



## Colmonoy® Surfacing Alloys Extending Useful Life of Downhole Tools

One sector of the Oil & Gas Industry that is still growing is directional drilling (slant drilling) of non-vertical wells. There are three main areas which we see growth; oilfield directional drilling, utility directional drilling (horizontal directional drilling) and directional boring. However, in order to increase drilling efficiencies, it is imperative to have very reliable downhole drilling tools and equipment.

Due to the ever increasing demands of directional drilling, there is an ever increasing level of wear exerted on the steering components of the drill string. Colmonoy® hardsurface coatings meet the demands of protecting and prolonging the useful life of the parts in this extremely severe environment.

Colmonoy® hardsurface coatings done by Laser Cladding, Plasma Transferred Arc Welding, HVOF, Plasma Spray, Spray Fuse, and Powder Welding meet the demands of protecting and prolonging the useful life of the parts in this extremely severe environment.

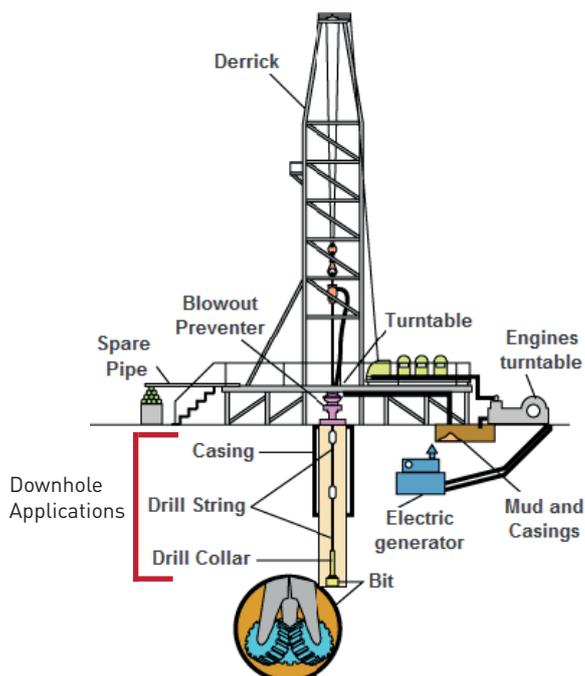


Figure 1: Typical Oil Rig system

### Trend towards PTA and Laser Cladding

Lately, there has been a trend towards PTA and Laser Cladding application methods for Oil & Gas Industry specifically for process equipment applications such as valves, choke valves, regulators and downhole tooling such as stabilisers, drill bits, steering pads and sometimes hard-banding on drill pipes.



Figure 2: PTA Machine applying coating to a downhole tool  
Photo courtesy of Lion Engineering Ltd (Great Yarmouth)

### Improved Performance: Automated and Repeatable

PTA and Laser Cladding are becoming more popular because the two processes offer improved performance against more traditional Flame Spray and Spray and Fuse methods of deposition. For stabilisers, processes can be automated thus reducing labour costs and improving repeatability. The inclusion of spherical cast tungsten carbides into the powder blend can increase life expectancy of the part against deposits using traditional tungsten carbide inserts cemented into place using a 25 HRC manual welding powder.

### Reduced Heat Input and Cooling Rates Produce Improved Grain Refinement Deposits

In examples such as valve slides and gates, PTA and Laser Cladding produce deposits with much improved grain refinement (over traditional arc welding techniques) when cladding with materials such as Wallex® 6 (Grade 6 cobalt alloys). This is due to significantly reduced heat input and cooling rates.



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In cases of laser cladding, where there is no discernible heated zone required, chemistry can be achieved sometimes in one pass instead of three significantly reducing costs in subsequent welding procedures and sometimes machining to final dimension.

Figures 3-6 show grain structures of Grade 6 cobalt alloys as deposited. Figure 3 illustrates that using PTA cladding shows a much better grain refinement than Figure 4 that was completed using MIG welding. Figure 5 and 6 show improved grain refinement for PTA and Laser Cladding. However, Figure 6 shows further grain refinement than Figure 5.

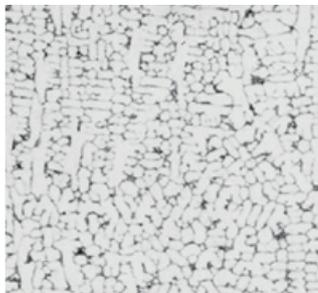


Figure 3. PTA Cladding



Figure 4. MIG Welding

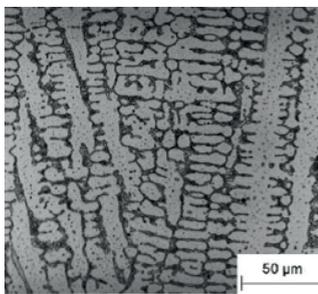


Figure 5. PTA Deposit

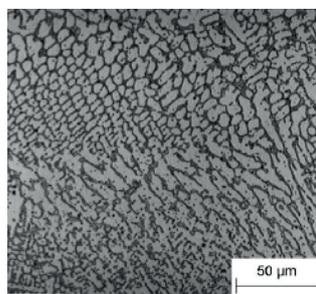


Figure 6. Laser Cladding Deposit

would include hard tungsten carbide particles. These tungsten carbide particles can range from cast and crushed tungsten carbide particles to spherical cast.

## Cast and Crushed Tungsten Carbide Alloys for Downhole Tools

The combination of an extremely tough matrix and very hard carbide produces an exceptional impact and wear resistance combination important for the Oil & Gas industry as such coatings reduce costly downtime for tool and component changes due to wear. The alloys dense carbide distribution with small inter-carbide spacing allows for a large surface area of tungsten carbide to be exposed to the wear environment to provide maximum service life.

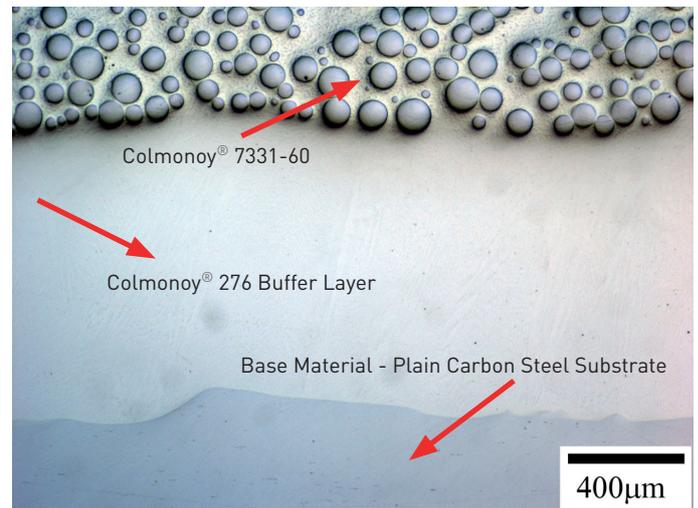


Figure 7: Photomicrograph (original at 400X) showing Colmonoy® 7331-60 being Laser Cladded with Colmonoy® 276 as a buffer layer - showing clean interfaces for both layers on top of plain Carbon steel substrate.

Colmonoy® 7331-60 and Colmonoy® 7251-60 are regularly used in oil-field downhole tool applications such as reamers; hole openers; steering pads; stabilisers; near-bit stabilisers; hard-banding; drill bits and more. At 60% tungsten carbide, the alloys offer the optimum level of wear resistance.

Colmonoy 7331-60 and Colmonoy 7251-60 are a composite blend of atomised nickel-based alloy powder both containing 60% cast and crushed tungsten carbide particles in a nominal 33 HRC or 27 HRC matrix (depending on customer requirements). Both can also be blended with spherical cast tungsten carbide and can be used with either PTA or laser cladding systems.

Buffer layers are needed when hard facing non-magnetic parts. The buffer layers provide a crack resistant interface between the base material and hard facing top layer. Colmonoy® 625 and Colmonoy® 276 both work extremely well as buffer layers.

### Advantages of PTA and Laser Cladding

- Easily Automated / Highly Repeatable Process
- Minimal Heat Affective Zone
- Minimal Dilution
- Deposit Durable and Tough Matrix Materials
- Enhanced material performance in comparison to conventional welding

### Deposit Durable and Tough Matrix Materials

For more severe applications such as downhole tools where compressive abrasion is encountered both PTA and Laser Cladding can be used to deposit durable and tough matrix materials that

### Standard Powder Welded Alloy for Securing Tungsten Carbide Inserts (TCIs)

Traditionally, Tungsten Carbide inserts are secured on the stabiliser, sleeve, steering pad and certain drill bits by powder welding Fusewelder™ Powders.

Colmonoy® 25F is a fuseweld alloy that is used to secure tungsten carbide inserts (TCIs) in downhole tool stabilisers, sleeves and steering pads. TCIs are very wear resistant – protecting the stabiliser, sleeve or steering pad from the extreme wear environment in oil exploration.

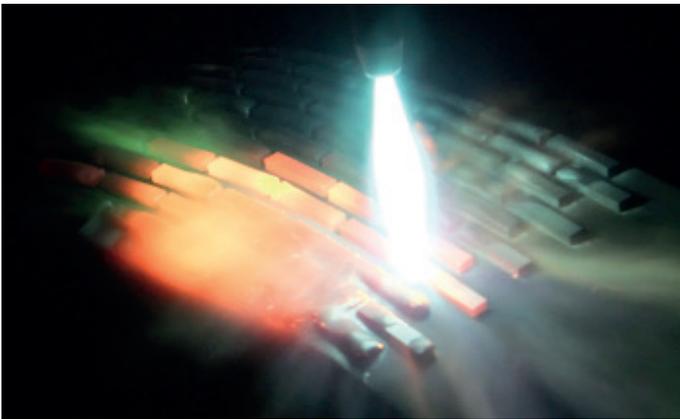


Figure 8: Colmonoy® 25F cementing tungsten carbide inserts onto an Integral Stabiliser for Oil & Gas Exploration Industry

When securing tungsten carbide inserts to the stabiliser, one wants a fluid and ductile product. The fast flow and easy wetting properties of Colmonoy 25F enable heavy deposits to be overlaid quickly allowing for efficient cementing of tungsten carbide tiles on standard steel and non-magnetic parts. The TCIs do the hardwork in protecting the part. Colmonoy 25F acts like a glue to secure the TCIs in place.



Figure 9: First completed section of as-welded stabiliser using Colmonoy® 25F

The leading edge on the stabiliser is where most erosion can occur. Erosion of the cementing alloy can lead to loss of TCIs or tiles and in turn, premature failure of the stabiliser. Colmonoy® 7541-55F can reduce the wear rate in these areas thus extending the service life of parts.

Colmonoy 7541-55F offers increased wear resistance over standard TCIs cemented into place using nominal 25 HRC powder welding grades. Colmonoy 7541-55F can be used in conjunction with standard TCIs and in areas of increased wear, replacing standard 25 HRC powder and increasing the amount of tungsten carbide overall. Colmonoy 7541-55F can also be used in other high wear areas such as steel-body welded drill bits, steering pads, sleeves and reamers.



Figure 10: Image shows the leading edge with tile loss and erosion of the cementing matrix powder. Further use would result in rapid tile loss. Colmonoy® 7541-55F improves performance in reducing wear rates in this area



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## Colmonoy® Surfacing Alloys for Downhole Tools

ALLOY	NOMINAL COMPOSITION (wt.%)	HARDNESS	DESCRIPTION / APPLICATION / USE
<b>Colmonoy® 7331-60</b>	B = 0.7 C = 2.5 Cr = 2.4 Fe = 0.7 Si = 1.8 W = 57.4 Ni = Balance	Matrix 30-40 HRC*  WC = >1900HV0.1.	Atomised, crushed or composite powders to be used with most laser cladding and PTA cladding equipment.
<b>Colmonoy® 7251-60</b>	B = 0.7 C = 2.4 Si = 1.1 W = 57.4 Ni = Balance	Matrix 25-31 HRC*  WC = >1900HV0.1.	Reamers; hole openers; steering pads, stabilisers, near-bit stabilisers, hard-banding, drill bits etc.
<b>Colmonoy® 625</b>	C = <0.075 Cr = 22 Fe = <5.0 Mo = 9.0 Nb = 3.75 Si = <0.5 Ni = Balance	Nominal 97 HRB**	Use as a buffer layer with the two products above on non-magnetic parts
<b>Colmonoy® 276</b>	Cr = 15.0 Fe = 3.5 Mn = 1.2 Mo = 16.0 Other = 1.2 W = 4.5 Ni = Balance	Nominal 25 HRC	
<b>Colmonoy® 25F</b>	B = 1.8 Si = 2.7 Ni = Balance	25-31 HRC	Atomised non-sparking, non-magnetic and non-galling alloy. Applied by powder welding or Fusewelder® Torch.  Dressing and re-dressing steel and non-magnetic stabilisers.
<b>Colmonoy® 7541-55F</b>	B = 0.75 C = 3.0 Co = 5.5 Cr = 3.4 Fe = 1.5 Si = 1.5 W = 46 Ni = Balance	Nominal 52 HRC  WC = 1900-2100HV0.1.	A composite blend of nickel-based matrix including tungsten carbide particles. Applied by powder welding or Fusewelder® Torch.  For use on steels, stainless steels, cast irons and nickel alloys.  Stabilisers, drill bits and steering pads for the oil & gas extrusion industry

\* Depending on method of deposition

\*\* Depending on application type and parameter settings

## Conclusion

Drilling within the Oil & Gas Industry continues to be strong. Downhole drilling tools guide or steer the drill head by changing its trajectory. This change of path results in ever increasing wear, occurring upon the drill head and the guide tools.

In order to extend the useful life, many downhole parts are coated with Colmonoy® hardsurfacing alloys – either by Plasma Transferred Arc (PTA), Laser Cladding, HVOF, Plasma Spray, Spray Fuse, or Powder Welding. There has been a trend lately towards PTA and Laser Cladding application methods over more traditional flame spray and spray fuse methods of deposition for stabilisers, sleeves, steering pads and drill bits. However, there still remains a strong demand for traditional spray and spray fuse methods.

Wall Colmonoy has over 60 years of extensive knowledge, experience and proven results with extending the useful life of downhole tools.

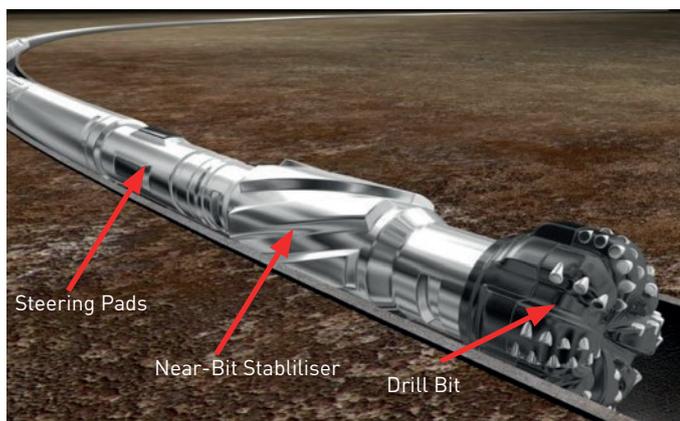


Figure 11: Image of typical Drill String showing showing the drill bit, near-bit stabiliser and steering pads.

## Application Method / Product for the Above Applications

### PTA / Laser cladding

- Colmonoy® 25P1, 25P2, 25P3
- Colmonoy® 7331-60
- Colmonoy® 7251-60
- Colmonoy® 625 or Colmonoy® 276 as buffer layers

### Powder Welding / Fuseweld™

- Colmonoy® 25F, 25E
- Colmonoy® 7541-55F

## References

1. Typical Oil Rig Schematic. Source – Wermac.org
2. PTA Machine applying coating to downhole tool. Source - Lion Engineering Ltd (Great Yarmouth)
3. Alloys for Laser Cladding, Technical Data Sheet, Wall Colmonoy Limited, March 2015
4. Colmonoy 7331-60 and 7251-60, Technical Data Sheet, Wall Colmonoy Limited, August 2015
5. Colmonoy 25 Alloys, Technical Data Sheet, Wall Colmonoy Limited, August 2015
6. Colmonoy 7541-55F - Technical Data Sheet, Wall Colmonoy Limited, August 2015
7. Typical Drill String. Source - Schoeller-Bleckmann



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SURFACING ALLOYS

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## About Wall Colmonoy

For over 75 years, Wall Colmonoy is a global leader in the manufacture and application of surfacing powders.

Wall Colmonoy's standard and custom range of surfacing alloys are applied by thermal spray processes extending the useful life of engineered components for such global industries as Glass Container, Power Generation, Oil & Gas, Energy, and Transportation.

Our specially formulated alloys, COLMONOY® and WALLEX®, have outstanding metallurgical and physical properties making them ideally suited to solving wear problems. The alloys are applied in a wide range of proven surfacing and thermal spraying techniques, including Laser Cladding, PTA, HVOF, Plasma Spray and Spray and Fuse.

Known for our unique proven way of creating superior performing alloys that extend the useful life of engineered components, we pride ourselves on long-term strategic customer collaboration that produces value-added ideas and creative solutions.

Combining over 75 years of engineering technology with a progressive, visionary outlook, Wall Colmonoy offers customers trusted, customized expertise that results in smart innovation and shared growth.

Our manufacturing facilities in North America and Europe are equipped with modern laboratory and testing facilities. Our products are manufactured to quality standards set by international and national industrial associations. We maintain the quality assurance of ISO 9001.

**Wall Colmonoy. Progressive Collaboration for Superior Performance. Worldwide.**

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