



# STELLOY Cobalt Products

Cobalt Base Welding Consumables  
for Cladding and Hardfacing



ACTING GLOBAL  
WELDING LOCAL



Since its foundation in 1966, the Welding Alloys Group, an independent group, has specialised in the manufacture of cored welding wires for cladding and hardfacing applications - 100% produced in our modern factories, 100% our own technology. The wide range of non-alloyed, low-alloyed and high-alloyed wires meets or exceeds the most stringent metallurgical standards.

# Stelloy Grades

TYPE	STELLOY 1	STELLOY 6BC	STELLOY 6	STELLOY 6HC	STELLOY 12	STELLOY 21	STELLOY 25
STELLOY cobalt (-G) semi automatic or fully automatic process (Ø mm)	1.2 - 2.4	1.2 - 2.4	1.2 - 2.4	1.2 - 2.4	1.2 - 2.4	1.2 - 2.4	1.2 - 2.4
STELLOY cobalt (-TIG) semi automatic or fully automatic process (Ø mm)	N/A	1.2 - 1.6	1.2 - 1.6	1.2 - 1.6	N/A	1.2 - 1.6	N/A
EN 14700 AWS A5.21	TCo3 ERCCoCr-C	TCo2 ERCCoCr-A	TCo2 ERCCoCr-A	TCo2 ERCCoCr-A	TCo2 ERCCoCr-B	TCo1 ERCCoCr-E	T ZCo1 -
Typical all-weld metal analysis (%) Cobalt base	C 2.3	C 0.9	C 1.05	C 1.2	C 1.5	C 0.25	C 0.15
	Cr 29	Cr 28.5	Cr 28.5	Cr 28.5	Cr 30	Cr 28	Cr 20
	W 12	W 4.5	W 4.5	W 4.5	W 7.5	Mo 5.5	W 14
	Mn 1.0	Mn 1.0	Mn 1.0	Mn 1.0	Mn 1.0	Ni 3.0	Ni 9.5
	Si 1.0	Si 1.0	Si 1.0	Si 1.0	Si 1.0	Mn 1.0	Mn 1.5
	Fe 4.0	Fe 4.0	Fe 4.0	Fe 4.0	Fe 4.0	Si 1.0	Si 1.0
							Fe 4.0
Weld Metal Hardness			Work Hardens			Work Hardens	
HRC at 20°C	53	38	42	44	45	33	21
HB at 20°C	495-560	350-380	380-415	410-430	415-455	300-340	210-260
HB at 200°C	465		370		410	280	180
HB at 400°C	420		320		370	255	145
HB at 600°C	370		255		315	235	130
HB at 800°C	330		240		275	220	120
Crack Resistance	*	****	***	**	**	****	****
Impact	*	***	***	**	**	****	****
Metal to Metal Wear	***	***	***	***	***	****	****
Corrosion	****	****	****	****	****	****	****
Cold Abrasion	****	**	***	***	****	**	**
Hot Abrasion	****	**	***	***	****	**	***
Machineability	*	***	**	**	**	****	****

Descriptions and Applications	STELLOY 1	STELLOY 6BC	STELLOY 6	STELLOY 6HC	STELLOY 12	STELLOY 21	STELLOY 25
	Excellent hot and cold abrasion properties with low coefficient of friction, erosion and oxidation resistance to over 1000°C. Do not use in applications involving impact and where crack free welds are essential. Used on valve steam hardfacing, wire guides, rubber and plastic mixers, extrusion screws and conveyors.	Substantially the same alloy as Stelloy 6 except for lower carbon content. Easier to machine and less crack sensitive than standard Stelloy 6. Used primarily in semi-automatic and automatic operations on surfacing of large components where the use of No. 6 is problematic due to cracking. Used on valve seats, wedges, and for direct welding of seats into valve bodies. Also used on cylinders where crack free welding is essential.	Combines all the outstanding properties of cobalt base alloys, i.e. excellent erosion and corrosion resistance. Very good metal to metal wear resistance; maintains hardness to elevated temperatures and can be machined. Used extensively on valve seats of diesel engines, cams, chainsaw bars, hot shear blades, cold forming rolls and hot rolling reinforcing bar, pump parts and components in hot zinc baths.	Substantially the same alloy as Stelloy 6 except for higher carbon content. Designed primarily for applications by MIG where hardness of 40-42 is specified and single run weld is to be used, with 10% dilution. Used on smaller valves and bodies, chain saw bars, extrusion dies etc.	Moderate impact resistance combined with very good metal to metal wear properties. Very good hot and cold abrasion. Retains hardness to high temperatures and less likely to crack than Stelloy 1. Used on saw teeth, cams, shafts, tappets and push rods for engines, screw conveyors and augers for rubber and plastics, seats and valves for oil and gas.	Soft as welded but with work hardening hardness increases to above 45 Rc. Less crack sensitive than other alloys, it is used for build up and on large sections. Moderate cold abrasion but excellent metal to metal wear combined with good corrosion resistance. Used for integral seats and guides of large water and high pressure valve bodies, drop forging dies, pump shafts and sleeves, hot punches etc.	Average hardness. It maintains its hardness at high °C. Not sensitive to cracking. Excellent metal-to-metal wear resistance at high temperatures make this alloy suitable for hot shear blades, hot forming rolls and hot zinc parts.

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Ceramic moulds for tyles production hardfaced with STELLOY 6-G



Ball valves hardfaced with STELLOY 21-G



Extrusion screw hardfaced with STELLOY 12-G



Forging die hardfaced with STELLOY 21-G

### Welding recommendations

#### Heating procedure

The lower the carbon content, the better the resistance to cracking. Grade 21 STELLOY is largely insensitive to cracking and offers good impact resistance. STELLOY 6, being harder, offers improved resistance to abrasion at both high and low temperatures, but is less crack-resistant.

To avoid cracking, any welding operation with this type of filler metal requires preheating and controlled cooling rate. Preheating can be beneficial in problems arising from hardsurfacing i.e. reduction of cracks, no hard zones adjacent to welds and minimisation of shrinkage and distortion. The table to the right is a general guide only and can vary with engineering experience and with consideration of component size and geometry.

### Welding conditions

#### MIG welding process

Pushing technique is highly recommended  
Typical welding procedure with diameter 1.2mm:

- Polarity:** Pulsed technique
- Wire speed:** 6-7 m/min
- Amperage:** 180-200 A
- Voltage:** 23-25 V
- Welding speed:** 37-39 cm/min
- Stick-out:** 15 mm
- Gas shielding:** I1 (100%Ar)
- Gas flow:** 16-19 l/min

#### TIG welding process

Typical welding procedure with diameter 1.2mm:

- Polarity:** DC-
- Wire speed:** 1.5-2.5 m/min
- Amperage:** 200-210 A
- Voltage:** 13-15 V
- Welding speed:** 15-19 cm/min
- Gas shielding:** I1 (100% Ar)

TIG hot wire technology is also possible and increases the deposition rate

#### Cracks and Porosity

If cracks and/or porosity occur, solve as follows :

Cracks and porosity:

- Make sure base is clean of oil, rust, grease etc. and check base metal for cracks before welding.
- Excess moisture, either in flux, rods etc. Rebake as follows: 6 hours at 150°C
- Reduce arc length during welding (voltage)

Cracks:

- Increase pre-heat temperature
- Hardsurface is too thick - reduce depth or change material
- Use softer grade, e.g. STELLOY 6BC instead of STELLOY 6
- Post-heat to 700-800°C in extreme cases and allow slow cooling

#### Hardness Variations and Controlling Dilution

Cooling rate will have little or no effect on hardness of cobalt base alloys. The principal cause for hardness variation in deposits is variation in dilution levels, particularly in the first two layers. Variations in the welding parameters can markedly change dilution levels. Dilution is measured by the percentage of base material in the weld metal. Dilution is reduced by decreasing: arc voltage, arc current, preheat and interpass temperature; and it is increased by decreasing travel speed.

### Recommended preheating temperature (°C) for 1-layer clad of STELLOY on different base metals

STELLOY Product	Base Metal Grade							
	< 0.3% Carbon Steel	0.3-0.5% Carbon Steel	Up to 3% Total Alloy Steels	3-10% Total Alloy Steels	Martensitic High Alloy Steels e.g. 12% Cr	Ferritic High Alloy Steels e.g. 17% Cr	Austenitic High Alloy Steels e.g. 316	Nickel Alloys e.g. Stelloy C
STELLOY 1	350	350	350	350	350	350	250	250
STELLOY 6BC	150	200	200	250	300	100	100	100
STELLOY 6	200	250	250	250	300	150	150	150
STELLOY 6HC	200	250	250	300	300	200	150	150
STELLOY 12	275	300	300	300	300	250	200	200
STELLOY 21	100	150	150	200	200	100	100	100
STELLOY 25	100	150	150	200	200	100	100	100

### Cladding STELLOY 6-G on S235 Carbon steel – 20 mm thick with different buffer-layers:

Type 309L

Type grade 6

Type grade 21

Measurements hardness layer 1 and 2

Base material S 235	Job 1		Job 2		Job 3	
	Layer 1	Layer 2	Layer 1	Layer 2	Layer 1	Layer 2
Type	TETRA S 309L-G	STELLOY 6-G	STELLOY 6-G	STELLOY 6-G	STELLOY 21-G	STELLOY 6-G
Diameter (mm)	1.2	1.2	1.2	1.2	1.2	1.2
Voltage (V)	29	21	21	23	20	21
Amperage (A)	250	180	180	180	170	180
Wire Feed (m/min)	9.6	5.1	5.1	5.1	6	5.1
Shielding Gas	M21 (Ar + 15-25% CO <sub>2</sub> )	I1 (100% Ar)	I1 (100% Ar)	I1 (100% Ar)	I1 (100% Ar)	I1 (100% Ar)
Welding Speed (m/min)	0.40m/min	0.38m/min	0.40m/min	0.38m/min	0.40m/min	0.38m/min
Pre-heating and inter-pass temp.		> 150°C	> 300°C	> 300°C	> 300°C	> 300°C
Current type	DC+	Pulsed	Pulsed	Pulsed	Pulsed	Pulsed
Results Hardness	<b>27 HRC</b>	<b>35 HRC</b>	<b>39 HRC</b>	<b>42 HRC</b>	<b>31 HRC</b>	<b>44 HRC</b>



Cladding :  
First layer 309L  
Second layer STELLOY 6-G



Cladding :  
First layer STELLOY 6-G  
Second layer STELLOY 6-G



Cladding :  
First layer STELLOY 21-G  
Second layer STELLOY 6-G

Most cobalt base alloys for hardfacing consist of alloying cobalt with chromium, tungsten, molybdenum, carbon, and occasionally with iron. Chromium aids in corrosion resistance, usually in the range of 25-35%. Tungsten usually in the range of 3-12% and molybdenum improves the strength at elevated temperatures. Alloys viewed under the microscope typically consist of chromium and tungsten carbides in a Co-rich tough matrix.



Micrograph of STELLOY 21-G 1.2 welding deposit

Excellent wear resistance as well as work hardening capacity of the Cobalt-rich matrix is due to low stacking fault energy and a high degree of stacking faults.

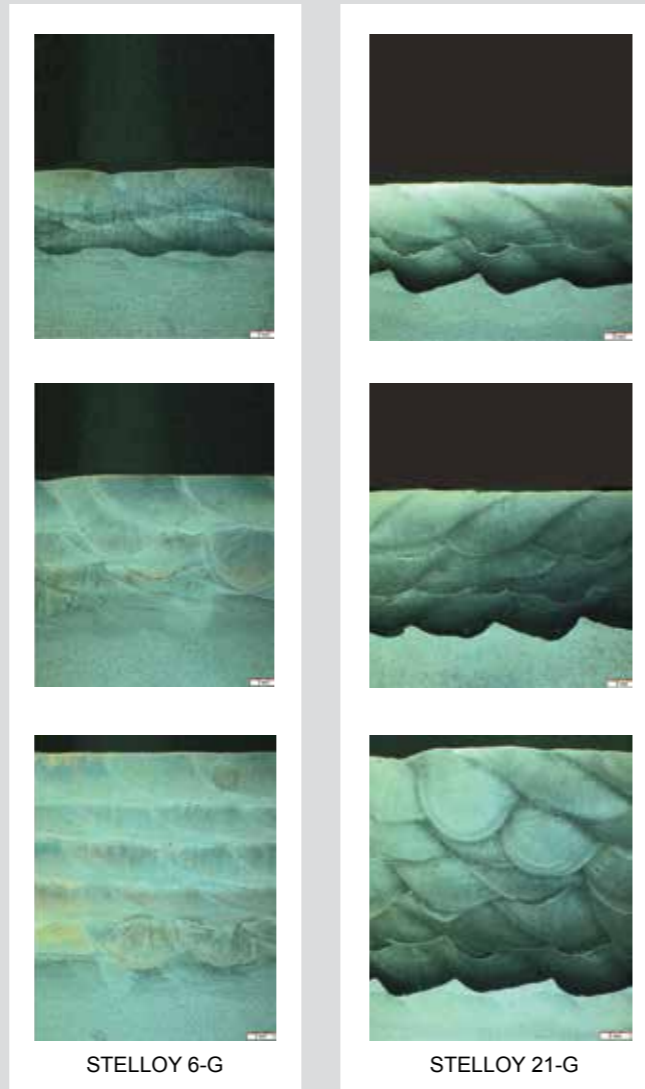
When Stelloy wires are welded using recommended welding conditions, a very low level of dilution is achieved and undiluted weld metal composition can be attained after 5 mm cladding (fig. 1).

Carbon is the principal addition to increase hardness of these alloys, with tungsten and chrome having a secondary effect. The higher the carbon the better the abrasion resistance, however, resistance to mechanical impact can be adversely affected.

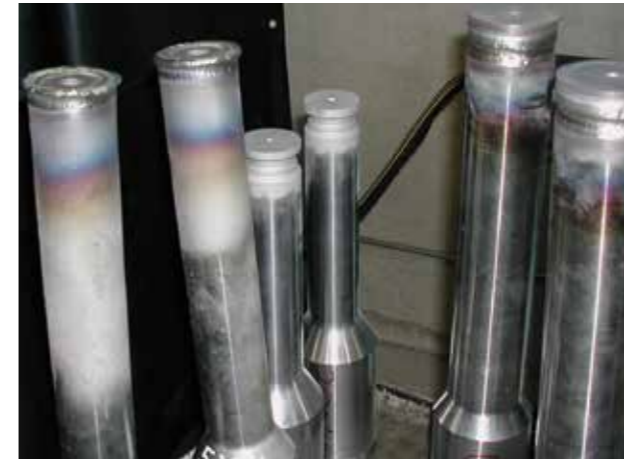


Micrograph showing the bonding between the base metal and the first layer

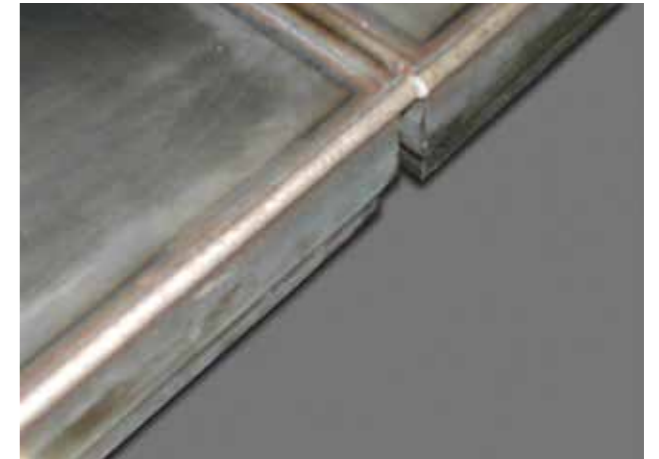
### High thickness weld deposit of STELLOY 21-G and STELLOY 6-G showing excellent compactness of the weld deposit



### Different applications STELLOY 6-G



Forging plunger for bearings manufacturing  
Hardfaced with STELLOY 6-G



Ceramic Mould detail  
Hardfaced with STELLOY 6-G

### Packaging

Metal basket spool	
Standard net weight:	25 kg
External diameter:	410 mm
Internal diameter:	300 mm
Width:	100+/-3 mm
EN ISO 544 standard:	B 450

Drum	
Standard net weight:	330 kg
External diameter:	580 mm
Height:	800 mm

**Certified ISO 9001**

Metal basket spool	
Standard net weight:	15 kg
External diameter:	300 mm
Internal diameter:	51.5 mm
Width:	103 mm
EN ISO 544 standard:	BS 300

Plastic spool*	
Standard net weight:	15 kg
External diameter:	300 mm
Internal diameter:	51.5 mm
Width:	103 mm
EN ISO 544 standard:	S 300

Plastic reel*	
Standard net weight:	15 kg
External diameter:	390 mm
Internal diameter:	305 mm
Width:	90 mm

Small plastic spool*	
Standard net weight:	5 kg
External diameter:	200 mm
Internal diameter:	51.5 mm
Width:	55 mm
EN ISO 544 standard:	S 200

Small metal basket spool	
Standard net weight:	5 kg
External diameter:	200 mm
Internal diameter:	51.5 mm
Width:	55 mm

\*Manufactured to order at client's request

# Our Technical 'Spark' Solves Your Industrial Challenges



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## WA Machines

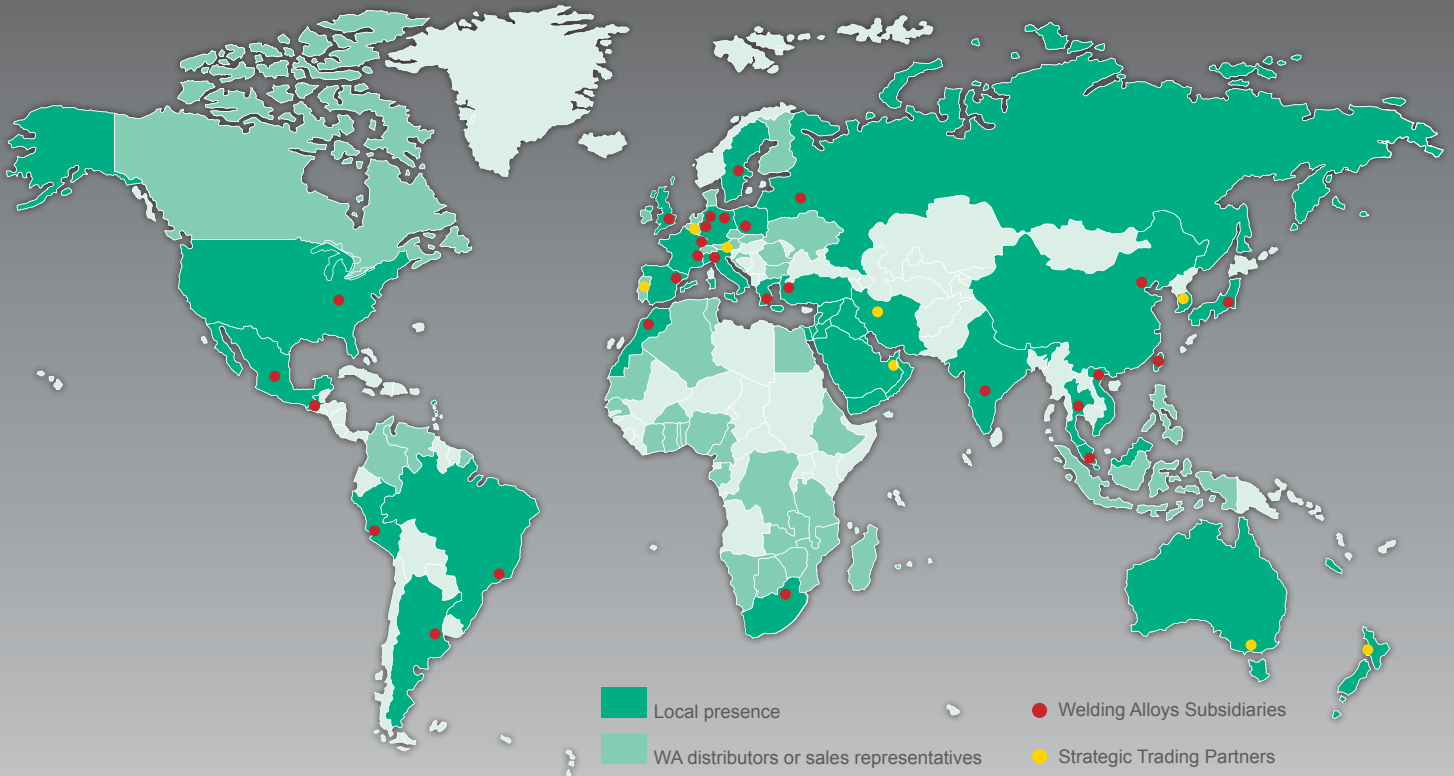
The go-to provider of automated equipment for wear protection



## WA Integra™

The go-to provider of engineered wear protection solutions

## A worldwide presence



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