V seminarium „**Kulturalne spawanie**”

FIGEL®
TECHNIKA SPAWALNICZA

LINCOLN® ELECTRIC
THE WELDING EXPERTS®

PLAN PREZENTACJI

13.15 *Filip Bidzinski – Indalco Kanada*
„Super Glaze – Unikalna technologia produkcji, wyjątkowe efekty w spawaniu”.
„Problemy w spawaniu aluminium – propozycje rozwiązań”.

14.00 *Grzegorz Welke – Lincoln Electric*
„Prefabrykacja rur – rozwiązania technologiczne na podstawie zebranych doświadczeń”.

SuperGlaze® MIG 4043

KLASYFIKACJA

AWS A5.10 : ER4043
ISO 18273 : S Al 4043 A (AlSi5)

OPIS OGÓLNY

Drut lity do spawania stopów aluminium–krzem
Doskonałe podawanie drutu i bardzo dobre właściwości spawalnicze
Skupiony i stabilny łuk
Również osiągalny w 120 kg beczkach AccuTrak®, które zwiększają wydajność, poprzez redukcję czasu potrzebnego na wymianę szpuli

GAZY OSŁONOWE (WEDŁUG ISO 14175)

I1 Gaz obojętny Ar (100%)
I3 Gaz obojętny Ar+ 0.5-95% He

DOPUSZCZENIA

TÜV
+

TYPOWY SKŁAD CHEMICZNY (W %)

Al	Mn	Si	Ti	Fe	Zn	Cu	Mg
reszta	0.01	4.7	0.001	0.3	0.002	0.01	0.004

WŁASNOŚCI MECHANICZNE STOPIWA

	Gaz osłonowy	Stan	Umowna granica plastyczności (N/mm²)	Wytrzymałość na rozciąganie (N/mm²)	Wydłużenie (%)	Udarność ISO-V (J) +20°C	Udarność ISO-V (J) -60°C
Typowe wartości PS: po spawaniu	I1	PS	100	160	15	20	20

WŁASNOŚCI FIZYCZNE

Temperatura topnienia	573 - 625°C
Gęstość	w przybliżeniu 2680 kg/m³

MATERIAŁY SPAWANE

Gatunek aluminium	Kod	Typ	W. Nr	Int.Reg.Nr.	Int.Cast.Nr.
Stopy Al do przeróbki plastycznej	DIN 1725-1	Al Mg Si 0.5	3.3206	6060	
		Al Mg Si 0.7	3.3210	6005A	
		Al Mg Si 0.8	3.2316	6181	
Odlewnicze stopy Al	DIN 1725-2	G-Al Si 5			443.0

OPAKOWANIE

Typ	Średnica (mm)	0.8	1.0	1.2	1.6
0.5 kg szpula plastikowa S100		X	X	X	X
7.26 kg szpula S300		X	X	X	X
7.0 kg szpula BS300		X	X	X	X
125 kg AccuPak				X	

Inne średnice i opakowania na zapytanie

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PRĘT ALUMINIOWY

SuperGlaze® TIG 4043

KLASYFIKACJA

AWS A5.10 : R4043
ISO 18273 : S Al 4043 A (AlSi5)

OPIS OGÓLNY

Pręt lity do spawania stopów aluminium–krzem
Doskonałe podawanie drutu i bardzo dobre właściwości spawalnicze
Skupiony i stabilny łuk

GAZY OSŁONOWE (WEDŁUG ISO 14175)

I1 Gaz obojętny Ar (100%)
I3 Gaz obojętny Ar+ 0.5-95% He

DOPUSZCZENIA

TÜV
+

TYPOWY SKŁAD CHEMICZNY (W %)

Al	Mn	Si	Ti	Fe	Zn
reszta	0.05	5.0	0.15	0.4	0.1

WŁASNOŚCI MECHANICZNE STOPIWA

	Gaz osłonowy	Stan	Umowna granica plastyczności (N/mm^2)	Wytrzymałość na rozciąganie (N/mm^2)	Wydłużenie (%)	Udarność ISO-V (J) +20°C	Udarność ISO-V (J) -60°C
Typowe wartości	I1	PS	100	160	15	20	20

PS: po spawaniu

WŁASNOŚCI FIZYCZNE

Temperatura topnienia 573 - 625°C
Gęstość w przybliżeniu 2680 kg/m^3

MATERIAŁY SPAWANE

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		Al Mg Si 0.7	3.3210	6005A	
		Al Mg Si 0.8	3.2316	6181	
Odlewnicze stopy Al	DIN 1725-2	G-Al Si 5			443.0

OPAKOWANIE

Typ	Średnica (mm)	1.6	2.0	2.4	3.2	4.0
2 i 5 kg tuba		X	X	X	X	X

Inne średnice i opakowania na zapytanie

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SuperGlaze® MIG 5183

KLASYFIKACJA

AWS A5.10 : ER5183
ISO 18273 : S Al 5183 (AlMg4.5Mn0,7)

OPIS OGÓLNY

Drut lity do spawania stopów aluminium o podwyższonej wytrzymałości i do pracy w obniżonej temperaturze (-196°C)
Doskonałe podawanie drutu i bardzo dobre właściwości spawalnicze
Skupiony i stabilny łuk
Również osiągalny w 90 kg beczkach AccuTrak®, które zwiększają wydajność poprzez redukcję czasu potrzebnego na wymianę szpuli

GAZY OSŁONOWE (WEDŁUG ISO 14175)

I1 Gaz obojętny Ar (100%)
I3 Gaz obojętny Ar+ 0.5-95% He

DOPUSZCZENIA

ABS	BV	DNV	GL	LR	TÜV
WC	WC	5183	S AlMg4.5Mn	+	+

TYPOWY SKŁAD CHEMICZNY (W %)

Al	Mn	Si	Ti	Mg	Zn	Cr	Fe	Cu
reszta	0.8	0.02	0.15	4.5	0.15	0.15	0.14	0.02

WŁASNOŚCI MECHANICZNE STOPIWA

	Gaz osłonowy	Stan	Umowna granica plastyczności (N/mm^2)	Wytrzymałość na rozciąganie (N/mm^2)	Wydłużenie (%)
Typowe wartości	I1	PS	140	300	30

PS: po spawaniu

WŁASNOŚCI FIZYCZNE

Temperatura topnienia 568 - 638°C
Gęstość w przybliżeniu 2400 kg/m^3

MATERIAŁY SPAWANE

Gatunek aluminium	Kod	Typ	W. Nr	Int.Reg.Nr.	Int.Cast.Nr.
Stopy Al do przeróbki plastycznej	DIN 1725-1	Al Mg 3	3.3535	5754	
		Al Mg 4.5 Mn	3.3547	5083	
		Al Mg 5	3.3555	6082	
		Al Mg Si 1			
Odlewnicze stopy Al	DIN 1725-2	G-Al Mg 3	3.3541		
		G-Al Mg 3 Si	3.3241		512.0
		G-Al Mg 5	3.3561		B 535.0
		G-Al Mg 5 Si	3.3261		

OPAKOWANIE

Typ	Średnica (mm)	0.8	1.0	1.2	1.6
7.26 kg szpula S300		X	X	X	X
7.0 kg szpula BS300		X	X	X	X
136 kg AccuPak				X	

Inne średnice i opakowania na zapytanie

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PRĘT ALUMINIOWY

SuperGlaze® TIG 5183

KLASYFIKACJA

AWS A5.10 : R5183
ISO 18273 : S Al 5183 (AlMg4.5Mn0,7)

OPIS OGÓLNY

Pręt lity do spawania stopów aluminium o podwyższonej wytrzymałości i do pracy w obniżonej temperaturze (-196°C)
Doskonałe podawanie drutu i bardzo dobre właściwości spawalnicze
Skupiony i stabilny łuk

GAZY OSŁONOWE (WEDŁUG ISO 14175)

I1 Gaz obojętny Ar (100%)
I3 Gaz obojętny Ar+ 0.5-95% He

DOPUSZCZENIA

TÜV
+

TYPOWY SKŁAD CHEMICZNY (W %)

Al	Mn	Si	Ti	Mg	Zn	Cr	Fe
reszta	0.8	0.1	0.02	4.5	0.15	0.15	0.2

WŁASNOŚCI MECHANICZNE STOPIWA

	Gaz osłonowy	Stan	Umowna granica plastyczności (N/mm^2)	Wytrzymałość na rozciąganie (N/mm^2)	Wydłużenie (%)
Typowe wartości	I1	PS	150	290	25

PS: po spawaniu

WŁASNOŚCI FIZYCZNE

Temperatura topnienia 568 - 638°C
Gęstość w przybliżeniu 2400 kg/m^3

MATERIAŁY SPAWANE

Gatunek aluminium	Kod	Typ	W. Nr	Int.Reg.Nr.	Int.Cast.Nr.
Stopy Al do przeróbki plastycznej	DIN 1725-1	Al Mg 3	3.3535	5754	
		Al Mg 4.5 Mn	3.3547	5083	
		Al Mg 5	3.3555	6082	
		Al Mg Si 1			
Odlewnicze stopy Al	DIN 1725-2	G-Al Mg 3	3.3541		
		G-Al Mg 3 Si	3.3241		512.0
		G-Al Mg 5	3.3561		B 535.0
		G-Al Mg 5 Si	3.3261		

OPAKOWANIE

Typ	Średnica (mm)	1.6	2.0	2.4	3.2	4.0
5 kg tuba		X	X	X	X	X

Inne średnice i opakowania na zapytanie

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SuperGlaze® MIG 5356

DRUT ALUMINIOWY

KLASYFIKACJA

AWS A5.10 : ER5356
ISO 18273 : S Al 5356 (AlMg5Cr)

OPIS OGÓLNY

Drut lity do spawania stopów aluminium zawierających ponad 3% Mg
Doskonałe podawanie drutu i bardzo dobre właściwości spawalnicze
Skupiony i stabilny łuk
Również osiągalny w 90 kg beczkach AccuTrak®, które zwiększają wydajność poprzez redukcję czasu potrzebnego na wymianę szpuli

GAZY OSŁONOWE (WEDŁUG ISO 14175)

I1 Gaz obojętny Ar (100%)
I3 Gaz obojętny Ar+ 0.5-95% He

DOPUSZCZENIA

ABS	BV	DNV	GL	LR	TÜV
WB	WB	5356	S ALMg5	+	+

TYPOWY SKŁAD CHEMICZNY (W %)

Al	Mn	Si	Ti	Mg	Cr	Cu	Fe	Zn
reszta	0.11	0.08	0.06	4.9	0.07	0.01	0.2	0.03

WŁASNOŚCI MECHANICZNE STOPIWA

	Gaz osłonowy	Stan	Umowna granica plastyczności (N/mm^2)	Wytrzymałość na rozciąganie (N/mm^2)	Wydłużenie (%)
Typowe wartości	I1	PS	110	250	25

PS: po spawaniu

WŁASNOŚCI FIZYCZNE

Temperatura topnienia 562 - 633°C
Gęstość w przybliżeniu 2640 kg/m^3

MATERIAŁY SPAWANE

Gatunek aluminium	Kod	Typ	W. Nr	Int.Reg.Nr.	Int.Cast.Nr.
Stopy Al do przeróbki plastycznej	DIN 1725-1	Al Mg 3	3.3535	5754	
		Al Mg 4,5	3.3345	5082	
		Al Mg 5	3.3555	5056A	
		Al Mg 2 Mn 0,8	3.3527	5049	
		Al Mg 2,7 Mn	3.3537	5454	
		Al Mg 4 Mn	3.3545	5086	
		Al Zn 4,5 Mg 1	3.4335	7020	
Odlewnicze stopy Al	DIN 1725-2	G-Al Mg 3	3.3541		
		G-Al Mg 3 Si	3.3241		512.0
		G-Al Mg 5	3.3561		B 535.0
		G-Al Mg 5 Si	3.3261		

OPAKOWANIE

Typ	Średnica (mm)	0.8	1.0	1.2	1.6
0.5 kg szpula plastikowa S100		X	X	X	X
2.0 kg szpula plastikowa S200				X	
7.26 kg szpula S300		X	X	X	X
7.0 kg szpula BS300		X	X	X	X
136 kg AccuPak				X	

Inne średnice i opakowania na zapytanie

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PRĘT ALUMINIOWY

SuperGlaze® TIG 5356

KLASYFIKACJA

AWS A5.10 : R5356
ISO 18273 : S Al 5356 (AlMg5)

OPIS OGÓLNY

Pręt lity do spawania stopów aluminium zawierających ponad 3% Mg
Doskonałe podawanie drutu i bardzo dobre właściwości spawalnicze
Skupiony i stabilny łuk

GAZY OSŁONOWE (WEDŁUG ISO 14175)

I1 Gaz obojętny Ar (100%)
I3 Gaz obojętny Ar+ 0.5-95% He

DOPUSZCZENIA

TÜV
+

TYPOWY SKŁAD CHEMICZNY (W %)

Al	Mn	Si	Ti	Mg	Cr
reszta	0.10	0.1	0.10	5.0	0.15

WŁASNOŚCI MECHANICZNE STOPIWA

	Gaz osłonowy	Stan	Umowna granica plastyczności (N/mm^2)	Wytrzymałość na rozciąganie (N/mm^2)	Wydłużenie (%)
Typowe wartościl1		PS	130	285	25

PS: po spawaniu

WŁASNOŚCI FIZYCZNE

Temperatura topnienia 562 - 633°C
Gęstość w przybliżeniu 2640 kg/m^3

MATERIAŁY SPAWANE

Gatunek aluminium	Kod	Typ	W. Nr	Int.Reg.Nr.	Int.Cast.Nr.
Stopy Al do przeróbki plastycznej	DIN 1725-1	Al Mg 3	3.3535	5754	
		Al Mg 4,5	3.3345	5082	
		Al Mg 5	3.3555	5056A	
		Al Mg 2 Mn 0,8	3.3527	5049	
		Al Mg 2,7 Mn	3.3537	5454	
		Al Mg 4 Mn	3.3545	5086	
		Al Zn 4,5 Mg 1	3.4335	7020	
Odlewnicze stopy Al	DIN 1725-2	G-Al Mg 3	3.3541		
		G-Al Mg 3 Si	3.3241		512.0
		G-Al Mg 5	3.3561		B 535.0
		G-Al Mg 5 Si	3.3261		

OPAKOWANIE

Typ	Średnica (mm)	1.6	2.0	2.4	3.2	4.0	5.0
5 kg tuba		X	X	X	X	X	X

Inne średnice i opakowania na zapytanie

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THE WELDING EXPERTS

WAVEFORM CONTROL TECHNOLOGY™

Surface Tension Transfer® (STT®)

STT on Pipe

Technip Offshore UK Ltd./UMAX

Technip Offshore UK Ltd. and UMAX partner to weld Coastal Ireland pipeline using Lincoln's STT process.

-PROBLEM-

Specifications for mechanical testing and qualification tests were especially restrictive on this project, causing concerns about maintaining production schedules.

-SOLUTION-

Lincoln's Power Wave 455M/STT power source combined with Outershield gas-shielded flux-cored wire.

-RESULTS-

Production was up 10-15% with a total of 50% reduction in manpower and 2,778 welds with a repair rate of less than one percent. Overall project costs were substantially reduced.

LINCOLN ELECTRIC NEXTWELD™

The Marathon Oil Company awarded Technip Offshore UK Ltd. with a contract to weld 15.5 miles (25Km) of 8 inch (203 mm) x 1/2 inch (12.7mm) grade X52 pipe for the Seven Heads contract (led by operator Ramco Oil & Gas Limited). Following completion of the project, Technip will provide gas processing and transportation services for the estimated natural gas reserves of approximately 300 billion cubic feet which is located 21.75 miles (35 Km) to the south-west of Marathon's Kinsale Head field in the Celtic Sea off the southern coast of Ireland.

After months of testing, Technip Offshore UK Ltd contacted UMAX Welding contractors at their Evanton location, where the Lincoln Power Wave® 455M/STT® was selected as the power source for this project. This was the first use of this STT-capable (Surface Tension Transfer®) power source in Europe for root pass MIG welding of the reeled pipe.

A Senior Welding Engineer for Technip Offshore UK Ltd, commented that "in conjunction with gas-shielded flux-cored wire fill and cap, production was up 10-15% together with a 50% reduction in manpower – this resulted in a substantial savings on the project costs".

Lincoln's Outershield® flux-cored wire in the .045" (1.2 mm) diameter was used for all hot, fill and cap passes. Shielding gas was a 80% Ar / 20% CO_2 mix. The Power Wave 455M/STT was used for the complete welding cycle on the all pipe butts welded.

That was 2,778 welds with a repair rate of less than one percent.

At the peak of production, 111 butt welds were being produced per day, with one pipe butt joint being welded every 5.5 minutes. This is particularly impressive, as specifications for mechanical testing and the welder qualification tests were especially restrictive for this project. The pipe will be reeled onto the CSO Apache reel lay vessel. The pipe is then unreeled from the boat to the sea floor, before spool tie-ins between the wellheads and the manifolds take place to complete the construction project.

"In conjunction with gas-shielded flux-cored wire fill and cap, production was up 10-15% together with a 50% reduction in manpower - this resulted in a substantial savings on the project costs"

Technip Offshore UK Ltd is regarded as a leader in the sub-sea pipeline technology market, and together with UMAX, the two companies are working with Lincoln Electric on a number of projects. On the drawing board are the Marathon Braemar

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Surface Tension Transfer® (STT®)

STT on Pipe

Technip Offshore UK Ltd./UMAX

10 inch / 6 inch (254 mm / 152 mm) pipe in pipeline for the North Sea utilizing the STT process together with Outershield gas-shielded flux-cored wire. Tie-in welds on the Williams Devils Tower project and BP King West project in the Gulf of Mexico will also be using Outershield wire.

UMAX has also ordered a dozen Lincoln European market LF30 wire feed units, which they will pair up to their existing Lincoln DC-400 power sources. These units are currently being used for all their flux-cored welding requirements.

Featured Lincoln Products

Power Wave® 455M/STT
Three ways to weld aluminum — standard push gun, spool gun, or push-pull aluminum feeding capability for high-quality feeding with thinner aluminum wires. No PC board add-on required! Synergic alignment of wire feed speed and voltage allows you to set weld procedures with only one control for simplicity and ease of use. Creates aluminum welds with a "TIG welding appearance" using Pulse-on-Pulse™ MIG welding.

Outershield® Wires
Lincoln's gas-shielded flux-cored process has become the predominant process in many industries where large weldments are required, where high deposition rates when welding out-of-position are needed, or when base material is too dirty for the MIG or metal-cored processes. Use Outershield wires in pipe, offshore, bridge and structural fabrication applications.

WHAT IS NEXTWELD?

The challenges facing industrial fabricators today are increasingly difficult. Rising labor, material, and energy costs, intense domestic and global competition, a dwindling pool of skilled workers, more stringent and specific quality demands.

Through our commitment to extensive research and investments in product development, Lincoln Electric has established an industry benchmark for applying technology to improve the quality, lower the cost and enhance the performance of arc welding processes. Advancements in power electronics, digital communications and Waveform Control Technology™ are the foundation for many of the improvements.

NEXTWELD brings you a series of Process, Technology, Application and Success Story documents like this one. NEXTWELD explains how technologies, products, processes and applications are linked together to answer the important questions that all businesses face:

- *How can we work faster, work smarter, work more efficiently?*
- *How can we get equipment and people to perform in ways they've never had to before?*
- *How do we stay competitive?*
- *How do we maintain profitability?*

NEXTWELD is the future of welding, but its benefits are available to you today. Ask your Lincoln Electric representative how to improve the flexibility, efficiency and quality of your welding operations to reduce your cost of fabrication.

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THE LINCOLN ELECTRIC COMPANY
www.lincolnelectric.com
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Robo Pipe™

Robotic Pipe Welding for High Productivity

Robo Pipe™ from Lincoln Electric Automation is a versatile, easy to use, cost effective and highly productive pipe welding system that is ideal for pipe fabricators. The Robo Pipe™ system takes the capabilities of Lincoln Electric's revolutionary Power Wave® 455M/STT® Robotic power source and combines them with an easy to use industry-leading robotic welding system.

Unique power source features such as STT® (Surface Tension Transfer®) and Waveform Control Technology® provide the capability to make open root welds with STT® and change "on the fly" to pulse spray GMAW (MIG) for the hot, fill and cap passes. Welding procedure flexibility in an easy to operate robotic system is why Robo Pipe™ is an unmatched automated welding solution for the pipe industry.

BENEFITS

- Shorter Cycle Times
- Excellent Bead Contour
- Reduced Cleaning
- Root Fusion
- Less Grinding
- Consistent Weld Quality

MATERIALS

- Carbon steel
- Stainless steel
- Duplex stainless steel

SPECIFICATIONS

- Pipe or Column Diameter: 5/8 inch to 45-1/4 inch with Model "B" 3-Jaw (HE) Chuck.
- Segment Length: up to 20 feet or up to 60 feet, depending on system configuration.
- Positioner Torque: 6,200 in.-lbs., 15,000 in-lbs., or 50,000 in.-lbs.
- Welding Power Source Rated DC Output: 450 Amps, 38 Volts, 100% Duty Cycle.
- Workstation: One- or two-axis.

TOLERANCES ON JOINT PREP

- Root Gap: 2-3 mm
- Land Thickness: 0-2 mm
- Misalignment: 1/2 Root Gap

LINCOLN® ELECTRIC AUTOMATION DIVISION

www.lincolnelectric.com/automated-solutions

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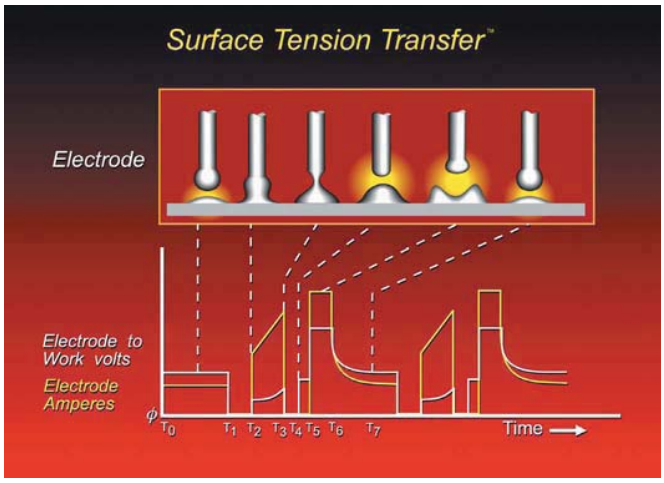
POWER WAVE® 455M/STT® ROBOTIC: HIGH PERFORMANCE INVERTER-BASED POWER SOURCE

The Power Wave® 455M/STT® Robotic is a proven inverter-based power source that is ideal for the pipe welding industry. The 455M/STT® is loaded with Nextweld® technologies including Lincoln Electric's proprietary Surface Tension Transfer® (STT®). STT® provides precise heat input control, minimal distortion and reduced spatter, characteristics that can improve the quality and efficiency of open gap root pass welding.

In addition, the reliability, durability and performance capability of the Power Wave® 455M/STT® Robotic make it the premier choice for satisfying the high duty cycle demands of robotic welding applications.

MORE ABOUT STT®

The STT® (Surface Tension Transfer®) process permits open gap root pass welding of pipe with greater ease of operation, consistent back beads and edge fusion, and less spatter and smoke than other available welding processes. STT® is different from traditional short arc MIG (GMAW) welding in that the current is precisely controlled independent of the wire feed speed. The traditional violent short arc "fuse explosions" are eliminated. This reduces the weld puddle agitation, spatter and smoke and provides increased control over the puddle and penetration.



ROBOTIC SYSTEM FEATURES

- FANUC Robotics ARC Mate® iC arm & Teach pendant.
- ArcTool™ welding software.
- Multiple E-Stop Locations.
- Welding schedules including: Voltage, Current, Wire Feed Speed, Torch Angle, Weave Width and Frequency, Travel Speed.
- Customized pipe welding program logic.
- Memory card.
- Ability to save approximately five hundred (500) complete pipe welding programs.

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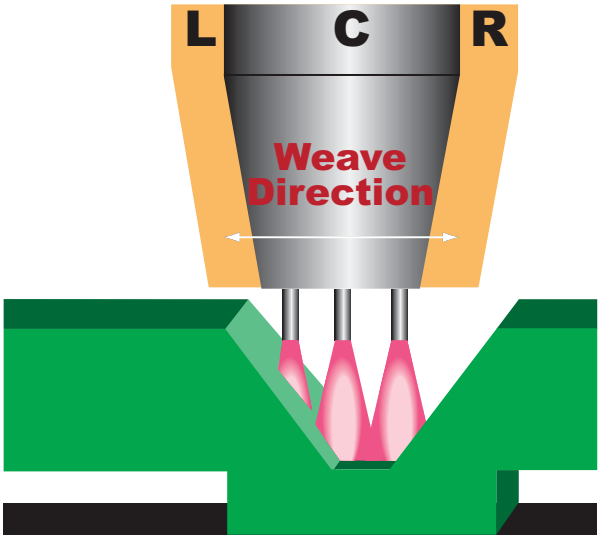
WHAT OPTIONS ARE AVAILABLE WITH ROBO PIPE™?

- Manual Seam Tracking via "Joy-Stick" Control and Through Arc Seam Tracking (TAST) allows an operator to move the robotic torch, both vertically and horizontally, to keep the weld pool in line with the joint.
- Through Arc Seam Tracking (TAST) can be enabled once the robot begins welding, after the root pass. The robot weaves across the weld joint and modifies its path based on any out-of-roundness or joint location shift.
- Adaptive Welding using Lased-Based Vision Tracking, also known as Joint Tracking, involves real time tracking just ahead of where the weld is being deposited. This allows for not only robot trajectory shifts, but also adaptive control such as adjustments to voltage, wire feed, travel speed, or weaving to change weld bead deposition.



Robot will automatically make path adjustments using input from TAST.

- Synchronized Tandem MIG®

  Tandem MIG® is a dual wire, high productivity MIG (GMAW) process which utilizes high-speed inverter Waveform Control Technology® to coordinate two separately generated GMAW welding arcs in unison for exceptional process flexibility.
  - Employs two electrically isolated wire electrodes positioned in line, one behind the other, in the direction of welding.
  - The first electrode is referred to as the lead electrode and the second electrode in line is referred to as the trail electrode.
  - The spacing between the two wires is usually less than 1/2 inch so that both welding arcs are delivering to a common weld puddle.
  - The function of the lead wire is to generate the majority of the penetration, while the trail wire performs the function of controlling the weld puddle for bead contour, edge wetting and adding to the overall weld metal deposit rate.

ROBO PIPE™ FAQ'S

What can Robo Pipe™ do for me?

Robo Pipe™ can weld about 80% of normal pipe shop production, and the flexibility of a robot arm accommodates welding on fittings such as Weldolet, Sockolet, Threadolet, Nipolet, Latrolet, Elbolet, and others.

What type of joint preparation is required?

- Robo Pipe™ is designed to operate with an open root of 3/32 inch (3 mm) and a 30 or 37.5 bevel (60 - 75 degree included angle).
- Flame-cut, hand-ground or machined bevels are all acceptable.
- The Surface Tension Transfer® (STT®) process is very tolerant of joint preparation variation.

The STT® process is very tolerant of joint preparation variation.

What other preparation is required?

- All joints need to be tack welded, typically in four places per joint.
- In order to ensure X-ray quality welds, Robo Pipe™ requires full penetration tack welds that are ground thin and additionally prepped to a tapered profile to insure a smooth root pass transition.
- It is common for operators to tack weld the joints to a near-closed root gap, and then mechanically open the joint using a hand grinder and a 1/16 inch cutting wheel.

What are limitations for Robo Pipe™?

Saddle welds and Miter welds can be accomplished on fittings, but are not recommended for pipe to pipe connections due to robotic torch interference and programming complexity.

Tandem MIG® Torch on Robot Arm.

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Robo Pipe™

Robotic Pipe Welding for High Productivity

VERNON TOOL™ PIPE AND TUBE CUTTING

(MPM) Flame-cutting Machines for Pipe-only

- VERNON Tool™ Flame-Cutting Machines can supply enough pipe to satisfy 5 to 10 fit-up and welding stations.
- Product range accommodates up to 60 inch diameter pipe.
- CAD-CAM compatible.
- An excellent tool to improve the speed and repeatability of each contour to feed Robo Pipe™ systems.

(MTC) Plasma-profiling for Round and Rectangular Tubing

- Accommodates up to 6 inch circular tube.
- Accommodates up to 4 x 6 inch or 5 x 5 inch rectangular tube.
- Min -max tube length is 14 - 44 ft.

(VAS) Abrasive Saw for pipe-only

- Pipe sizes: 1-24 inches O.D.
- Semi-automatic material handling.
- Uncontaminated machine-like finish on all pipe materials.

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PIPE WELDING CONSUMABLE SOLUTIONS

MIG Wire Solutions

Pipeliner® 70S-G has a low silicon level for unblemished welds with less clean up required. Provides good back bead shape when using the STT® process on root passes. It is recommended for root pass welding of up to X100 grade pipe as well as hot, fill and cap pass welding of up to X70 grade pipe.

Pipeliner® 80S-G is the highest strength all-position MIG wire in the Pipeliner® family. Recommended for root pass welding of up to X100 grade pipe as well as hot, fill and cap pass welding of up to X80 grade pipe.

For more information request publication C1.100.

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Lincolnweld® LAC-690

Low Alloy Cored Electrode • AWS ECG

Key Features

- Combine with Lincolnweld® 888™ flux for H4 diffusible hydrogen weld deposits.
- Charpy V-notch test results capable of exceeding 27 J (20 ft•lbf) @ -73°C (-100°F) with Lincolnweld® 888™ flux.
- Excellent Tandem, AC and DC Operation
- Clean and easy slag removal minimizes risk of inclusions, even in narrow gap applications.

Conformances

AWS A5.23/A5.23M: 2007 F11A10-ECG-G-H4
F11P6-ECG-G-H4

Recommended Fluxes

Lincolnweld® 888™

DIAMETERS / PACKAGING

Diameter in (mm)	50 lb (23 kg) Coil
3/32 (2.4)	ED032958
1/8 (3.2)	ED032959
5/32 (4.0)	ED033302

DEPOSIT COMPOSITION[1]

	%C	%Mn	%Si	%S	%P
Lincolnweld® LAC-690[2]	0.08	1.51	0.36	0.007	0.011
	%Cr	%Ni	%Mo	%Cu	Diffusible Hydrogen (mL/100g weld deposit)
Lincolnweld® LAC-690[2]	0.36	2.59	0.44	0.04	3.6

[1]See test results disclaimer below. [2]Limits are for weld metal deposited with a particular flux (Lincolnweld® 888™ flux).

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Robust high strength welding solution for demanding offshore jack-up rigs

Sev Johansson & Peter Pletcher
Lincoln Electric, Cleveland Ohio USA

OFFSHORE STRUCTURES MUST WITHSTAND THE HARSHEST environments where failure is never acceptable. Offshore structural designs take into account anticipated loads, including relevant environmental loads. Often, these structures work in remote locations far from land. One popular mobile offshore drilling unit (MODU) called the jack-up rig is towed or self-propelled to the work site and designed to then "self-install" for drilling oil wells. Jack-up rigs are also used to perform other work functions including offshore wind tower installations.

As the jack-up rig concept uses the ocean floor to support its typical three or four structural legs, there is a practical limitation to the water depth jack-up rig systems can work due to the stability of the self floating unit when the legs are fully retracted for relocation. Premium jack-up rigs are generally defined as rigs capable of drilling in water depths of 76 m and greater with an independent leg design. Jack-up rigs are available for working in water depths up to 168 m.

Figure 1. Premium jack-up rig

High strength steels have played an important role in reducing the weight of jack-up rigs for the benefit of increasing accessible water depths and reducing the overall jack-up rig weight for increased payload and topside equipment. Plate thickness for a 690 MPa yield steel is about half compared to a 355 MPa yield steel. Hence, engineers have standardised on 690 MPa yield steels and the advantages of a truss leg design to optimise weight savings for the premium jack-up rig design. Welding this high strength, thick section primary load bearing structure to withstand harsh offshore conditions requires the highest level of weld quality and integrity.

Submerged Arc Welding (SAW) is capable of high deposition productivity for thick high strength offshore structural sections with robust quality. Most commonly, traditional d.c.+ polarity has been selected for welding the higher strength steels but expanding these options to a.c. and tandem arc welding are now successful.

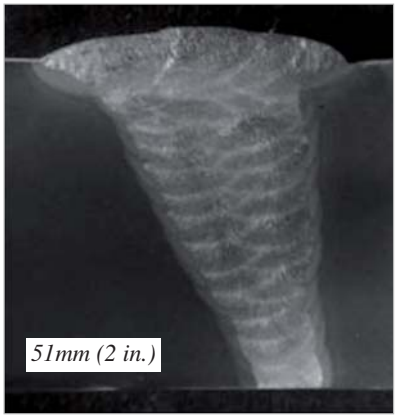

Figure 2. Macro photo of welded test plate

Cored SAW welding consumables such as Lincoln Electric's Lincolnweld® LAC-690 are capable of delivering weld deposits that meet these highest levels of weld quality in d.c, a.c. and tandem configurations. Such consumables when combined with an appropriate flux have been approved to meet ABS 5YQM690 H5 and DNV V YM69 (H5) agency classifications using a.c. or d.c.+ polarity.

Welding with power sources that can provide tandem welding, such Lincoln's Power Wave® AC/DC 1000 SD, can offer productivity increases when compared to d.c.+ without sacrificing the quality of mechanical properties. In addition to electrical savings achieved from the inverter and switch, precise control of the welding waveform gives a consistent

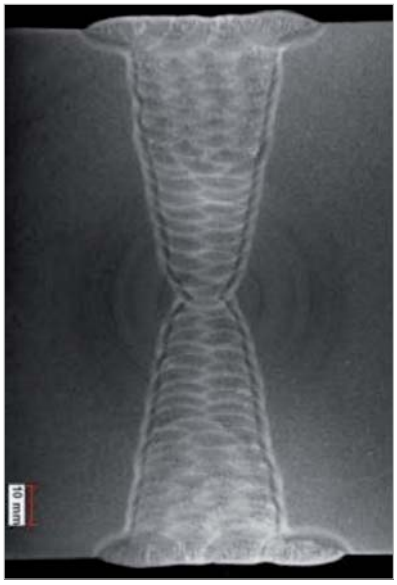

Figure 4. Rack-to-rack weld using Lincolnweld® LAC-690/888

Polarity (Electrode Diameter)	Heat Input, kJ/mm	Number of Passes	Deposition Rate, kg/hr	Deposition Rate Increase	Weld Mid CL Impact Toughness Joules @ -60°C
d.c.+ (4.0 mm)	2.02	26	8.7	Baseline	117
a.c.+ (4.0 mm)	2.03	24	10	15%	124
Tandem (both 3.2 mm)	2.13	23	13	50%	111

Figure 3. Productivity Comparison for Lincolnweld® LAC-690/888 at comparable heat inputs

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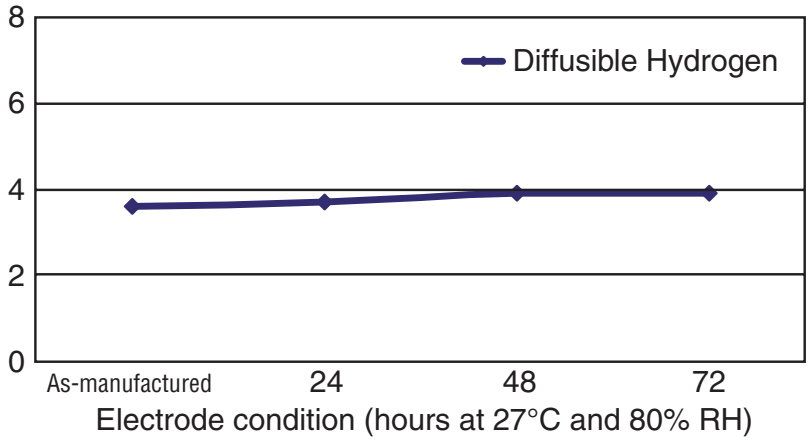

Figure 5. Lincolnweld® LAC-690 diffusible hydrogen results after exposure

stable arc. Three 51 mm plates with a 30 degree single bevel joint were welded in d.c.+, a.c. and tandem (see Figure 2), all using a 32 mm contact tip to work distance. Similar heat inputs were targeted by increasing the travel speeds of the higher productivity procedures. Figure 3 shows the reduction of welding passes and the difference in deposition rates. Welding with a conservative tandem setup using d.c.+ for the lead and a.c. for the trail resulted in a deposition rate increase of 50% with three fewer passes compared to single arc d.c.+.

Achieving higher productivity without sacrificing weld quality is especially important when welding on thicker sections. Welding a solid rack-to-rack joint can be very time consuming and poor weld quality can lead to expensive repairs. Figure 4 shows a macro of a 140 mm thick PQR qualification plate for a production 210 mm rack-to-rack section. When dealing with thick weld joints associated with these applications, tight included angles are desired to reduce the amount of required welding.

High strength, thick welds under restraint are especially prone to the effects of diffusible hydrogen in the weld metal. If low hydrogen consumables and processes are not used for welding high strength steels, the risk of experiencing fabrication hydrogen-assisted cracking (HAC) increases. Electrode exposure has traditionally been a concern with regards to its effect on the diffusible hydrogen content of the weld metal. Using an environmental chamber, Lincolnweld® LAC-690 cored welding consumable was exposed to a 27ºC environment at 80% relative humidity for periods of time and then tested for deposited weld metal diffusible hydrogen (see Figure 5). Such welding consumables are resistant to moisture pick-up, resulting in low diffusible hydrogen content, even after the electrode has been exposed to hot, humid environments.

The offshore industry is driving the use of higher strength steels for the most demanding applications. The welding consumables used must be able to deliver robust mechanical properties at more stringent levels such as those seen in offshore classifications of 5YQ690M H5. The ability to weld using AC and tandem processes allow for increased productivity without sacrificing weld metal quality, this helps fabricators reduce their overall welding costs.

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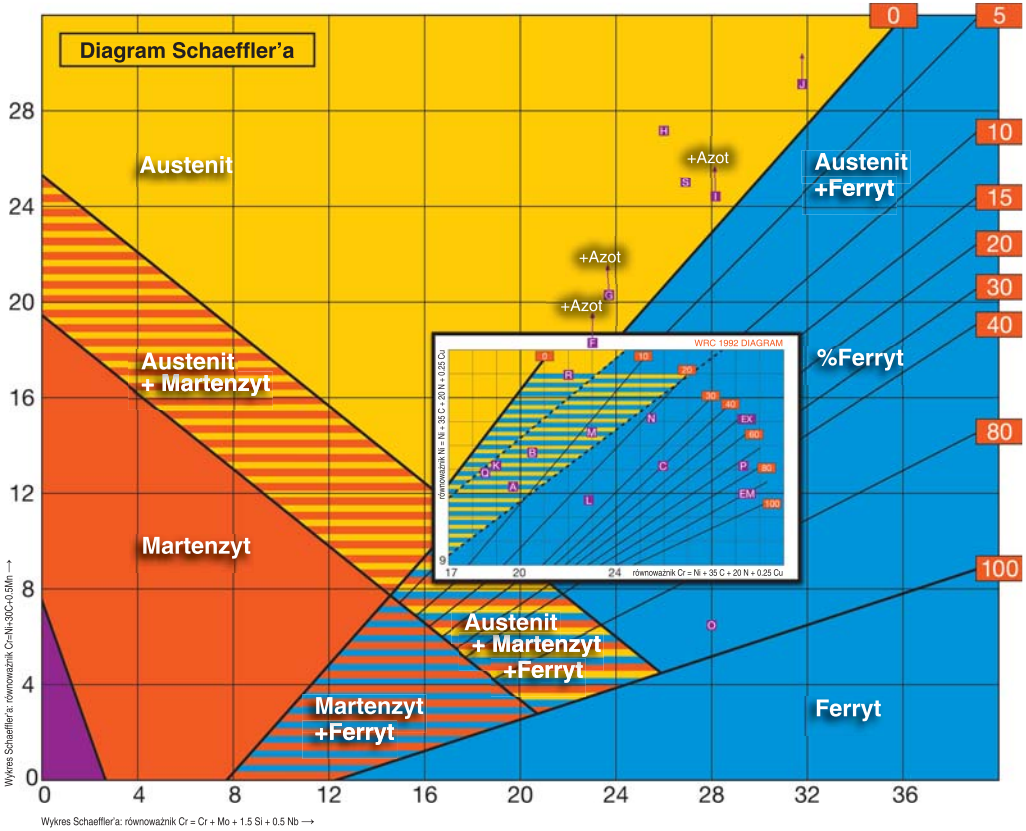
*Plakaty przygotowane w ramach projektu prowadzonego przez **Lincoln Electric Bester Sp. z o.o.** wspólnie z **Instytutem Spawalnictwa w Gliwicach***

Wykres struktur dla stopiwa stali nierdzewnych



Kompletny wybór materiałów

Struktura stopiwa Zastosowanie	Klasyfikacja [1])	Pozycja na Wykresie	Proces spawania: MMA (111)	FCAW (136)	TIG/MIG (141/131)	SAW (121)
Austenityczna Ogólna odporność na korozję	19 9 L	A	Vertarosta 304L Arosta/Limarosta 304L Limarosta 304L-130 Jungo 304L	Cor-A-Rosta 304L Cor-A-Rosta P304L	LNT/LNM 304LSi	LNS 304L / P2000
	19 9 Nb	A	Arosta 347/Jungo 347	Cor-A-Rosta 347	LNT/LNM 347Si	LNS 347 / P2000
	19 12 3 L	B	Vertarosta 316L Arosta/Limarosta 316L Limarosta 316L-130 Jungo 316L	Cor-A-Rosta 316L Cor-A-Rosta P316L	LNT/LNM 316LSi	LNS 316L / P2000
	19 12 3 Nb	B	Arosta 318/Jungo 318		LNT/LNM 318Si	LNS 318 / P2000
Ferrytyczno-Austenityczna (stale duplex I super-duplex) Odporność na korozję naprężeniową.	22 9 3 N L	C	Arosta 4462 Jungo 4462	Cor-A-Rosta 4462 Cor-A-Rosta P4462	LNT/LNM 4462	LNS 4462 / P2000
	Z 25 7 4 N L	EM			LNT/LNM Zeron 100M	LNS Zeron 100M / P2000
	25 9 4 N L	EX	Jungo Zeron 100X		LNT/LNM Zeron 100X	LNS Zeron 100X / P2000
W pełni austenityczna Podwyższona odporność na korozję ogólną	18 16 5 N L	F	Arosta 4439/Jungo 4439	Cor-A-Rosta 317L	LNT/LNM 4439Mn	LNS 4439Mn / P2000
	19 13 4 N L	G	Jungo 4455		LNT/LNM 4455	LNS 4455 / P2000
	20 25 5 Cu	H	Jungo 4500		LNT/LNM 4500	LNS 4500 / P2000
	25 22 2 N L	I	Jungo 4465		LNT/LNM 4465	LNS 4465 / P2000
	27 31 4 Cu L	J	NiCro 31/27		LNT/LNM 31/27	LNS 31/27 / P2000
Austenityczno – ferrytyczna Warstwy buforowe/złącza różnoimienne	18 8 Mn	K	Arosta 307/Jungo 307		LNT/LNM 307Mn	LNS 307 / P2000
	20 10 3	L	Nichroma			
	23 12 L	M	Arosta/Limarosta 309S Limarosta 309S-130	Cor-A-Rosta 309L Cor-A-Rosta P309L	LNT/LNM 309LSi	LNS 309L / P2000
	23 12 Nb	M	Arosta 309Nb			
	23 12 2 L	N	Arosta 309Mo Nichroma 160	Cor-A-Rosta 309MoL Cor-A-Rosta P309MoL		
	29 4	O	Arosta 329			LNS 329 / P2000
	29 9	P	Limarosta 312			
Austenityczna Odporność na wysoką temperaturę	19 9 H	Q	Arosta 304H		LNT/LNM 304H	LNS 304H / MIL 800H
	22 12	R	Arosta 309H			
	25 20	S	Intherma 310		LNT/LNM 310	LNS 310 / P2000

[1]) oznaczenia wg norm EN (tj. EN 1600, EN 12072, EN 12073)

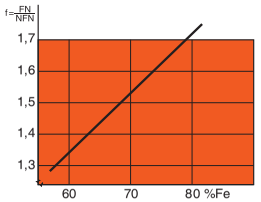
Obliczanie zawartości ferrytu

- **Metoda metalograficzna**. Dokładność zależy od jakości trawienia oraz stosowanego oprzyrządowania.
  Powiązana norma: ASTM E 562 – 99
- **Metoda magnetyczna z wykorzystaniem wagi torsyjnej** wg ISO8249 i AWS A4.2-97.
  Metoda obejmuje zakres FN 0-95.
  Waga torsyjna kalibrowana według norm NIST.
  Pozostałe urządzenia kalibrowane wg odpowiednich norm przedmiotowych.
- **Metoda Indukcji Magnetycznej**. Urządzenia i Ferrytoskop kalibrowane wg norm przedmiotowych.
- **Pomiar Liczby Ferrytowej (FN) w warunkach rzeczywistych**.
  Raport końcowy Międzynarodowego Instytutu Spawalnictwa IIW Round Robin /7/.
- **Skład chemiczny, położenie na układzie równowagi**
  – Wykres Schaeffler'a /1/ - Wykres WRC 1988 /3/
  – Wykres DeLong'a /2/ - Wykres WRC 1992 /4/

Lincoln Electric Europe połączył najbardziej dokładny Wykres WRC 1992 z podstawowym Wykresem Schaeffler'a po to, aby ocena zawartości ferrytu w strukturze była jak najbardziej precyzyjna.

Zależność pomiędzy zawartością Ferrytu a Liczbą Ferrytową

Objętościowa zawartość Ferrytu w % (NFN) jest powiązana z Liczbą Ferrytową (FN) wg zależności NFN = $\frac{FN}{f}$



Współczynnik f zależy od zawartości żelaza (%Fe) w stopiwie /5/.

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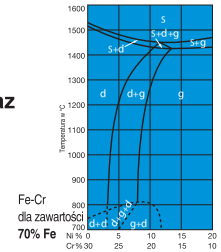
/2/ DeLong W.T. 1974.Welding Journal, 53 (8) p.273s-286s
/3/ Siewert T.A., McCowan C.N., Olson D.L. 1988.Welding Journal 12 (1988) p.289s-298s
/4/ **Kotecki D.J., Siewert T.A.** 1992. Welding Journal 5 (1992) p.171s-178s
/5/ **Kotecki D.J.** 1982. Welding Journal Nov. (1982) p.352s-361s
/6/ **Schafmeister P., Ergang R.** 1939. Arch. Eisenhüttenwesen 12 (1939) p.459-464
/7/ **Farrar J.C.M.** 2004. IIW DOC II-1531-04

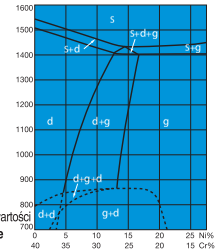
Rodzaj krystalizacji

A: Struktura w pełni austenityczna (γ) przy temperaturze pokojowej
AF: austenit(γ)i ferryt wysokotemperaturowy(δ)
FA: Krystalizacja na drodze reakcji perytektycznej (δ+γ), podczas chłodzenia, austenit i ferryt wysokotemperaturowy w formie siatki
F: ferryt wysokotemperaturowy (δ), powstawanie austenitu (γ) w osnowie ferrytu (δ)

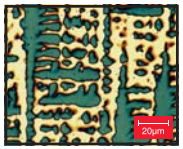
Układy równowagi faz

Struktura po krystalizacji w oparciu o podwójne układy równowagi faz /6/

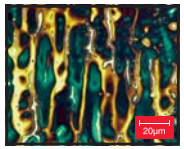




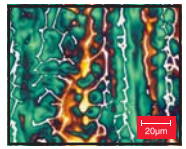
Ferryt w strukturze stopiwa



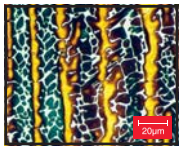
Arosta 4439
FN=0 Rodzaj krystalizacji: A



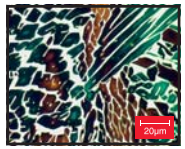
Arosta 309H
FN=3 Rodzaj krystalizacji: AF



Arosta 316L
FN=7 Rodzaj krystalizacji: FA



Limarosta 309S
FN=15 Rodzaj krystalizacji: FA



Arosta 4462
FN=35 Rodzaj krystalizacji: F

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Dziękujemy za udział w naszym seminarium!

Chętnie odpowiemy na Państwa pytania w zakresie prezentowanych rozwiązań i nie tylko. Zapraszamy do kontaktu z naszymi specjalistami! Zachęcamy również do odwiedzenia naszej strony internetowej, gdzie znajdą Państwo dużo interesujących informacji technicznych oraz naszych aktualnych promocji.

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E: wwroblewski@lincolnelectric.eu

06.02.2014, Gdańsk
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