

GREAT DESIGNS IN **STEEL**

GMAW CONSUMABLE INNOVATIONS TO IMPROVE WELDING QUALITY ON ZINC- COATED STEELS

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WELDING QUALITY CHALLENGES WITH ZINC-COATED STEEL

Challenge #1: Paint Adhesion

Incompatible with acid descaling ^[1]



Silicon-based slag obstructs post-weld coating adhesion



Corrosion vulnerability of the weld surface

Challenge #2: Weld Quality

Zinc-based porosity



Compromises fusion zone mechanical properties

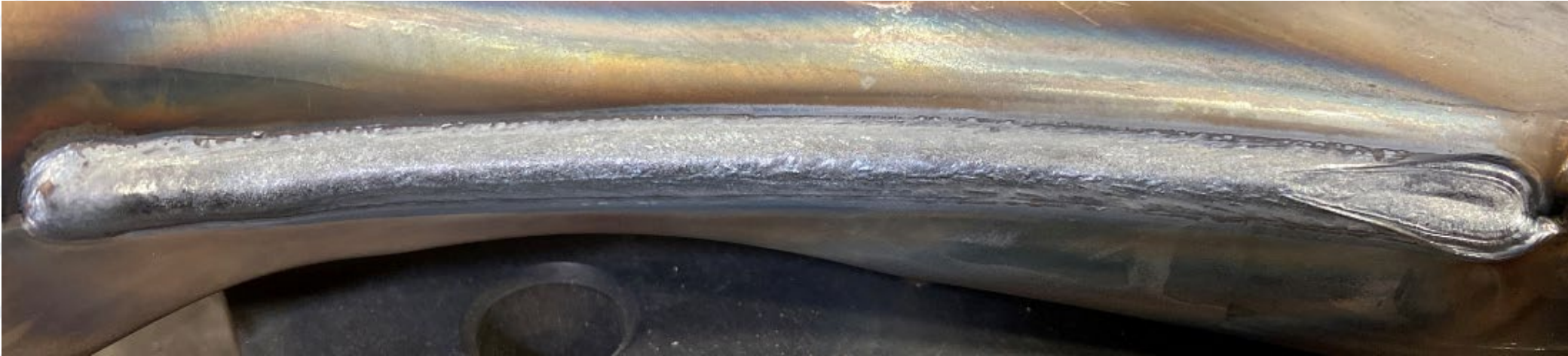


Pre-mature failure of welded components ^[2]

GMAW OF ZINC-COATED STEEL

SuperArc® XLS

- Solid, copper coated GMAW wire
- Engineered to reduce silicon-based slag formation



Alternative solution for zinc-coated steel ^[3]

- Improved post-weld coating adhesion and corrosion resistance

SURFACE SILICATE V. SURFACE OXIDE

ER70S-3

SuperArc® XLS



As-welded

Electro-coated

120 CCT*

As-welded

Electro-coated

120 CCT*

Non-conductive slag impairs the painting process

Uncoated materials: Acid descale for surface cleaning

Coated materials: Incompatible with acid descale

4.2 mm uncoated HSLA 550, no acid descale

* CCT = Cyclic Corrosion Test

WELDING QUALITY CHALLENGES WITH ZINC-COATED STEEL

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REALITIES OF WELDING ZINC-COATED STEEL

- Zinc contamination:
 - Weld metal solidification traps zinc vapor
 - Porosity → weld integrity concerns
- Zinc-coated steel welding:
 - Slower travel speeds
 - Spatter → 5x greater than uncoated steel
 - Fume generation and exposure → 3.5x higher particulate

POROSITY AS A DEFECT

Example industry specification:

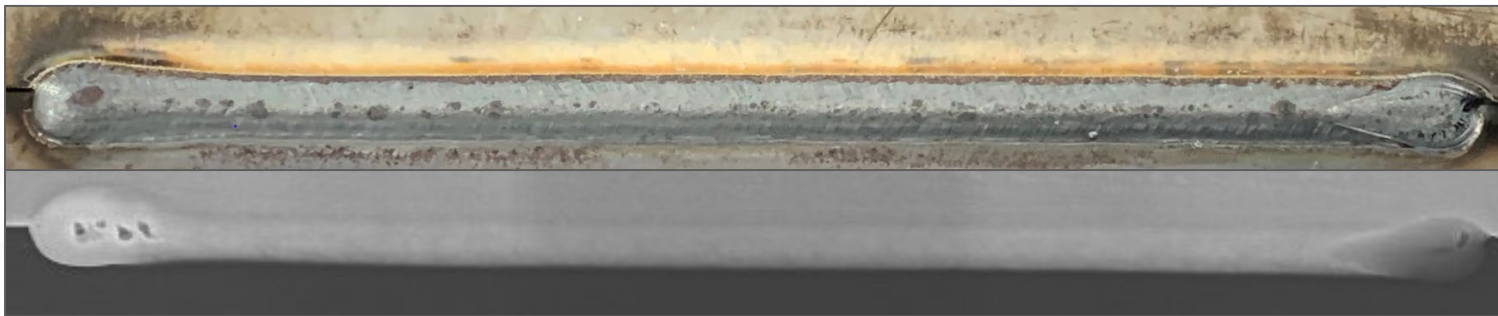
6mm of porosity allowed per 25mm of linear weld

10% by area for a 3mm fillet

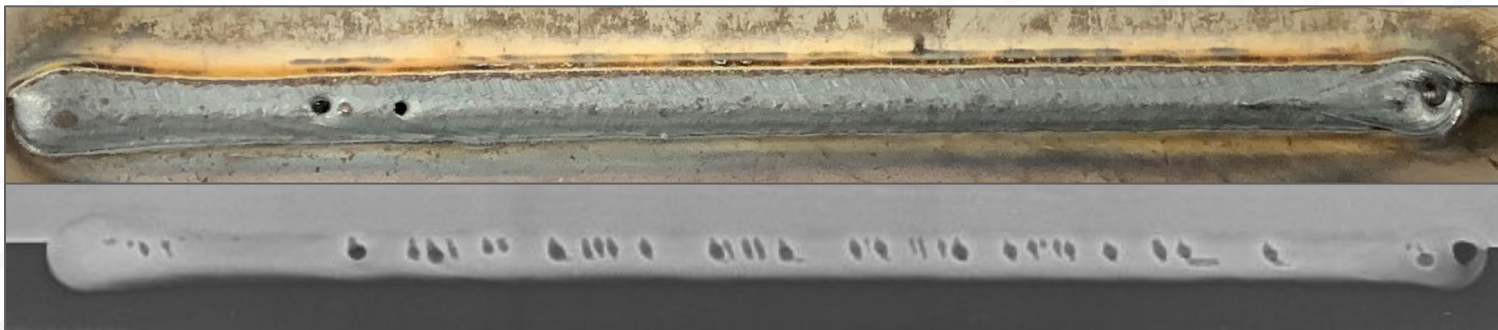
Visible/external: > 5% by area

Ideal condition: < 3% by area

1% or less



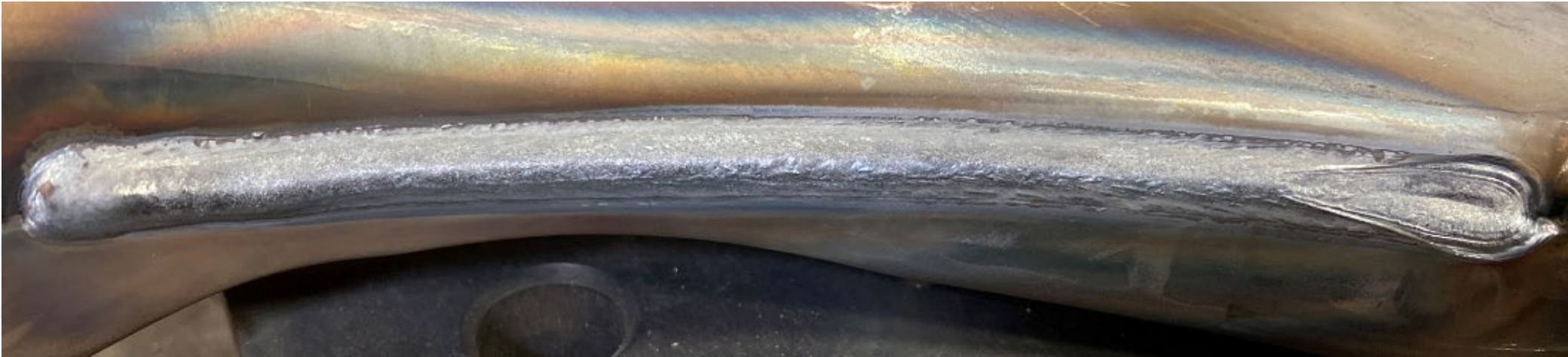
5% or more



GMAW OF ZINC-COATED STEEL

SuperArc® XLS

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- Engineered to reduce silicon-based oxide formation



Alternative solution for zinc-coated steel ^[3]

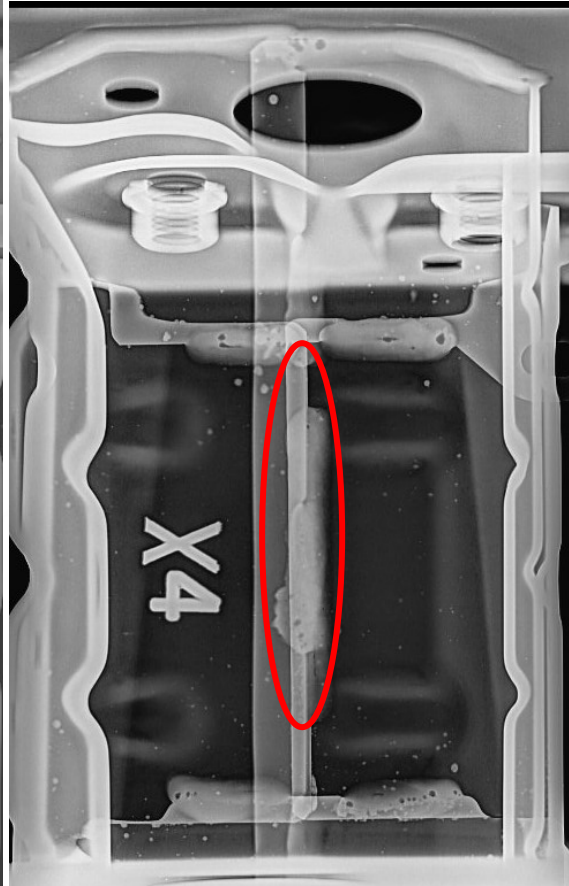
- Improved post-weld coating adhesion and corrosion resistance
- Reduced internal porosity

SUPERARC® XLS X-RAY EXAMPLES

ER70S-3



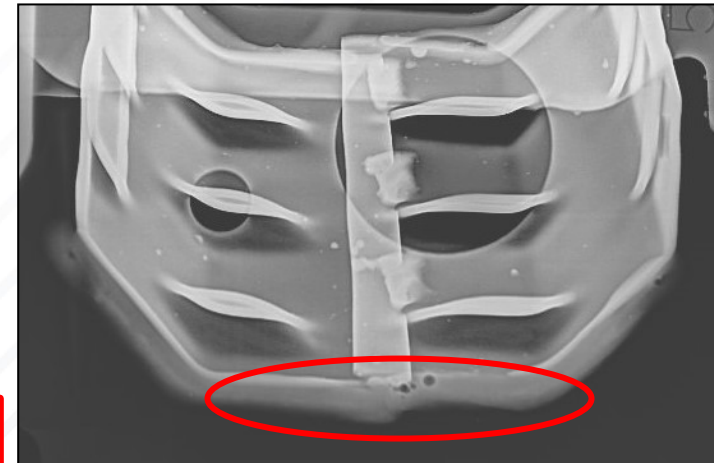
SuperArc® XLS



ER70S-3



SuperArc® XLS



Question: How does zinc interact with the weld pool differently between ER70S-3 and SuperArc® XLS?

EXPERIMENT

Objective: to compare the interaction of zinc vapor with the weld pool for two electrodes:

- ER70S-3 and SuperArc[®] XLS

Test: observe zinc vapor behavior via two in situ imaging methods:

1. High-speed X-ray video to show inside the weld pool
2. High-speed video of weld pool surface



Power Wave[®] R450



STT[®] Module

Joint Type	lap, zero gap
Shielding Gas	90% Argon / 10% CO ₂
Welding Process	(1) Rapid X [®] , (2) Rapid X [®] LS
Travel Speed	40 in/min (1 m/min)
Contact Tip to Work Distance	3/4" (19 mm)
Electrode Size	0.045"
Electrode Type	(1) ER70S-3, (2) SuperArc [®] XLS

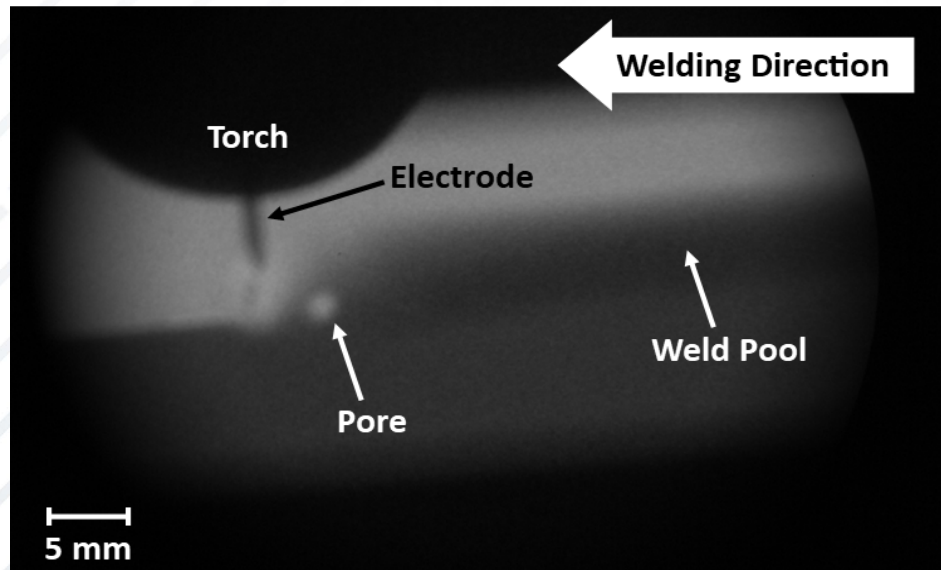
TEST 1: HIGH-SPEED X-RAY VIDEO

Test Plan

- Weld 5 joints with each electrode
- Capture X-ray video at 1000 fps

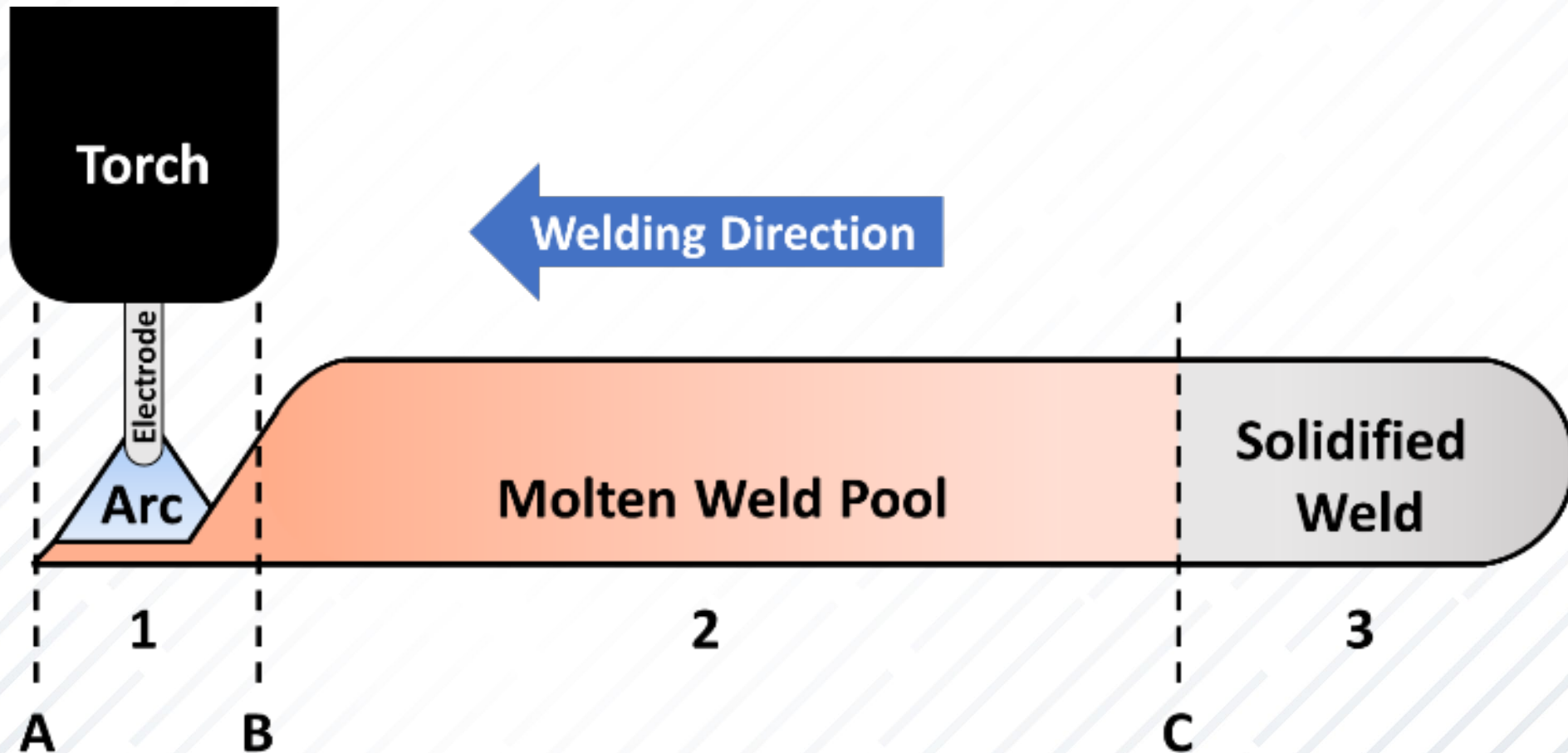
Response

- X-ray video analysis
 - Characterize behavior of zinc vapor inside the weld pool



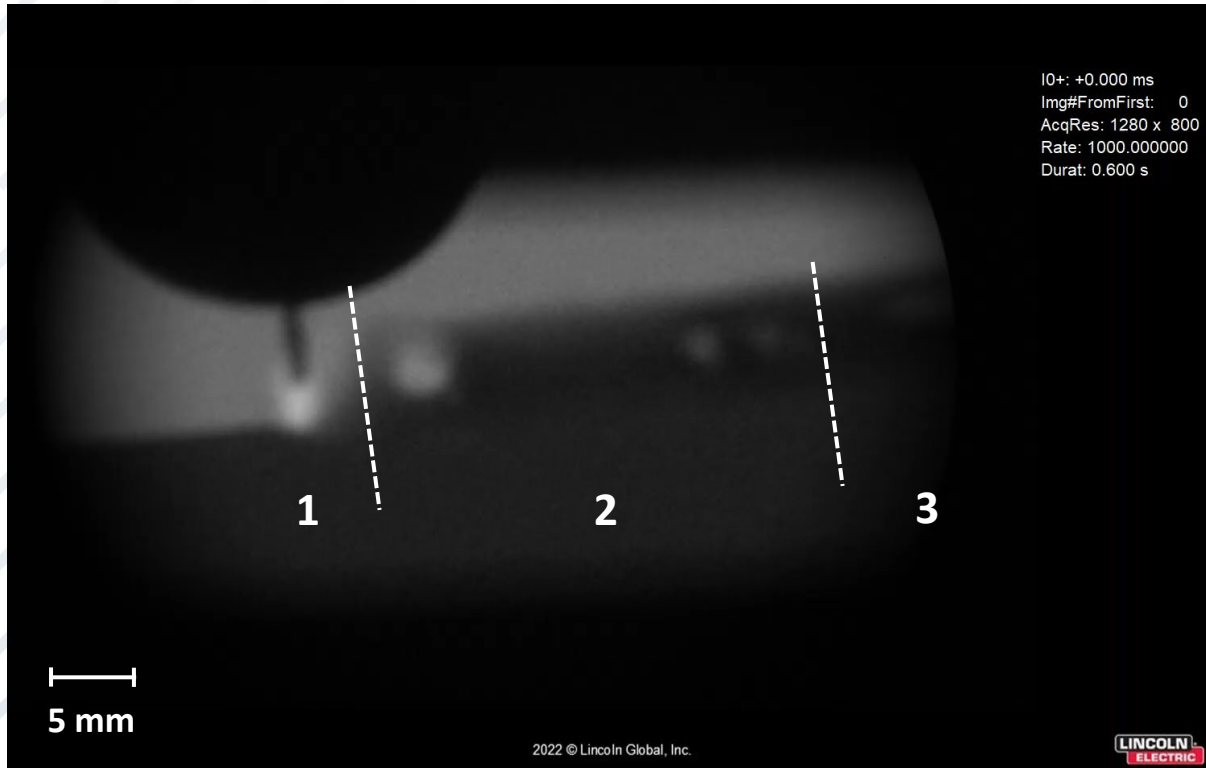
Base Material Thickness	2.0 mm
Base Material Type	HSLA 550
Coating Type	Hot Dipped Galvanized (GI)
Coating Weight	50G/50G
Welding Position	horizontal

TEST 1: 3 REGIONS OF ZINC VAPOR BEHAVIOR

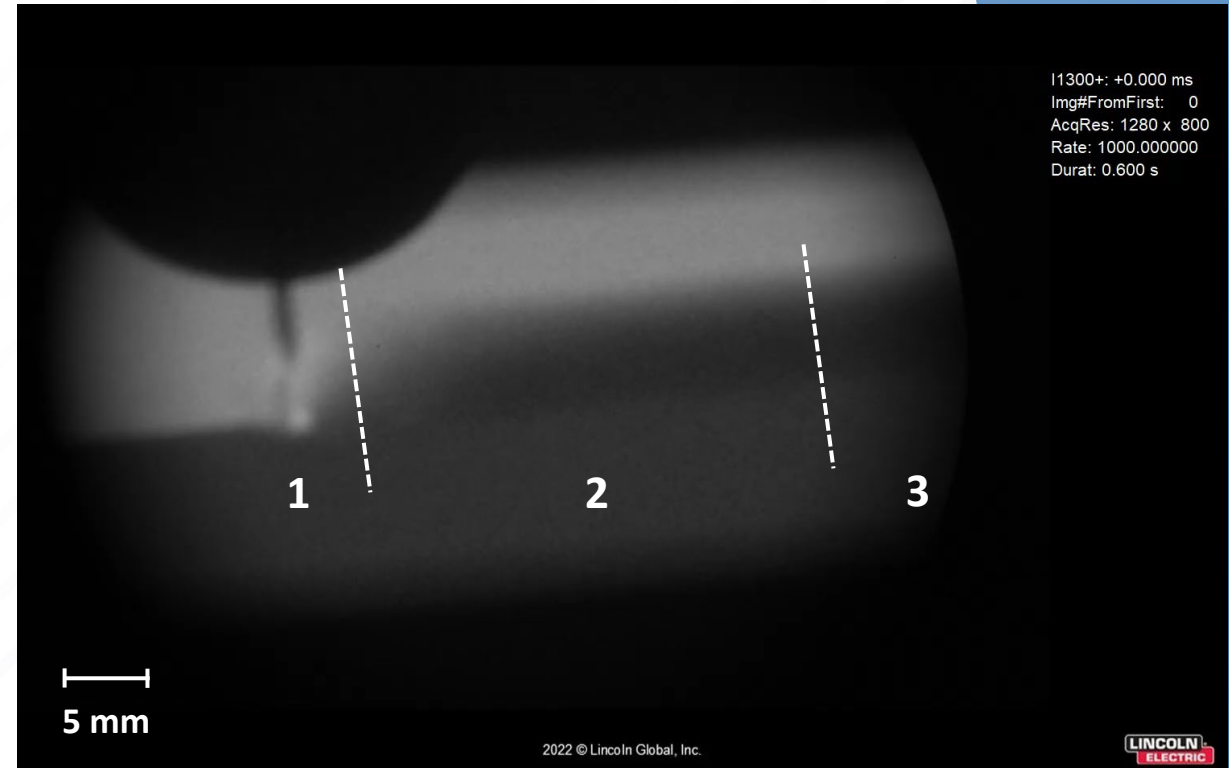


TEST 1: HIGH-SPEED X-RAY VIDEO CLIPS

ER70S-3



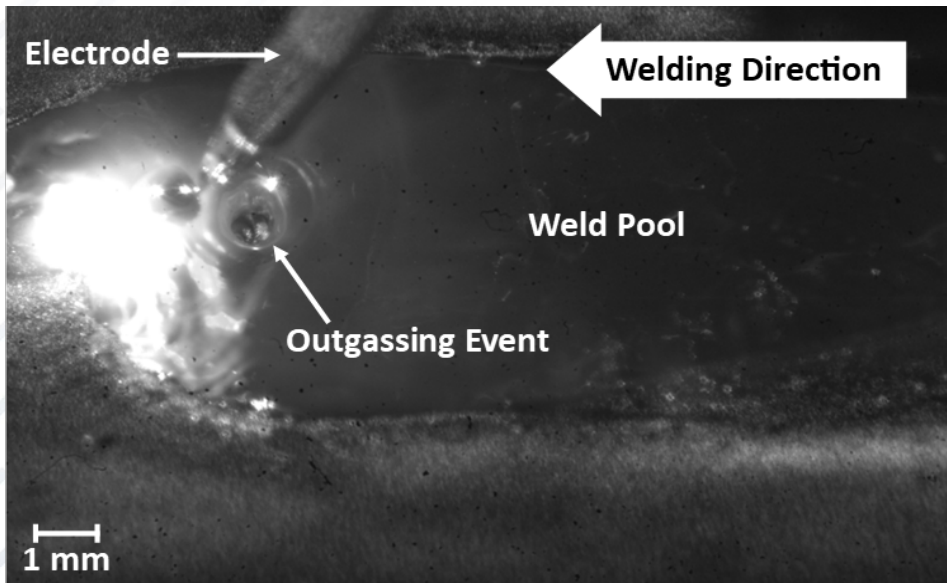
SuperArc® XLS



TEST 2: HIGH-SPEED VIDEO OF OUTGASSING

Test Plan

- Weld 5 joints with each electrode
- Capture video at 2500 fps



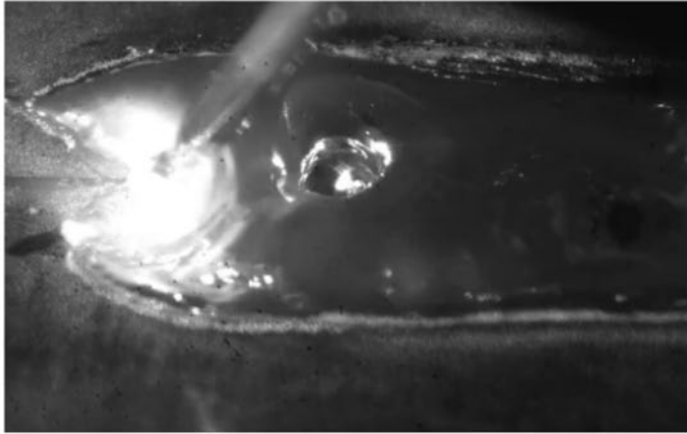
Responses

- High-speed video analysis
 - Characterize zinc vapor outgassing in the near-arc region
- Post-weld X-ray, porosity by % area

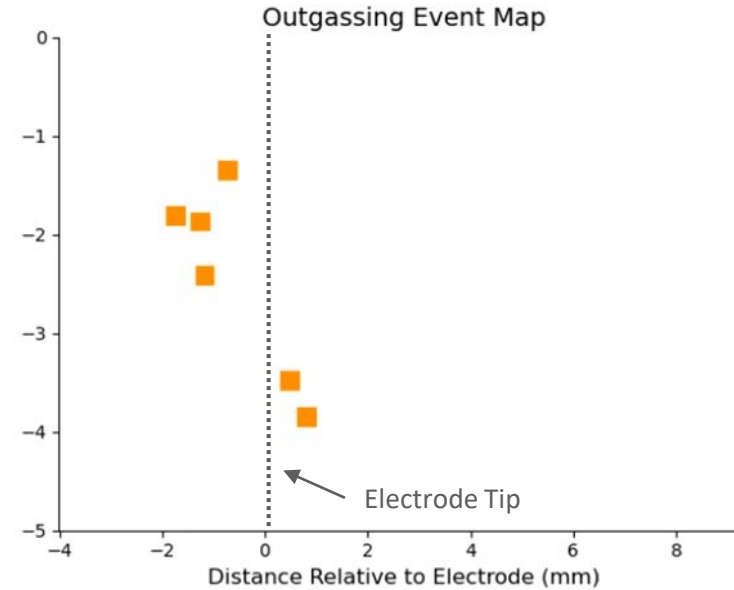
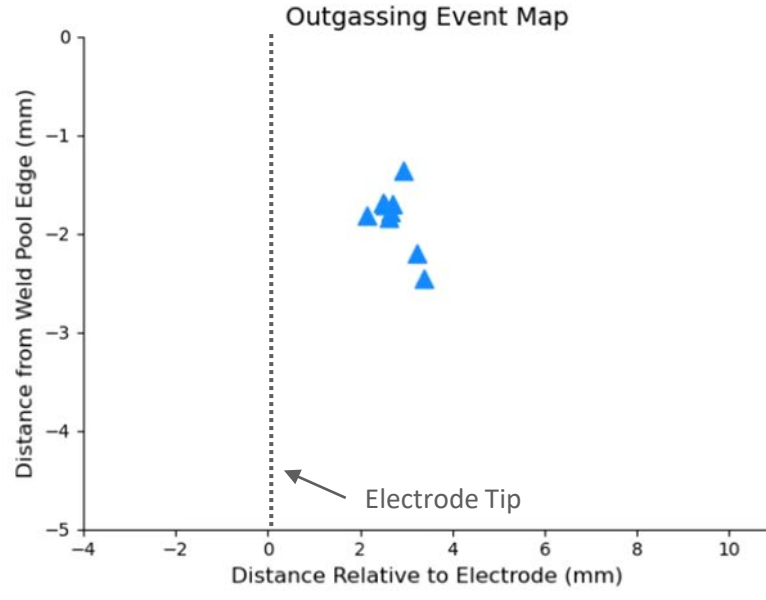
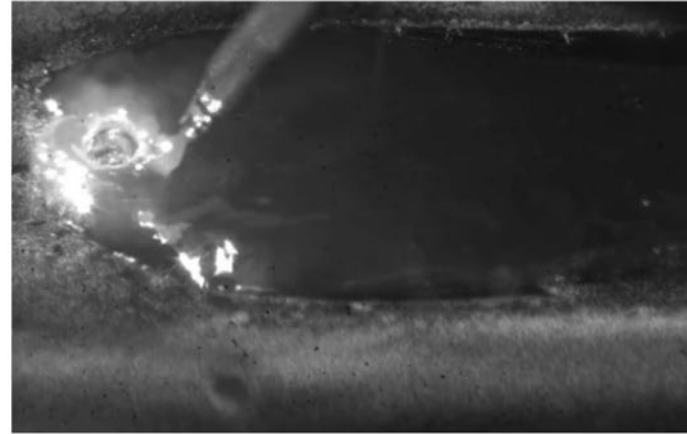
Base Material Thickness	2.0 mm
Base Material Type	HSLA 550
Coating Type	Hot Dipped Galvanized (GI)
Coating Weight	70G/70G
Welding Position	flat

TEST 2: OUTGASSING VIDEO CLIPS

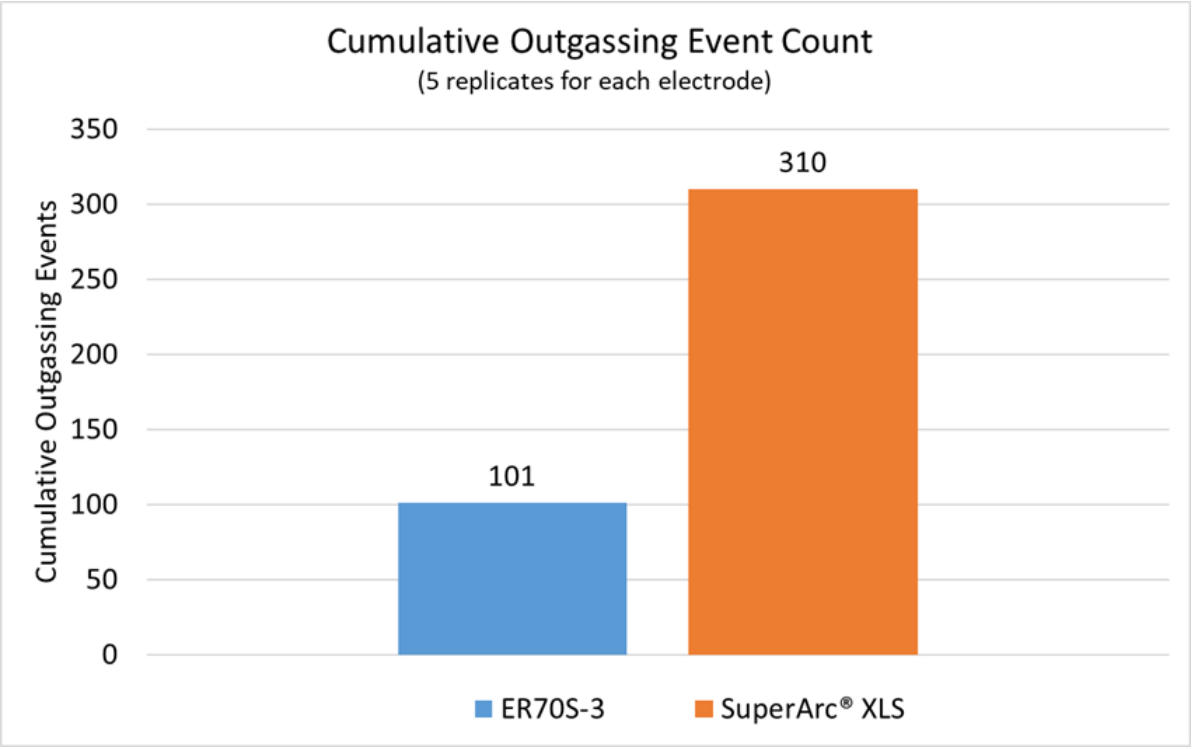
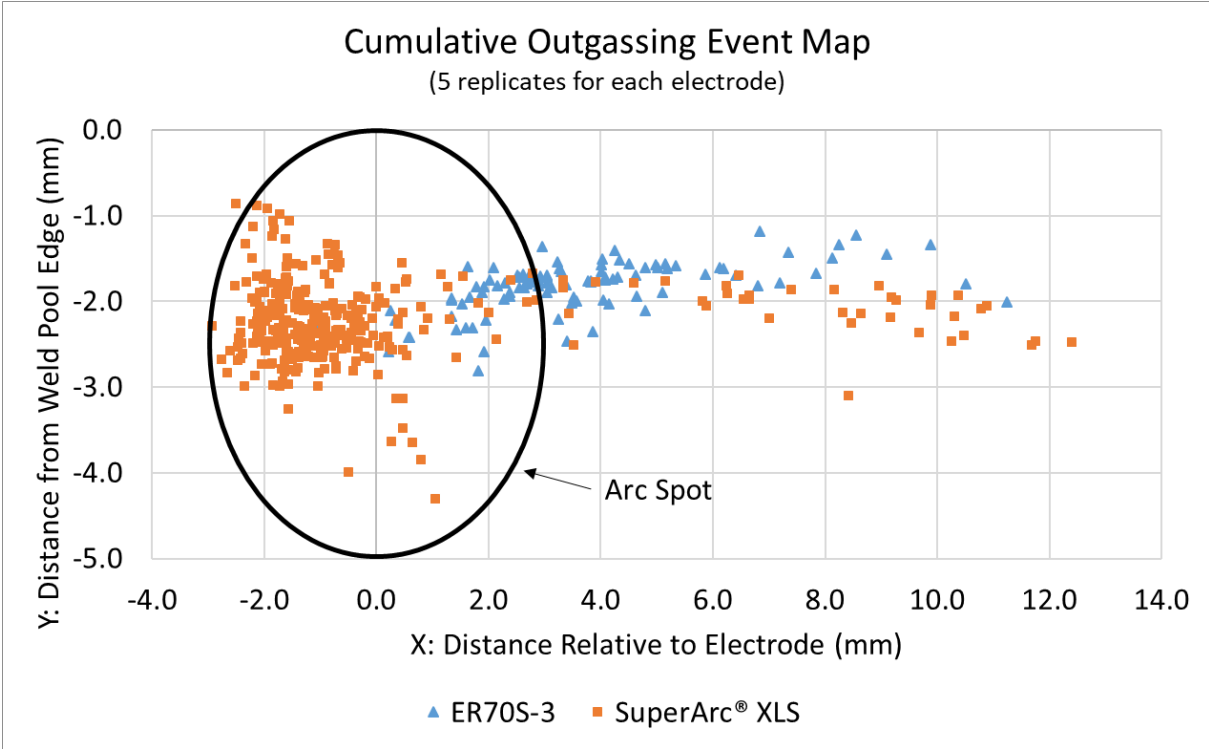
ER70S-3



SuperArc® XLS



TEST 2: OUTGASSING EVENT SUMMARY



SuperArc® XLS showed 38% less porosity in post-weld X-rays.

CONCLUSIONS

Improved welding on zinc-coated steels with SuperArc® XLS

- Slag improvements impact paint adhesion
 - Increase corrosion life of welded regions



SuperArc® XLS exhibited a fundamentally distinct interaction with zinc vapor in the weld pool

- 3x more outgassing events
- Unique location of outgassing events
 - Close to the arc
 - Region of greatest benefit
- Lower porosity improves productivity and quality
 - Increases travel speeds
 - Improves internal weld quality

QUESTIONS

References

- [1] Anderson, B. “Descaling: Challenges of Processing Zinc and Aluminum Substrates.” *The Electrocoat Conference*, Apr. 2018.
- [2] Mei, L., Chen, G., Jin, X., Zhang, Y., Wu, Q. “Research on laser welding of high-strength galvanized automobile steel sheets.” *Optics and Lasers in Engineering*, Nov. 2009, Vol. 47, Issue 11, p1117-1124.
- [3] Dittrich, T., Fleming, K., Hurley, T. “Advancements in GMAW Technology for Zinc-Coated Steels.” *Sheet Metal Welding Conference XIX*, Nov. 2021.

FOR MORE INFORMATION

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