



Photomicrograph of Colmonoy® 6 fused coating, original at 50x

# Colmonoy® 6 Alloys (6, 6PTA, 6L)

## A Nickel-Based Hard-Surfacing Alloy to Resist Wear, Heat, Corrosion and Galling

### Description:

Colmonoy® 6 Alloys are rated excellent in resistance to abrasion, corrosion and galling and good on impact. The alloy has excellent red hardness and has no peer in weldability. Colmonoy® 6 Alloys are very stable and do not anneal. The alloys excel in metal-to-metal wear due to low coefficient of friction. The alloys can be hot-formed while in the plastic condition (between the solidus and liquidus temperatures). Colmonoy® 6 Alloys are spray deposited and fused to achieve a hardness range of **Rockwell C 56-63**.

Applications include shafts, sleeves, and valve trims. Some specific examples are ball joints, bearings, brick augers, bushings, cams, chuck jaws, conveyor parts, deep hole drills, feeder shoes, glass plungers, mill guides, mixing blades, pistons, plug gauges, pump shafts, rocker arms, screw conveyors, sprockets center, trip dogs, valves, disks, and seats.

### Specification Equivalents:

GE P50YP164, N99646 , MIL-RNiCr-C-1 (Rod), and AWS A5.21 Classification ERNiCr-C (applicable to chemistry only).

### Nominal Composition - % by Weight:

Alloy	B	C	Cr	Fe	Si	Ni
6	3.0	0.6	14.0	4.0	4.2	Bal
6PTA 6L	2.1	1.1	20.0	5.7	5.6	Bal

### Forms Available:

Colmonoy® 6 Alloys are supplied as crushed powder for application with Wall Colmonoy's Spraywelder™ System. The alloys are available as atomized powders for Plasma Transferred Arc welding (PTA) and Laser Cladding. Also available as ingot, concast bare rod.

Alloy	Mesh Size	Application
Colmonoy® 6	38 - 106 micron	Spray-n-Fuse
Colmonoy® 6PTA	53 - 150 micron	PTA Welding
Colmonoy® 6L	53 - 150 micron	Laser Cladding

### Colmonoy® 6:

Colmonoy® 6 is designed for spray and fuse applications, using combustion thermal spray systems such as Wall Colmonoy Spraywelder™ System and Wall Colmonoy Fusewelder™ Torch.

Fused coatings form a metallurgical bond with the substrate providing inter-particle cohesive strength and substrate-to-coating adhesive strength with very low porosity. The coatings show good resistance to wear and impact and their hot hardness is excellent. (Table 3)

## Properties:

**Table 1: Physical Properties (approximate):**

Deposits produced by Spray-n-Fuse

<b>Density</b>	0.281 lb/cu in
	7.78 g/cc
<b>Melting Point</b>	1900°F
	1040°C
<b>Specific Heat</b>	0.190 Btu/lb °F (77-212°F)
	0.7955 kJ/kg °C (25-100°C)
<b>Thermal Coef. of Expansion</b>	8.14 x 10 <sup>-6</sup> in/in °F (122-1202°F)
	14.7 x 10 <sup>-6</sup> cm/cm °C (50-650°C)
<b>Thermal Conductivity</b>	104 Btu ft/hr/sq. ft/°F
	1.8 watt/cm/°C
<b>Coefficient of Friction (6 - micro surface finish)</b>	0.10
<b>Magnetic Permeability</b>	1.005 N/A <sup>2</sup>
<b>Modulus of Elasticity, (Tension or Compression)</b>	32 x 10 <sup>6</sup> psi

**Table 2: Room Temp. Mechanical Properties:**

Deposits produced by Spray-n-Fuse

<b>Compressive strength, (ave.)</b>	300,000 psi
	2,068.43 Mpa
<b>Tensile strength, (ave.)</b>	30,000 psi
	206.84 Mpa
<b>Charpy impact*, (ave.)</b>	1.5 ft-lb
	2.0 N-m
*Specimens having 1/2-inch-radius notch and polished to remove all possibility of stress concentrations	

**Table 3: Room & Elevated Temp. Hardness:**

Deposits produced by Spray-n-Fuse

<b>Test Temp (°F / °C)</b>	<b>Rockwell C Hardness</b>
70 / 21	56-63
600 / 315	55
800 / 425	52
1000 / 540	48
1200 / 650	44

## Application Methods:

Colmonoy® 6 Alloys are easily applied to all steels having less than .25% carbon, gray cast iron; Meehanite, malleable, ingot and wrought iron; nickel, Monel<sup>a</sup> alloy 400, Inconel<sup>a</sup> alloy 600, Nichrome, Chromel<sup>b</sup>. Most high-temperature alloys can be overlaid without special precautions.

Steel having more than .25% carbon can also be overlaid, but requires controlled slow cooling after fusion, in suitable insulation such as Sil-O-Cel, mica, etc. Do not apply to ferrous metals that require subsequent hardening and tempering, because the dimensional change associated with the formation of martensite will crack the deposits of Colmonoy® 6. Hardenable base metals may be overlaid, but must be annealed isothermally after uniform austenitizing to prevent cracking of the deposits of Colmonoy® 6. (Consult [Technical Services](#) for further details).

## Application by Spraywelder™:

Colmonoy® 6 powder is applied by use of the Spraywelder™, which is the recommended Thermal Spray system designed by Wall Colmonoy to produce dense coatings. The powder is sprayed on the part to be hard surfaced as in ordinary metal spraying procedure, and the overlay is then fused to the base metal by torch, induction or furnace. This is ideal when deposits of uniform thickness are being applied over a large area. Reference Spraywelder™ Brochure and Manual for more information.

## Application by Fusewelder™:

Colmonoy® 6 powder is applied by Fusewelder™ or similar torch. The Fuseweld Process is a coating application method to apply metallurgically bonded coatings to the edges and corners of molds and blanks. Small shafts, the leading edge of flights for augers and centrifuge scrolls, keyways, splines, and cams can all be efficiently coated or rebuilt with this process.

## Application by PTA Welding:

There are numerous Plasma Transferred Arc Welding systems on the market and a wide range of welding parameters can be used with Colmonoy® 6PTA to produce excellent weld overlays.

Wall Colmonoy recommends that a pure argon plasma gas be used in combination with an argon-hydrogen shielding gas and an argon carrier gas.

Welding parameter settings will depend on the base metal, its thickness, geometry and metallurgical condition as well as the desired properties/geometry of the weld overlay and the type of PTA equipment being used.

Preheat and weld inter-pass temperature can affect the quality of the weld deposit and its wear properties.

Preheat Temperature by Class for steels					
Class	Description	up to ½"	½" to 1"	1" to 2"	Interpass
10xx	C steels	100 – 600	100 – 700	100 – 800	200 – 700
13xx	Mn steels	350 – 500	400 – 600	450 – 700	450 – 600
23xx	Ni steels	200 – 400	200 – 500	300 – 700	300 – 600
31xx	Ni – Cr steels	200 – 600	300 – 700	400 – 900	>400
32xx	Ni – Cr steels	300 – 900	400 – 1000	500 – 1100	500 – 900
33xx	Ni – Cr steels	500 – 900	600 – 1000	700 – 1100	700 – 900
34xx	Ni – Cr steels	900 – 1100	900 – 1100	900 – 1100	900 – 1100
4140	Cr – Mo steel	600	700	800	600 – 800
4340		600	800	900	700 – 900
46xx		400 – 600	500 – 700	600 – 800	≅ 600
4820		600	700	800	600 – 800
5120		100 min	200 – 300	250 – 350	≅ 300
5145		400 – 500	450 – 550	500 – 600	≅ 500
86xx		100 – 400	200 – 500	300 – 600	≅ 400
High strength alloy steels (quenched and tempered)					
A533, B		50 – 200	100 – 350	200 – 450	100 – 350
A542		150 – 300	200 – 350	250 – 450	200 – 350
HY-130		75 – 225	75 – 275	200 – 375	200 – 350

## Application by Laser Cladding

Laser cladding utilizes a laser beam as a heat source to weld a surfacing material to a substrate. Surface cladding powder is delivered to the weld zone through a powder feeder with an inert gas carrier. The power level of the laser, the powder feed rate, pre-heat of the base metal, and 3-dimensional movement speeds must be balanced to produce a metallurgically bonded, low dilution, crack free, porosity free clad overlay.

Properly applied laser clad overlays can have significantly higher hardness than a corresponding thermal spray applied coating of the same material. Alloy selection for the laser cladding process should take this into consideration.

Laser cladding can be conducted in a sealed, inert environment, or in an open shop environment. In

the latter case, the use of argon or helium carrier gases with argon and/or helium shielding gases are recommended. Nitrogen is not an inert gas and it is not recommended for general use in laser cladding.

## Machining, Grinding and Lapping:

There are several techniques used for material removal that produce high quality finished products.

Machining can be done, using cubic boron nitride tooling. Use GE's BZN compacts (such as BRNG-43T) or Kennametal's CNMA 433KC-210. Use a negative rake tool, with a 15-degree lead angle. It should have a 3/64-in. radius and T-land edge preparation. Set tool at centerline of work. Feed at 0.005-0.010 IPR, with depth of cut up to 0.125-in., at 200-300 SFM or higher.

The coatings can be machined with difficulty by carbide-tipped tools, such as Kennametal K6, Carboly 883 or equivalent. For roughing, grind the tool with a slight lead and rake angle, and a slight radius (approx. 1/32"). Use a fine feed, about 0.003" per revolution, with a depth of cut about 0.015" at 15 SFPM. Set tool about 1/32" below center. For finishing, grind the tool with the same slight lead and rake angles and with about a 1/16" radius. Use a fine feed, about 0.003" per revolution, with a maximum cut of 0.005" at approximately 45 SFPM.

Grinding is used after machining to remove the last 0.005-0.006" of material. Actually, the entire finishing is most commonly done by grinding, which eliminates machining. Grinding produces a near-frictionless mirror finish. Such smooth surfaces usually wear better, because they generate less heat and friction. Whereas a diamond wheel is preferred, green silicon carbide wheels (hardness H to K) can be used. Use 24 to 36 grit for roughing and 60 grit or finer for finishing. Grind wet when possible; do not let the wheel get loaded; dress frequently. Take light, fast cuts. (Manufacturer can provide full details for grinding.)

Dry lapping can be used to give the alloy an excellent finish. Silicon carbide, boron carbide and diamond dust are all capable of cutting the Colmonoy® coating, but they must be embedded in a cast iron or steel wheel to properly lap fused deposits of Colmonoy® 6 Alloys. Apply with a steady pressure and avoid overheating. If the lapping compounds are used loose, they will cut the nickel matrix before the chromium carbides, giving the surface an etched appearance.

## Safety:

When handling powders do so in such a way to avoid creating a dust cloud; avoid inhalation or contact with skin or eyes. Conduct coating operations in a properly ventilated area. For more information, consult 11.8 (Ventilation), *AWS Thermal Spraying: Practice, Theory, and Application* available from American Welding Society, OSHA Safety and Health Standards available from U.S. Government Printing Office, and the manufacturer's Material Safety Data Sheet (MSDS).

**Warning: Sprayweld type torches used for application of this product utilize compressed gases including oxygen and a flammable fuel gas. Follow your employers safety procedures when using and handling these gases and equipment. Infrared and Ultraviolet radiation (light) emitted from flame and hot metal can injure eyes and burn skin. Use appropriate personal protective equipment.**

**Danger: Plasma transferred arc (PTA) welding is a welding process used for application of this product. Follow your employer's safety procedures and the equipment manufacturer's instructions when PTA welding. Electric shock can kill. Properly install and ground electrical equipment prior to use. Infrared and ultraviolet radiation emitted from the hot metal or welding arc can injure eyes and burn skin. Use appropriate personal protective equipment.**

**Warning: Laser cladding processes may use high power levels when applying this product. Follow your employer's safety procedures and the equipment manufacturer's instructions when laser cladding. Refer to AISI Z136.1 "Safe use of Lasers" and consult your employer's Laser Safety Officer regarding the proper use of personal protective equipment.**

## Storage Requirements:

Keep thermal spray powders in a closed container and protect against moisture pick-up. The containers should be tumbled before using the powder. If moisture is absorbed from the atmosphere, it can be removed and flowability can be restored by drying the powder, with the seal removed and lid loosened, at 150-200°F (66-93°C) for two hours prior to use.

*The information provided herein is given as a guideline to follow. It is the responsibility of the end user to establish the process information most suitable for their specific application(s). Wall Colmonoy assumes no responsibility for failure due to misuse or improper application of this product, or for any incidental damages arising out of the use of this material.*

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*b Registered trademark of Concept Alloys.*

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