SUPERARC XLS MIG WIRE FROM LINCOLN ELECTRIC:

ELIMINATES SURFACE SILICATES, IMPROVES PAINT ADHESION, REDUCES CORROSION, AND IMPROVES WELDING QUALITY ON ZINC-COATED MATERIALS

ARTICLE

INTRODUCTION

As the automotive industry evolves, thinner and lighter weight components become increasingly important to meet the ever challenging CAFE standards to improve gas milage. The use of thinner materials in auto manufacturing compared to thicker materials in previous decades results in a need for some form of protection against premature failures from rust-out. Most under-belt materials are now zinc coated and painted after processing to aid in corrosion life. The GMAW process prior to painting presents a unique challenge, as the weld deposit leaves behind surface silicates. These silicates will not bond to the paint, which creates potential corrosion initiation points. In the past, an acid descale process could be performed on thicker materials that were not zinc coated. This acid descale process would remove the surface silicates from the weld before the start of the painting process. With zinc-coated materials, removing surface silicates with acids is no longer an option, as the process would also remove the zinc.

Per the request of several global automotive OEMs, Lincoln Electric created SuperArc® XLS, a new wire classified as an ER70S-9 electrode per AWS specification A5.18. SuperArc XLS's unique chemistry with very low silicon levels (Figure 1), results in a change to the formation of surface materials on the weld. This change results in the formation of surface oxides, rather than traditional weld surface silicates. These oxides have proven to be easily electro-coated, resulting in improved corrosion resistance verified in numerous industry studies. A side benefit from the changed chemistry is an improvement in the weld quality when welding on zinc-coated materials as it pertains to porosity. Studies have shown that reducing the silicon levels in GMAW consumables will require more arc energy for proper transfer. This increased arc energy and the resulting change in surface tension of the liquid weld metal pushes zinc gases out at the arc cone. With traditional GMAW ER70S-3 or S-6 wires, the gases try to escape behind the arc in the solidification zone. Studies have shown three times more zinc outgassing with SuperArc XLS, resulting in an average reduction of porosity by up to 40%.

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Electrode composition (weight %)	ER70S-9 Requirements	Electrode Results
C	0.03 - 0.12	0.08
Mn	1.25 - 2.20	1.65
Si	0.15 max.	0.05
S	0.035 max.	0.005
P	0.025 max.	0.008
Cr	0.15 max.	0.03
Ni	0.50 max.	0.27
Mo	0.15 max.	0.01
V	0.03 max.	0.01
Cu (Total)	0.50 max.	0.14
Ti+Zr	0.05 - 0.25	0.12

Figure 1 (AWS ER70S-9 chemistry requirements and SuperArc XLS electrode results)

SuperArc XLS offers the automotive industry a premium wire with consistent results. The combination of RAPID X® LS, a newer innovative waveform, and SuperArc wire produces a weld very similar to standard GMAW ER70S-3 or S-6 without the surface silicate formations. This combination may also increase manufacturers' welding confidence on zinc-coated materials -- when it comes to both porosity at higher travel speeds and the performance needed for high-volume production.

Kevin Fleming, Global Industry Segment Manager at Lincoln Electric, says the impetus to develop the SuperArc XLS wire was the result of a specific request from the automotive industry.

"The ask from the industry was, 'Can you remove surface silicates from the weld that will help us with paint adhesions and therefore give us better corrosion life?'" says Fleming, who specializes in the automotive sector. "Silicon acts as a de-oxidizer and a wetting agent for the weld to wet out properly, so any company that makes a welding wire knows that removing silicon from the chemistry will create challenges. It took the know-how of our consumable R&D and waveform teams to engineer a solution that would make welds that our customers would be satisfied with. That was the challenge that we answered."

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Improved paint adhesion resulting in better corrosion resistance

Recent automotive initiatives to increase frame and chassis component corrosion life have challenged automotive OEMs and suppliers to improve the corrosion resistance of electro-coated and painted welds.

"Automotive manufacturers face challenges to improve final product corrosion resistance and are meeting those challenges by increasing the number of zinc-coated parts used during part creation," according to Taylor Dittrich, Consumables Engineer at Lincoln Electric. "However, those same zinc-coated parts are subject to additional complications during post-weld processing due to surface silicate formation during the welding process via deoxidizing reactions between the welding shielding gas and wire/base material deoxidizing elements. These non-conductive oxides interfere with the automotive electrostatic painting process and can cause premature corrosion failure."

Paint adhesion in the electrocoating process is directly affected by the presence of silicates in the weld. These surface silicates mainly consist of a mixture of silicon oxide and manganese oxide with a small variety of additional oxides. Surface silicates occur during welding on both uncoated and coated materials as a number of deoxidation reactions occur, regardless of the presence of zinc.

Surface silicates are non-conductive and interfere with the automotive electrostatic painting process, producing two typical scenarios that can cause premature corrosion complications (Figure 2):

- Paint will not adhere to the surface silicate.
- The surface silicate will detach during post-weld processing, removing any paint coating that may have adhered.

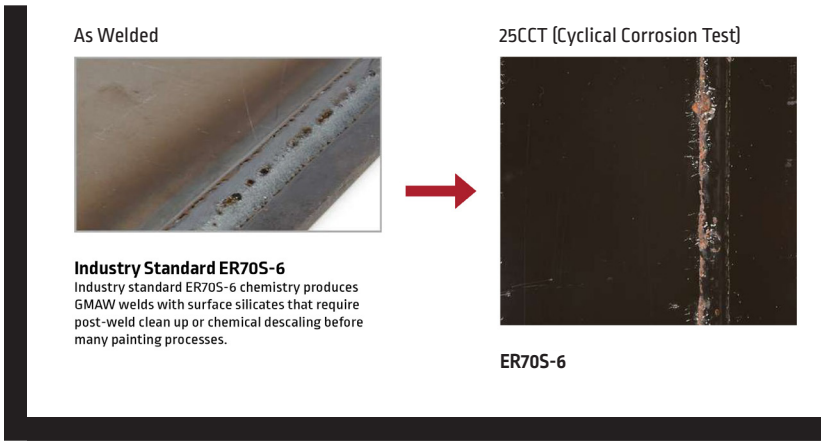

Figure 2

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Silicates versus oxides

SuperArc XLS is Lincoln Electric's direct response to these issues. Low-silicon GMAW wires "change the composition, surface tension, and amount of surface material created along a weld surface," says Dittrich. "There is a visible change in surface material formation from a surface silicate to a surface oxide when using a low silicon wire – a change from a brown, glassy surface material that easily flakes off the weld surface to a gray surface coating that remains in place. For most low-silicon wires, general surface material formation is minimized as compared to a standard ER70S-3 wire."

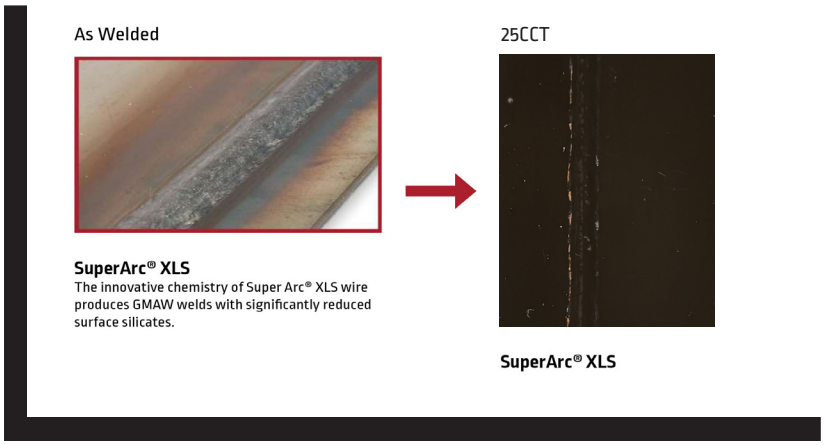

Figure 3

Surface oxides have proven to be easily electro-coated, and two separate industry studies showed an improvement in corrosion resistance over standard ER70S-series wires. (Figure 3).

Quality, consistency, and confidence

To reduce vehicle weight, thinner, high-strength steels are used for many chassis components and body panels. To improve the corrosion resistance of these thinner materials, product designers and materials engineers frequently specify zinc-coated steels for these components.

However, the welding of coated steels has always been a critical issue with conventional processes and consumables, due to the low boiling temperature of zinc (906°C), says Dittrich. Vaporized zinc is trapped during weld solidification, generating both internal and external porosity.

"Welds made on zinc-coated material are often rejected due to internal and external porosity caused by trapped zinc vapor," says Dittrich. "While there are some methods that mitigate the inherent limitations of welding on zinc-coated steels, they often fall short when welding on more difficult joints, at higher travel speeds, or with other unusual welding circumstances. SuperArc XLS, when combined with Rapid X LS, shows a clear performance improvement when used on welding zinc-coated steels as compared to traditional ER70S-3 or ER70S-6 wires."

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A comparison study showed a 40% reduction in porosity when welding on zinc-coated steels with SuperArc XLS over the traditional ER70S-3 GMAW consumable. The research methodology and results were presented at the 2022 IIW conference by Corey Cox, Machine R&D Engineer at Lincoln Electric. The study showed a clear distinction of the outgassing behavior of the zinc gases between the two consumables. With traditional ER70S-3 wires, the outgassing takes place behind the arc cone near the solidification zone, but with SuperArc XLS, most of the outgassing takes place at the front edge of the arc cone, as pictured in Figure 4 and Figure 5.

Another observation made by Cox during his research was that the number of outgassing events increased by up to 300% with SuperArc XLS over the ER70S-3 consumable. He made this observation in both studies of using high speed video and continuous X-ray of the weld as it was being made. (Figure 6)

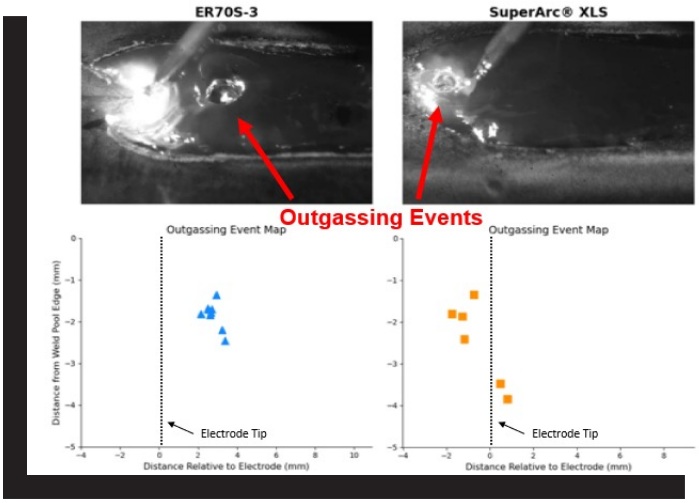

Figure 4 (High speed video documenting outgassing events)

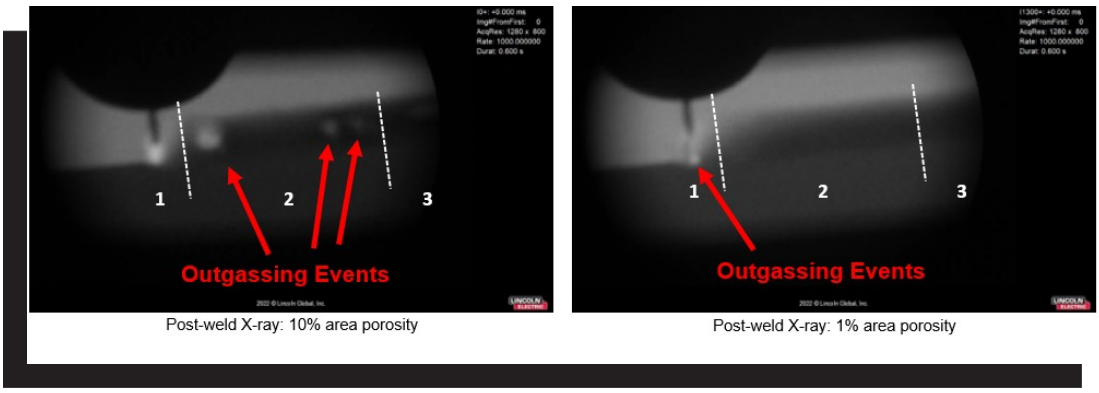

Figure 5 (Continuous X-Ray while welding, showing outgassing events. Zone 1 Arc Cone, Zone 2 Liquid Metal behind the arc, Zone 3 Solidification Zone)

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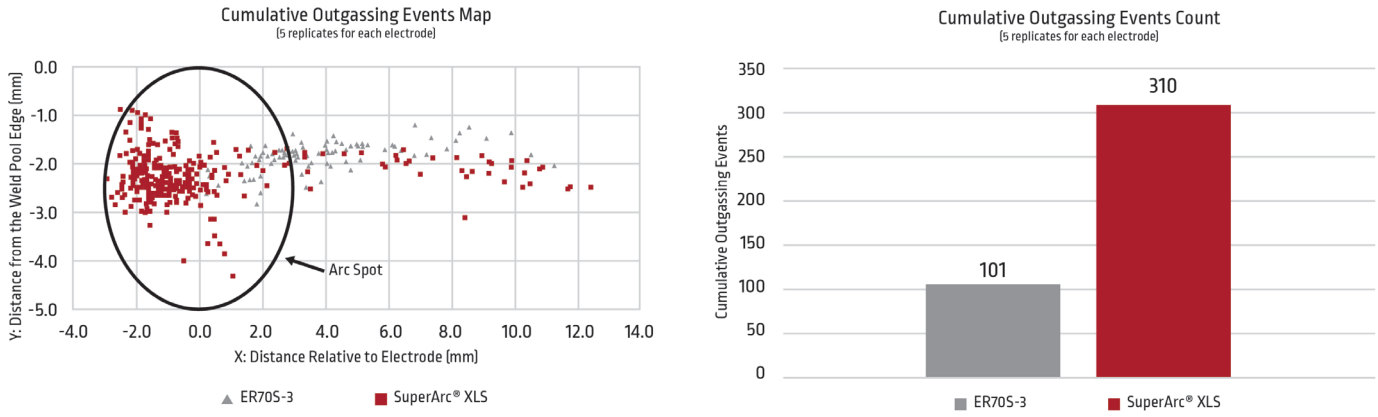

Figure 6 (300% increase in outgassing events with SuperArc XLS)

Other studies conducted by Lincoln Electric in previous years have shown that as little as seven percent porosity in welds can reduce fatigue life by as much as fifty percent, says Fleming. “But now that we have SuperArc XLS, a wire that can reduce the porosity by up to forty percent on average compared to a standard wire, auto manufacturers can have a higher level of confidence in the quality and consistency of their welds.”

Along with all the other high-quality and consistent consumables that Lincoln Electric is known for, SuperArc XLS is becoming the new standard for the automotive industry, improving corrosion life by aiding in paint adhesion and welding performance on zinc-coated materials.

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