: k-sg.sales@kennametal.com

INDIA HEADQUARTERS
Kennametal India Limited
CIN: L27109KA1964PLC001546
8/9th Mile, Tumkur Road
Bangalore - 560 073
Tel: +91 080 22198444 or +91 080 43281444
E-mail: bangalore.information@kennametal.com

kennametal.com

STELLITE Star J

STELLITE™ **Star J Alloy**

TECHNICAL DATA

CASTINGS | POWDER METALLURGY COMPONENTS

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	W	C	Fe	Ni	Others	Hardness	Density	Melting Range
Bal	32.5	17.5	2.5	2.0	2.0	Mn, Si	50-63 HRC	0.316 lb/in^3 8.76 g/cm^3	1215-1299°C 2220-2370°F

STELLITE COBALT-BASED ALLOYS consist of complex carbides in an alloy matrix. They are resistant to wear, galling, and corrosion and retain these properties at high temperatures. Their exceptional wear resistance is due mainly to the unique inherent characteristics of the hard carbide phase dispersed in a CoCr alloy matrix.

STELLITE STAR J is recommended for use in extreme conditions of wear, abrasion, and heat. The alloy is similar to **STELLITE 3** in carbon content but with a higher tungsten content. This results in higher hot hardness and superior strength. The tungsten also changes the morphology and type of carbides resulting in improved abrasion resistance at the expense of ductility. Wear parts such as pads, pins, balls, and certain valve components in extreme environments are common applications for **STELLITE STAR J**.

FINISHING

STELLITE STAR J can be rough machined with carbide-tipped tools, albeit with difficulty. Grinding is recommended, particularly when higher than RC55. Stress relieving before and during machining is recommended.

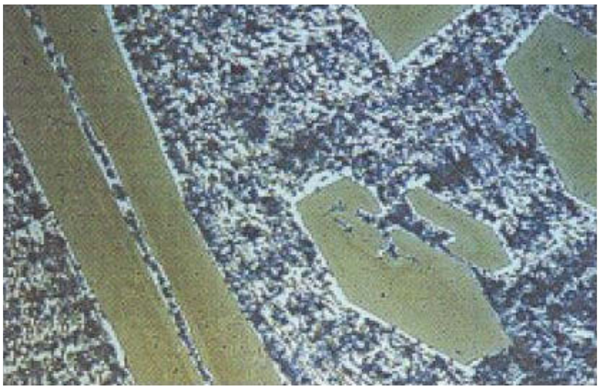
WEAR

The higher tungsten content results in a stronger alloy with excellent hot hardness. It is similar to **STELLITE 3** in wear resistance and is non-galling when mated with other Stellite alloys. The high tungsten content also results in a change in morphology and type of carbides, giving this alloy superior low-stress abrasion compared to **STELLITE 3**.

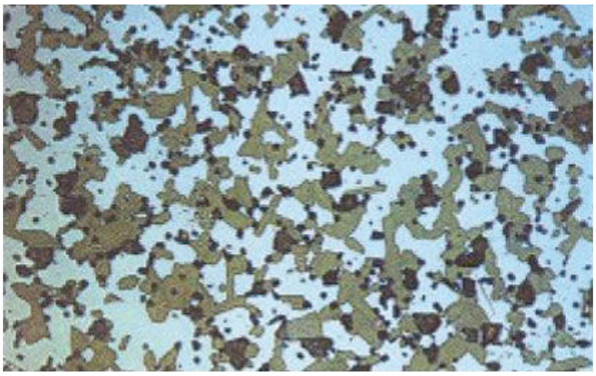
CORROSION

STELLITE STAR J exhibits similar corrosion resistance to **STELLITE 3** but inferior to **STELLITE 6**. **STELLITE STAR J** resists many oxidizing acids if temperature is low but not recommended for reducing environments. The alloy has excellent oxidation resistance. Corrosion will vary depending on concentration, temperature, stress, and contaminants, thus production exposure tests are recommended.

Stellite Star J microstructure



Casting



Powder Metallurgy

KENNAMETAL STELLITE

www.stellite.com

NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

	Ultimate Tensile Strength		Yield Stress Rp (0.2%)		Elongation	Elastic Modulus	
	ksi	MPa	ksi	MPa	A(%)	ksi	MPa
Castings	62	427	Near UTS		—	37,500	258 x 10^3

NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)	1000°C (1832°F)
µm/m.K	12.06	12.06	12.24	12.24	12.60	12.78	13.14	13.68	14.22	15.12
µ-inch/inch.F	6.7	6.7	6.8	6.8	7.0	7.1	7.3	7.6	7.9	8.4

THERMAL PROPERTIES

	Approximate Value at Room Temperature	
Thermal Conductivity	102 Btu-in/hr/ft²/°F	14.81 W/m.K

HOT HARDNESS (DIAMOND PYRAMID NUMBER)

	20°C (68°F)	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)
DPN	670	600	552	516	476	441	412	340	245	132

COMPRESSIVE AND IMPACT STRENGTH

Compressive Strength (Ultimate)	355 ksi (2309 MPa)
Impact Strength (RT), IZOD Unnotched	2.5 ft.lb (3.4 Joules)

AVAILABLE PRODUCT FORMS:

STELLITE Star J is available as finished castings, and powder metallurgy components.

DESIGNATION	PRODUCT FORM
UNS R31001	Castings
UNS R30102	Powder Metallurgy

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

TRIBALOY

TRIBALOY™ T-400/T-400C ALLOYS

TECHNICAL DATA

CASTINGS & POWDER METALLURGY I TIG & OXY-ACELYLENE WELDING I PTA & LASER WELD DEPOSITION I HVOF & PLASMA SPRAY DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

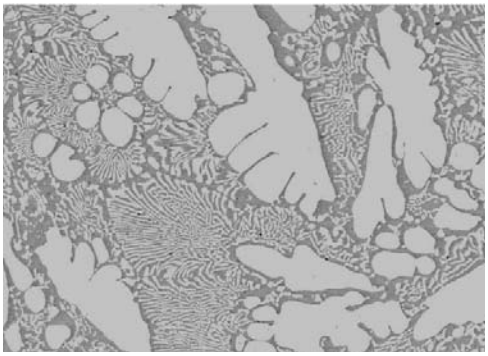
	Co	Cr	Mo	C	Si	Others	Hardness	Density	Melting Range
T-400	**Base**	8.5	28	<0.08	2.5	Ni, Fe	51-58 HRC	8.90 g/cm^3 0.325 lb/in^3	1288-1340°C 2350-2440°F
T-400C	**Base**	14	27	<0.08	2.6	Ni, Fe	48-56 HRC	8.86 g/cm^3 0.320 lb/in^3	1315-1335°C 2400-2435°F

TRIBALOY COBALT-BASED ALLOYS consist of a hard, intermetallic (Laves) phase dispersed in a softer matrix of eutectic or solid solution. They exhibit outstanding resistance to wear and galling, high corrosion resistance, and are particularly suitable where lubrication is a problem. Wear resistance of Tribaloy alloys is highly dependent on the volume percentage of the Laves phase.

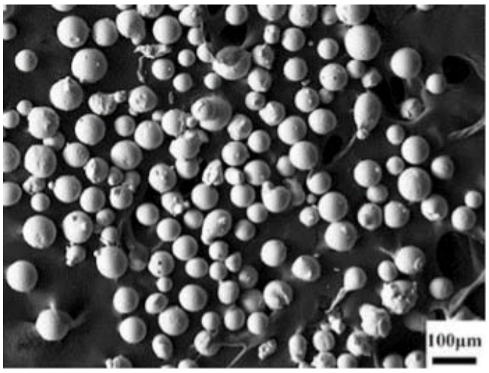
TRIBALOY T-400 combines excellent mechanical wear resistance with good corrosion resistance. T-400 contains hard intermetallic phases of Mo and Si which give the alloy excellent wear properties over a wide temperature range. T-400 exhibits outstanding resistance to galling. T-400C offers improved oxidation corrosion and high temperature wear resistance over T-400 as well as improved thermal shock resistance.

T-400 and T-400C are known for their use in automotive turbocharger applications. Other areas of application are in situations where:

- Metal-to-metal wear exists
- Surfaces cannot be lubricated (e.g. high temperatures)
- Lubrication starvation exists
- Fluid lubricant is of low viscosity
- Both wear and corrosion are factors



Typical Microstructure Tribaloy T-400 (500x)



Tribaloy T-400 Powder

NOMINAL HOT HARDNESS (VICKERS, 1000G LOAD)

Tribaloy Alloy	20°C (68°F)	315°C (600°F)	537°C (1000°F)	650°C (1200°F)	760°C (1400°F)	870°C (1600°F)
T-400	565	490	445	495	380	255
T-400C	590	480	465	470	430	225

KENNAMETAL STELLITE

www.stellite.com

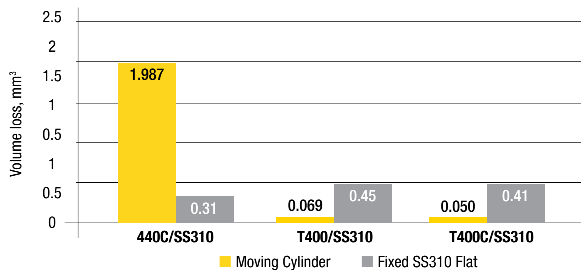
NOMINAL TENSILE PROPERTIES AT ROOM TEMPERATURE

Tribaloy Alloy	Tensile Strength (ksi)	Elastic Modulus (ksi)
T-400	100	38600
T-400C	95	36400

PLINT WEAR RESISTANCE ASTM G133

This test demonstrates the wear performance of T-400 and T-400C in high-temperature unlubricated, sliding wear conditions using an investment cast cylinder for the Tribaloy materials against a nitrided 310 stainless steel flat specimen.

TRIBALOY ON NITRIDED 310SS PLINT TEST AT 900°F



CORROSION RESISTANCE, MM PER YEAR

Media	Condition	T-400	T-400C
H_2SO_4	10%, 102°C	180	27
HNO_3	65%, 66°C	780	195
HCl	5%, 66°C	5.1	3

T-400 and T-400C both offer very good corrosion protection in a range of environments. The higher chromium content in T-400C offers improved corrosion resistance over T-400. Since corrosion resistance varies with concentration, temperature, stress, and contaminants, it is best to use production exposure tests to determine the suitability for each application.

AVAILABLE PRODUCT FORMS: TRIBALOY T-400 and **T-400C** are available as finished castings, powder metallurgy components, rod, and powder.

DESIGNATION	PRODUCT FORM
UNS R30400	Castings, Powder Metallurgy, Powder, and Rod

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

TRIBALOY™ **T-800 ALLOY**

TECHNICAL DATA

CASTINGS & POWDER METALLURGY I TIG & OXY-ACELYLENE WELDING I PTA & LASER WELD DEPOSITION I HVOF & PLASMA SPRAY DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	Mo	C	Si	Others	Hardness	Density	Melting Range
Base	17.5	28.5	<0.08	3.4	Ni, Fe	54-62 HRC	8.6 g/cm^3 0.312 lb/in^3	1288-1352°C 2350-2465°F

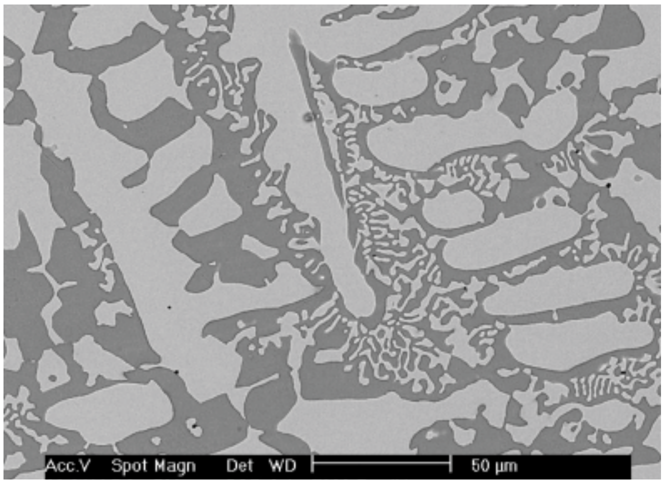
TRIBALOY COBALT-BASED ALLOYS consist of a hard, intermetallic (Laves) phase dispersed in a softer matrix of eutectic or solid solution. They exhibit outstanding resistance to wear and galling, high corrosion resistance, and are particularly suitable where lubrication is a problem. Wear resistance of Tribaloy alloys is highly dependent on the volume percentage of the Laves phase.

TRIBALOY T-800 alloy contains hard intermetallic phases of Mo and Si which give the alloy excellent wear properties over a wide temperature range. T-800 was designed to resist high temperature wear and abrasion and has exceptional oxidation and corrosion resistance due to its high chromium content. T-800 is harder and more resistant to abrasive wear, corrosion, and oxidation than **TRIBALOY T-400.** T-800 exhibits outstanding resistance to galling and is particularly suitable where lubrication is a problem.

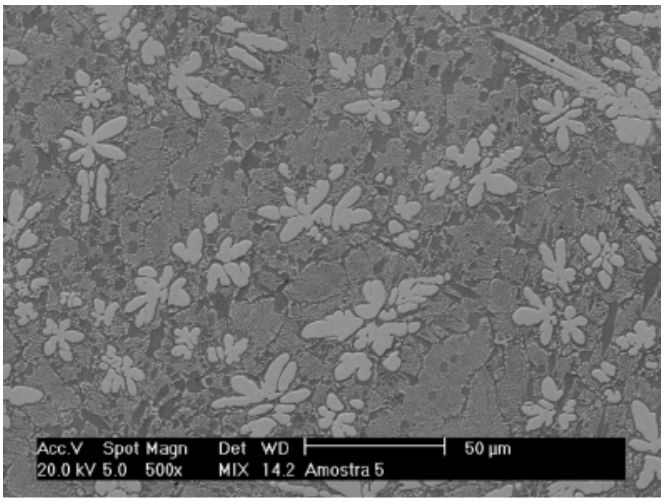
TRIBALOY T-800 has been used in a wide range of applications, most notably as a wear surface in aircraft engines. Other applications include galvanizing roll bushings, cams, retainer rings, diesel piston rings, mechanical seals, bearing seats, valve trim, and pump components.

Areas of application where Tribaloy alloys are used:

- Metal-to-metal wear
- Surfaces that cannot be lubricated (e.g. high temperatures)
- Lubrication starvation
- Fluid lubricant is of low viscosity
- Both wear and corrosion are factors



Micrograph of T-800 Casting 500x



Micrograph of T-800 As Deposited 500x

NOMINAL HOT HARDNESS (HV1000)

	22°C (72°F)	427°C (800°F)	538°C (1000°F)	649°C (1200°F)	760°C (1400°F)
GTAW	725	660	620	485	310

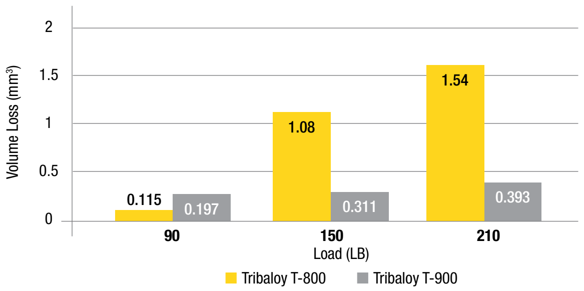
KENNAMETAL™ STELLITE

www.stellite.com

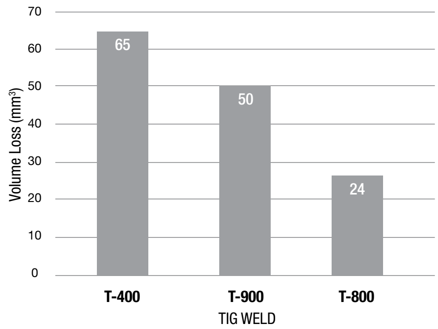
WEAR RESISTANCE

Tribaloy alloys all have outstanding resistance to metal-on-metal wear and galling. Comparing T-800 and T-900 alloys in a block-on-ring wear test, T-800 has a performance benefit at low loads, whereas T-900 has better wear performance at higher loads. T-800 shows a performance advantage in low-stress, abrasive-wear conditions as shown in G65 tests due to having more Laves phase and a coarser Laves phase.

ASTM G77 ADHESIVE WEAR



ASTM G65 ABRASIVE WEAR



NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	100°C (212°F)	200°C (392°F)	300°C (572°F)	400°C (752°F)	500°C (932°F)	600°C (1112°F)	700°C (1292°F)	800°C (1472°F)	900°C (1652°F)	1000°C (1832°F)
µm/m.K	10.62	11.43	11.86	12.2	12.47	12.87	13.36	13.75	14.00	14.15
µ-inch/inch.°F	5.9	6.35	6.59	6.78	6.93	7.15	7.42	7.64	7.78	7.86

CORROSION RESISTANCE, MM PER YEAR

Media	Condition	T-800
CH_3COOH	50% 105°C	0.002
H_2SO_4	10% 102°C	0.860
H_3PO_4	28% 110°C	0.026
HCl	5% 66°C	0.040
HCOOH	45% 104°C	0.040
HNO_3	65% 66°C	1.080

The high chromium and molybdenum content in T-800 gives the alloy excellent corrosion properties in a range of corrosive environments. Since corrosion resistance varies with concentration, temperature, stress, and contaminants, it is best to use production exposure tests to determine the suitability for each application.

PRODUCT FORMS AND CROSS-REFERENCE SPECIFICATIONS:

TRIBALOY T-800 is available as finished castings, powder metallurgy components, rod, and powder.

SPECIFICATION	PRODUCT FORM
B50TF193	Solid Weld Rod
B50TF190	Powder

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com

TRIBALOY

TRIBALOY™ T-900 ALLOY

TECHNICAL DATA

CASTINGS & POWDER METALLURGY I TIG & OXY-ACELYLENE WELDING I PTA & LASER WELD DEPOSITION I HVOF & PLASMA SPRAY DEPOSITION

NOMINAL COMPOSITION (MASS %) AND PHYSICAL PROPERTIES

Co	Cr	Mo	C	Si	Ni	Hardness	Density	Melting Range
Base	18	23	<0.08	2.7	16	52-57 HRC	8.9 g/cm³ 0.312 lb/in³	1288-1352°C 2350-2465°F

TRIBALOY COBALT-BASED ALLOYS consist of a hard, intermetallic (Laves) phase dispersed in a softer matrix of eutectic or solid solution. They exhibit outstanding resistance to wear, and galling, high corrosion resistance, and are particularly suitable where lubrication is a problem. Wear resistance of Tribaloy alloys is highly dependent on the volume percentage of the Laves phase.

TRIBALOY T-900 is a cobalt-based Laves phase-containing alloy with improved crack resistance over traditional **TRIBALOY T-800**. Unlike T-800, which requires a preheat of 1000°F or higher, T-900 can be PTA welded with a preheat of 500°F. ASTM G77 adhesive wear test results indicate that **TRIBALOY T-900** has similar wear resistance to alloy T-800 under low loads and outperforms T-800 under high loads.

TRIBALOY T-900 is most effective in applications where corrosion or high-temperature wear resistance is needed. It has been used in a range of applications, including bleed valves on commercial aircraft engines, wedge valves, and seat rings.

Areas of application where Tribaloy alloys are used:

- Metal-to-metal wear
- Surfaces that cannot be lubricated (e.g. high temperatures)
- Lubrication starvation
- Fluid lubricant is of low viscosity
- Both wear and corrosion are factors

TRIBALOY T-900 microstructure, PTA at 100x

KENNAMETAL™ STELLITE

www.stellite.com

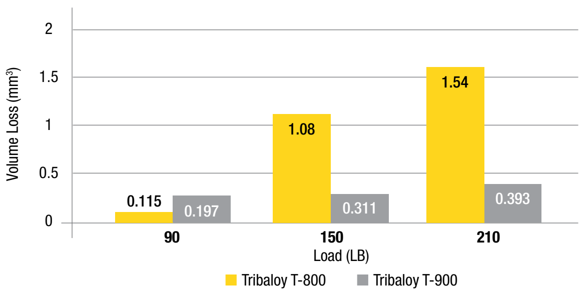
NOMINAL HOT HARDNESS (DPH)

	20°C (68°F)	135°C (275°F)	260°C (500°F)	413°C (775°F)	543°C (1010°F)	682°C (1260°F)	732°C (1350°F)
Casting	700	690	675	650	590	450	310

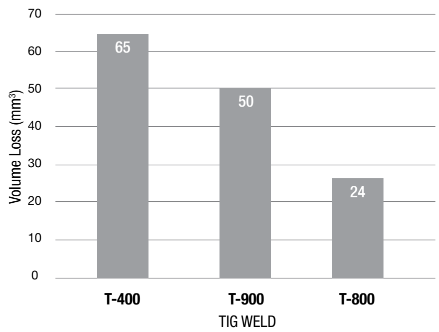
WEAR RESISTANCE

Tribaloy alloys all have outstanding resistance to metal-on-metal wear and galling. Comparing T-800 and T-900 alloys in a block-on-ring wear test, T-800 has a performance benefit at low loads, whereas T-900 has better wear performance at higher loads. Alloyed with nickel, T900 tends to stabilize the Face Centered Cubic (FCC) microstructure, and hence is less brittle than T800, which contributes to its high load wear characteristics.

ASTM G77 ADHESIVE WEAR



ASTM G65 ABRASIVE WEAR



NOMINAL THERMAL EXPANSION COEFFICIENT (FROM 20°C/68°F TO STATED TEMPERATURE)

	815°C (1500°F)
µm/m.K	12.8
µ-inch/inch.°F	7.1

CORROSION RESISTANCE, MM PER YEAR

Media	Condition	T-900
CH_3COOH	50% 105°C	0.06
H_2SO_4	10% 102°C	2.7
H_3PO_4	28% 110°C	0.02
HCl	5% 66°C	0.09
HCOOH	45% 104°C	0.16
HNO_3	65% 66°C	5.95

The high chromium and molybdenum content in T-900 gives the alloy excellent corrosion properties in a range of corrosive environments. Since corrosion resistance varies with concentration, temperature, stress, and contaminants, it is best to use production exposure tests to determine the suitability for each application.

AVAILABLE PRODUCT FORMS:

TRIBALOY T-900 is available as finished castings, powder metallurgy components, rod, and powder.

SALES OFFICE - COMPONENTS

Kennametal Stellite
471 Dundas St. East
Belleville, Ontario
K8N 1G2
Canada
T: 1 613 968 3481
F: 1 613 966 8269
E-mail: k-blvl.service@Kennametal.com

SALES OFFICE - WELDING CONSUMABLES

Kennametal Stellite
1201 Eisenhower Drive N
Goshen, Indiana
46526
USA
T: 1 574 534 2585
F: 1 574 534 3417
E-mail: k-gshn.service@Kennametal.com

KENNAMETAL STELLITE

www.stellite.com