Metrode Products Limited

Technical Profiles

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1. INTRODUCTION

Supercore – Metrode stainless steel flux cored wire – an established name as we enter the 21st century - has far more users than when it was first conceived. Great strides have been made in developing the quality, reliability, performance and range of products available. Supercore and Cormet are well established in many markets; however, many fabricators are not fully exploiting all the benefits and advantages they offer.

This document explains how, with Supercore, productivity and economic benefits can be gained, to the benefit of the fabricator.

Originally the Supercore name was closely associated only with 300 series stainless steel flux cored wires, which produced superb downhand welds and mitred HV fillet welds. This remains true – but the Supercore range has been expanded and now offers fully positional wires and other alloy compositions including grades for duplex, superduplex, high temperature stainless steels (e.g. 304H, 347H, etc.) and for modified 9CrMo (P91 and P92)* creep resisting steels.

Supercore wires are only part of the picture; there are also Cormet wires for standard CrMo creep resisting steels. This Profile introduces Metrode's flux cored wires – Supercore and Cormet – and aims to demonstrate how you can benefit from using them.

* Metrode's flux cored wires for P91 and P92 are called Supercore, but are CrMo types and further details will be found with the Cormet range.

2. WHY SUPERCORE AND CORMET?

Pressure on fabricators to reduce costs and increase competitiveness is a fact of 21st century life; Supercore and Cormet wires can provide that competitive edge.

Supercore combines the productivity of continuous GMAW (MIG) with the operability and bead appearance of SMAW (MMA) electrodes, and this alone would justify the decision to switch to Supercore/Cormet. But many additional benefits - such as low cost introduction, ease of use, excellent weld appearance and radiographic quality – have all contributed to its success.

Four main factors will influence your decision to use Supercore and Cormet wires:

Minimal Capital Outlay

Supercore and Cormet both use standard GMAW equipment and Argon/CO_2 or CO_2 shielding gas, all of which are readily available, making investment in additional equipment or gases unnecessary.

Increased Productivity

Twice the weld deposition rate of SMAW electrodes and approximately four times the productivity can be achieved.

Reliable Weld Quality

Metrode's research and development of the Supercore and Cormet range has focussed on combining all that is best in SMAW quality with GMAW productivity. High quality weld profiles and surface finish, good penetration, high radiographic quality and virtually spatter-free welding, are all consistently and reliably achievable.

Economics

The productivity gains possible with Supercore and Cormet reduce the cost of fabrication, with inevitable beneficial effects upon the "bottom line".

These four factors are discussed in more detail in the following sections.

2.1 Minimal Capital Outlay

To achieve optimum, spatter free, positional welding with solid GMAW wires it is necessary to invest in expensive synergic pulsed GMAW welding equipment. With the all-positional Supercore and Cormet wires these same results are achieved using standard DC rectifier power sources.

Solid stainless steel GMAW wires require high argon content gases or argon-helium mixtures with low levels of O_2 or CO_2. Supercore and Cormet are designed to operate on argon-20%CO_2 shielding gas, which is a low cost, readily available gas mixture. The Supercore and Cormet wires will in most cases operate using 100%CO_2 shielding gas. (further details on gases from our Technical Department)

2.2. Increased Productivity

The overall productivity can best be determined from practical experience. Table 1 shows data for an ASME 6G pipe weld, typically found in the power generating industry. The joint was completed using Cormet 2 in about 65% of the time it took to complete a similar joint using the SMAW process.

Table 1: Welding Productivity Potential

Number of welders – one per joint
Based on Cormet 2, 1.2mm ∅ :
Pipe size – 220mm (8 in) ∅, 25mm (1 in) wall thickness.
Welding position – ASME 6G

Process (No of runs)	**GTAW (2)**	**FCW (18)**	**SMAW (27)**	**Total Time**
Production time (TIG/FCAW)	30	235	-	265 min
Production time (TIG/SMAW)	30	-	390	420 min
Production time Saving: ~35%				

Deposition Rate

The first step in judging the productivity of a particular process is often the comparative deposition rate, Figure 1. Even using the simplistic statistic of deposition rate Supercore/Cormet prove to be more productive than SMAW or GMAW.

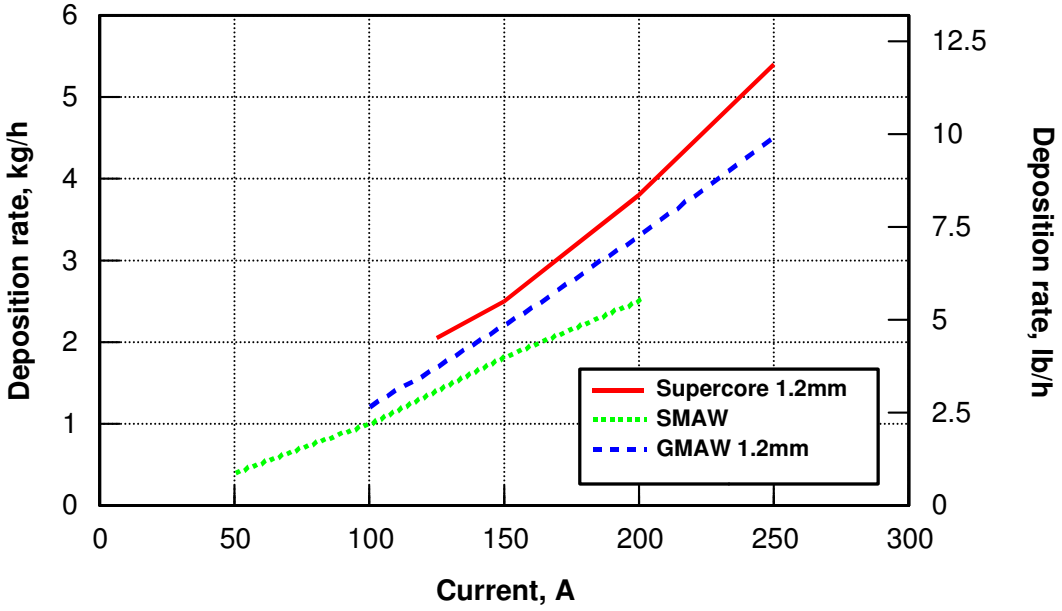


Figure 1 – SMAW, GMAW and Supercore - Comparison of weld metal deposition rates for 300 Series stainless steels.

Deposition Efficiency

A reel of Supercore wire offers 90% efficiency – for 1 Kg (2.2lbs) of consumable, 0.9 Kg (2lbs) of weld metal can be deposited.

The SMAW welding process, with its unused length of rod and high slag content, is approximately 65% efficient – 1 Kg (2.2 lbs) of electrode depositing only ~0.65 Kg (~1.4 lb) of weld metal.

Run-Out-Length

The continuous nature of the welding process is limited only by the configuration of the job and the duty cycle of the equipment. Unlike SMAW, which typically achieves a 200mm (8in) run-out per electrode, Supercore and Cormet wires can produce welds of virtually unlimited length, dependent only on the stamina of the welder.

Duty Cycle

The continuous Supercore process (semi- or fully-automatic) contributes to achievement of a high duty cycle by minimising the number of stop/starts. The Supercore wires can deposit either large welds in the minimum number of runs, or smaller welds at high travel speeds, using the same welding parameters. The adaptability of Supercore minimises setting-up times and allows the same parameters to be used for many different joints significantly increasing the duty cycle. Easy slag release and spatter free welding using Supercore/Cormet further enhance the potential duty cycle by avoiding/minimising the need for time-consuming and expensive post-weld dressing.

2.3 Reliable Weld Quality

Radiographic Quality

The spray arc characteristics of Supercore/Cormet produce reliable fusion and penetration, compared with the GMAW process which can be prone to lack-of-fusion/penetration. In relation to the SMAW process the consistent penetration of Supercore/Cormet wires proves beneficial, but the significant reduction in stop/starts also greatly aids weld quality.

Feedability

Consistent, smooth wire travel from the spool through the wire feeder to the weld pool, is a major factor in weld quality improvement. Metrode's flux cored wires have been developed to maximise feedability, enabling continuous, trouble-free welding which translates into defect-free welds. The feedability of all batches of Supercore and Cormet are tested on Metrode's specially designed test rig. This extensive testing ensures users can have confidence that all Metrode wires will provide consistent trouble-free feeding.

2.4 Economics

Cost of Weld Metal

The production efficiency of flux cored wire (90% as opposed to 65% for SMAW) is the first factor in the equation which, when it includes the cost of labour and post-weld treatment, demonstrates that the overall cost of the weld deposit is significantly lower.

Post-Weld Dressing

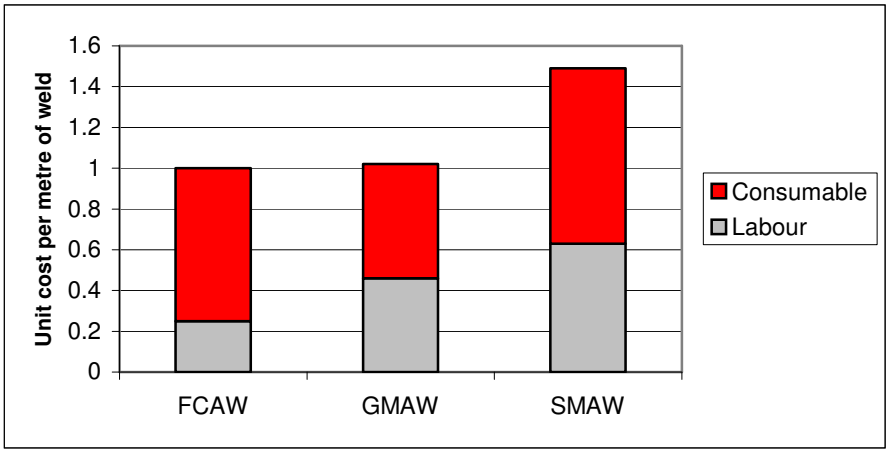
Continuity is only part of the reason for flaw-free weld beads. The slag, designed to protect the bead yet separate cleanly at the right time, ensures an excellent cosmetic finish. Post-weld dressing, and therefore additional labour cost, is minimised.

Labour Cost

While flux cored wire may cost more per unit than comparable electrodes, the significant reduction in working time produces a disproportionate reduction in the total cost of fabrication.

The true cost of a typical metre length of 9mm plate butt weld, based on current average UK rates for material and labour are shown in Figure 2.

Figure 2: An example based on typical UK production costs



Based on 12mm 3G butt weld in 316L stainless steel
Assumptions Made – consumable costs based on UK list prices
Ar/20% CO_2 gas for FCAW and Ar/He/CO_2 mixture for GMAW
Labour cost based on typical UK rates

The cost saving in comparison to SMAW is immediately evident; the economic advantage of using Supercore compared to GMAW is not quite so obvious. The actual benefit of using Supercore will be evident in the increased productivity, the improved bead finish and operator appeal compared to GMAW.

3. METRODE PRODUCT RANGE

The full Metrode product range is shown in Table 3, along with national specifications and a brief description of the applications.

3.1 Classification Information

To help understand the information presented in Table 3, a brief guide to the national specifications is given before the Metrode wires are described. In most cases the designations for the flux/metal cored wires are similar to the corresponding SMAW electrodes.

Key to AWS Specifications for Gas Shielded Flux Cored Wire

CrMo Wires	Stainless Steel Wires	
AWS A5.29	AWS A5.22	
EX**0**TX-XX	EXXXT**0**-X	**0** = Downhand/HV
EX**1**TX-XX	EXXXT**1**-X	**1** = All-positional
EXXTX-XX**M**	EXXXTX-**4**	**M** or **4** = Ar/15-25% CO_2 shielding gas
EXXTX-XX**C**	EXXXTX-**1**	**C** or **1** = 100%CO_2 shielding gas

3.2 CORMET

The Cormet range comprises two groups of wires:-

- all-positional CrMo pipe welding wires
- metal cored CrMo wires

All-positional wires

This is the most important group of Cormet wires, covering 1CrMo, CrMoV, 2CrMo, CrMoV, 5CrMo, 9CrMo, P91 and P92 – Cormet 1, 1V, 2, 2L, 5, 9 and Supercore F91 and F92. All of these wires are suitable for all-positional use, including fixed pipework in the ASME 5G/6G positions.

Metal cored

The final wire in the Metrode product range is Cormet M91, a metal cored wire for modified 9CrMo (P91) materials, and an ideal wire for the repair of castings and overlays.

3.3 SUPERCORE

The Supercore range of Metrode wires can be broadly divided into three categories:-

- standard downhand wires
- fully positional wires
- special wires for high temperature service with 300H stainless steels
- 'CF' controlled ferrite wires for low temperature applications e.g LNG.

Downhand Supercore Wires

These wires are available in 20.9.3, 309L, 309Mo, 308L, 347, 316L, 316NF, 2205, 2507 and 2507Cu grades. They are designed to produce the optimum bead appearance for flat fillet and butt welds (ASME: 1F and 1G) and HV fillet welds (ASME 2F). Depending on joint configuration and component size, other positions are possible.

Positional Supercore 'P' Wires

The positional wires, which are suitable for use in all welding positions, including fixed pipework in the ASME 5G/6G positions, are designated by the P suffix in the product name. The all-positional wires are available in the 309LP, 308LP, 316LP, 2205P, 2507P, Z100XP and 2507CuP grades.

Wires for 300H

The wires in this group – 308H/308HP, 347HP and 16.8.2/16.8.2P – although also possessing excellent operability characteristics, are primarily designed to ensure good high temperature weld metal properties. The weld metal integrity is ensured by stringent compositional control eliminating elements, such as bismuth, which can increase sensitivity to weld metal grain boundary failure during high temperature service.

All of the productivity benefits which can be achieved with the standard Supercore wires can also be achieved using Supercore 308H/308HP, 16.8.2/16.8.2.P and 347HP.

Controlled Ferrite ('CF') Wires for Cryogenic Applications

The wires in this group – 308LCF and 316LCF – have controlled ferrite and composition to ensure excellent impact properties at -196°C. The wires are all positional so are suitable for pipe welding applications. All batches are tested to ensure 0.38mm lateral expansion is met at -196°C. The main area of application to date has been in LNG (liquefied natural gas) terminals but the wires are suitable for any industry where cryogenic impact properties are specified.

Table 3

Cormet

METRODE ALLOYED FLUX CORED WIRES
THE COMPLETE PICTURE

METRODE Supercore

Alloy	Designation	Data Sheet	AWS	BS EN	Materials
Low Alloy Types	**Cormet 1**	A-12	E81T1-B2C/M	T55T1-1M-1CM	All positional FCW for creep resisting 1CrMo (P11) steels
	Cormet 1V	A-14	-	-	All positional FCW for creep resisting CrMoV steels
	Cormet 2	A-13	E91T1-B3C/M	T62T1-1M-2C1M	All positional FCW for creep resisting 2CrMo (P22) steels
	Cormet 2L	A-13	E91T1-B3LC/M	T62T1-1M-2C1ML	All positional FCW for as-welded repairs of creep resisting 2CrMo (P22) steel
	Cormet 5	A-15	E81T1-B6C/M	T55T1-1M-5CM	All positional FCW for creep resisting 5CrMo (P5) steels
	Cormet 9	A-16	E81T1-B8C/M	T55T1-1M-9C1M	All positional FCW for creep resisting 9CrMo (P9) steels
	Cormet M91	A-17	(E90C-B9)	T69T15-0M-9C1M	Metal cored wire for downhand MIG/GMAW welding of modified 9CrMo (P91) steels
	Supercore F91	A-17	E91T1-B9C/M	T69T1-1M-9C1MV	All positional FCW for welding modified 9CrMo (P91) steels
	Supercore F92	A-20	-	-	All positional FCW for welding modified 9CrMo (P92) steels

Dissimilar Welding	**Supercore 20.9.3**	E-20	E308MoT0-1/4	T 20 10 3 R C/M 3	Austenitic weld metal for armour plate and mixed welding
	Supercore 20.9.3.P	E-20	E308MoT1-1/4	T 20 10 3 PC/M 2	All positional austenitic weld metal for armour plate and mixed welding
	Supercore 309L	B-50	E309LT0-1/4	T 23 12 L R C/M 3	Rutile FCW for dissimilar welding and buffer layers
	Supercore 309LP	B-50	E309LT1-1/4	T 23 12 L P C/M 2	All positional FCW for dissimilar welding and buffer layers
	Supercore 309Mo	B-51	E309LMoT0-1/4	T 23 12 2 L R C/M 3	Rutile FCW for dissimilar welding and buffer layers
	Supercore 309MoP	B-51	E309LMoT1-1/4	T 23 12 2 L P C/M 2	All positional FCW for dissimilar welding and buffer layers

Alloy	Designation	Data Sheet	AWS	BS EN	Materials
Austenitic Stainless Steel	**Supercore 308H**	C-10	E308HT0-1/4	TS308H-FB0	Rutile FCW for 304/304H used at elevated temperature
	Supercore 308HP	C-10	E308HT1-1/4	TS308H-FB1	For all positional welding of 304/304H used at elevated temperature
	Supercore 308L	B-30	E308LT0-1/4	T 19 9 L R C/M 3	Rutile FCW for 304L stainless steels
	Supercore 308LP	B-30	E308LT1-1/4	T 19 9 L P C/M 2	For all positional welding of 304L stainless steels
	Supercore 308LCF	B-37	E308LT1-1/4	T 19 9 L P C/M 2	All positional wire for cryogenic applications e.g LNG
	Supercore 347	B-31	E347T0-1/4	T 19 9 Nb R C/M 3	Rutile FCW for 321 and 347 stainless steels
	Supercore 347HP	C-11	E347T1-1/4	T 19 9 Nb P C/M 2	For all positional welding of 321H and 347H stainless steels
	Supercore 16.8.2	C-12	-	(TS16-8-2-FB1)	Rutile FCW for high temperature 3XXH stainless steels
	Supercore 16.8.2.P	C-12	-	(TS16-8-2-FB1)	For all positional welding of high temperature 3XXH stainless steels
	Supercore 316L	B-32	E316LT0-1/4	T 19 12 3 L R C/M 3	Rutile FCW for 316L stainless steels
	Supercore 316LP	B-32	E316LT1-1/4	T 19 12 3 L P C/M 2	For all positional welding of 316L stainless steels
	Supercore 316LCF	B-38	E316LT1-1/4	TS316L-FB1	All positional wire for cryogenic applications e.g LNG
	Supercore 316NF	B-33	-	(T 18 16 5 NL R C/M 3)	Rutile FCW for cryogenic and non-magnetic stainless steels
	Supercore 317LP	B-35	E317L1-1/4	TS317L-FB1	For all positional welding of 317L stainless steels

Lean Duplex, Duplex & Superduplex Stainless Steel	**Supercore 2304P**	B-59	-	-	All positional welding of lean duplex stainless steels (UNS 32304, S32101)
	Supercore 2205	B-60	E2209T0-1/4	T 22 9 3 N L R C/M 3	Rutile FCW for standard duplex stainless steels (UNS S31803)
	Supercore 2205P	B-60	E2209T1-1/4	T 22 9 3 N L P C/M 2	All positional welding of standard duplex stainless steels (UNS S31803)
	Supercore 2507	B-62	-	-	Rutile FCW for superduplex stainless steels (UNS S32750)
	Supercore 2507P	B-62	-	-	All positional welding of superduplex stainless steels (UNS S32750)
	Supercore Z100XP	B-61	-	-	All positional welding of superduplex stainless steels (UNS S32760)
	Supercore 2507Cu	B-63	-	-	Rutile FCW for Cu containing superduplex stainless steels
	Supercore 2507CuP	B-63	-	-	All positional FCW for Cu containing superduplex stainless steels

4. SUMMARY

The following points summarise the benefits of using Metrode Supercore and Cormet wires.

4.1 Cormet All-Positional CrMo Wires

Cormet 1, 1V, 2, 2L, 5, 9 and Supercore F91 and F92
(P11, CrMoV, P22, P5, P9, P91 and P92 materials)

- Fully positional wires usable in all positions, including pipework in the challenging ASME 5G/6G (EN287-1 PC/H-L045) positions.
- Joint completion rates on 5G/6G pipe can be reduced by up to 40% compared to SMAW.
- Excellent slag release, even under 'hot work-piece' conditions, provides good bead profile and finish, with minimum post-weld dressing.
- Recommended for welding pipework above ~220mm (8in) diameter and ~12mm (0.5in) wall thickness.
- Fully positional capability using standard DC rectifier power sources and readily available Ar-CO_2 gas mixtures or 100%CO_2.
- The adaptability of the process minimises setting-up times and allows the same welding parameters to be used for many different joints.
- High current density ensures reliable fusion and penetration, and also increases wire burn-off (deposition) rate.

4.2 Cormet Metal Cored Wire

Cormet M91

- Metal-cored wire ensures high productivity in the flat and HV positions.
- The metal-cored wire means there is no slag coverage, which helps increase duty cycle for multi-pass welding.

4.3 Downhand Stainless Steel Supercore Wires

Supercore 20.9.3, 309L, 309Mo, 308L, 347, 316L, 316NF, 2205, 2507 and 2507Cu

- Designed for use with readily available Ar/15-25%CO_2 shielding gases; will also operate on 100%CO_2.
- User friendly rutile flux-cored wires with faster burn-off (deposition) rate and longer run-out potential.
- Excellent slag release characteristics, even under hot workpiece welding conditions; means no post-weld dressing is required to achieve the best cosmetic appearance.
- Reliable fusion and penetration characteristics, combined with the low frequency of stop/starts, produce excellent radiographic quality.
- The adaptability of the process minimises setting-up time by allowing the same welding parameters to be used for many different joints.
- The continuous nature of the Supercore process ensures a high duty cycle is achieved with the associated improvement in productivity.
- Provide easy use on standard DC power sources, reducing equipment costs whilst maximising operability.
- Supercore provides fabricators the production efficiency and cost benefits of semi-automatic welding with the high integrity and cosmetic appearance of the best MMA electrodes.
- The deposition efficiency of Supercore wire gives you a third more weld metal for your money compared to SMAW electrodes.
- Using 1.2mm at high travel speed it is possible to weld material down to 3mm thickness.

4.4 Positional Stainless Steel Flux Cored Wires

Supercore 20.9.3.P, 309LP, 309MoP, 308LP, 308LCF, 317LP, 2304P, 2205P, 2507P, 2507CuP and Z100XP

- Fully all-positional rutile flux cored wires usable in all positions, including the challenging ASME 5G/6G welding positions.
- Designed for operation on economic, readily available gas mixtures of Ar/15-25%CO_2; will also operate on 100%CO_2.
- Fully positional capability is achieved using standard DC rectifier power sources without the need for synergic pulsed GMAW equipment
- Recommended for pipework and fittings above ~220mm (8in) diameter and 12mm (0.5in) wall thickness.
- Joint completion rates can be reduced by as much as 40% compared to SMAW.
- Reliable fusion and penetration characteristics, combined with the low frequency of stop/starts, produce excellent radiographic quality.
- Supercore wires offer the fabricator the production efficiency and cost benefits of semi-automatic welding with the high integrity and cosmetic appearance of the best SMAW electrodes.

4.5 Supercore Wires for 300H Stainless Steels

Supercore 308H, 308HP, 16.8.2, 16.8.2.P and 347HP

- Wires specifically designed for 3XXH stainless steels operating at 550-750^{O}C.
- Special flux formulations avoid elements, such as Bi, which increase sensitivity to weld metal grain boundary failure during service.
- 308HP, 16.8.2.P and 347HP wires have all the positional benefits of the other positional Supercore wires.
- The 308H and 16.8.2 wires provide all benefits of the standard downhand Supercore wires.

4.6 Controlled Ferrite 'CF' Supercore Wires for Cryogenic Applications

Supercore 308LCF and 316LCF

- Wires specifically designed to achieve 0.38mm lateral expansion at -196°C.
- All batches tested to ensure required impact properties are met at -196°C.
- Proven track record on LNG projects..
- The 308LCF and 316LCF wires provide all the benefits of the standard positional Supercore wires.

5. Further Information

- Detailed data sheets are available for each of the products discussed in this brochure.
- A brochure giving further information on the practical aspects of using Supercore and Cormet wires is also available – “Getting the Best out of Supercore and Cormet”.
- More in-depth technical information is available for some of the products in Metrode Technical Profiles. Products covered include:
  - Supercore F91
  - Supercore F92
  - Supercore 2205/2205P, 2507/2507P and Z100XP
  - Cormet 1 and 2
  - Supercore 308H/308HP and 16.8.2/16.8.2.P
  - Supercore 308LCF and 316LCF.
- To obtain further information contact your local Sales Representative, The Technical or Customer Care Departments at Metrode.