Outermost Technology

Sample Report: Building Materials Analysis

Metal Piece Thickness and Composition

Innovation Together

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Analysis Goals

- ❑ Measure the thickness of all four sides of the metal pieces in the left.
- ❑ The material is a steel with Zn-coated on both sides. Figure out the level of carbon contents the steel body material.
- ❑ Figure out the thickness of Zn-coated layers

Test procedure

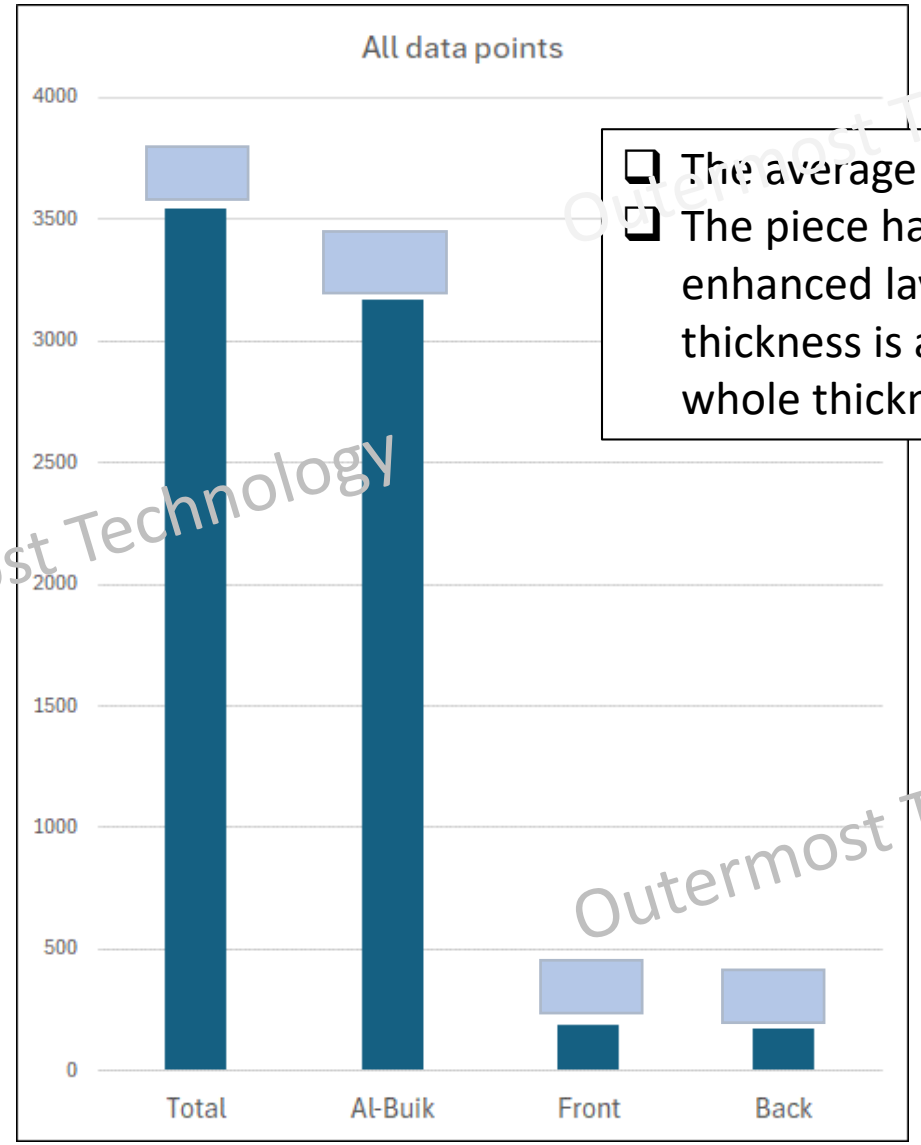
- 0.8” x 0.8” squares were cut out from each sample by water-jet cutter.
- Four sides of each sample were molded and polished so that the cut cross-section is facing surface normal direction.
- Thickness was measured – two locations for each sides
- Composition analysis was done for one sample by SEM/EDS

Summary

- Composition analysis by SEM-EDS
  - The edge consist of mostly Aluminum (~ X%), Carbon (~ X%), Oxygen (~ X%) and small Zn (X%)
  - The bulk area is mostly Aluminum (~ X%), Carbon (~ X%), and Oxygen (~ X%), while it also contains small amounts of other metals - Mg (X%), Mn (X%), Fe, X), and Ag (X%).
  - The line scan profile shows enriched Oxygen and Zn in Edge area, while more Carbon in bulk.
- Thickness measurement
  - The average total thickness: X ± X um (± 2.43%)
  - The average bulk thickness: X± 100 um (± 3.15%)
  - The average front layer thickness: X ± 35 um (± 18.82%)
  - The average back layer thickness: X ± 21 um (± 12.07%)
  - Sample #3 is the thickest while #1 was the thinnest. (ΔTh = X um)
  - Sample #4 shows thicker front and back layers while its bulk is thinner, which seems to be related to its high curvature.

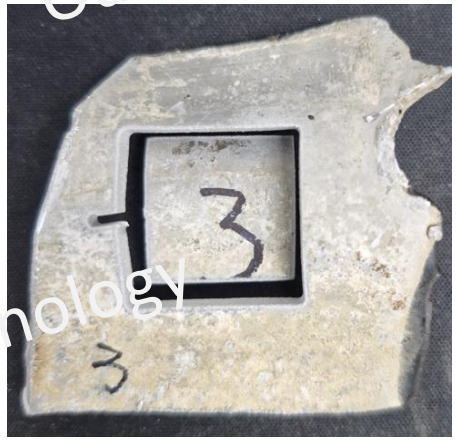
Summary: Thickness – All Data

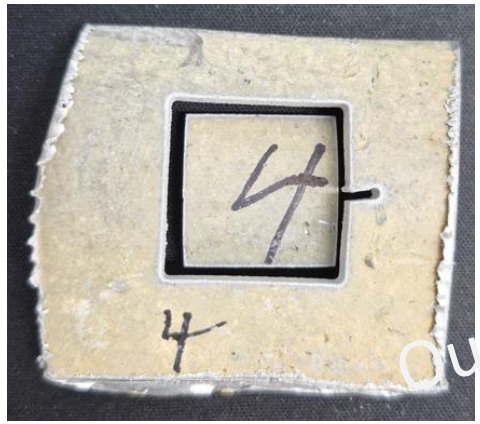
	Total (um)	Al-Buik (um)	Front (um)	Back (um)
Top, #1				
Bottom, #1				
Left, #1				
Right, #1				
Top, #2				
Bottom, #2				
Left, #2				
Right, #2				
Top, #3				
Bottom, #3				
Left, #3				
Right, #3				
Top, #4				
Bottom, #4				
Left, #4				
Right, #4				
Average (um)				
Stdev (um)				



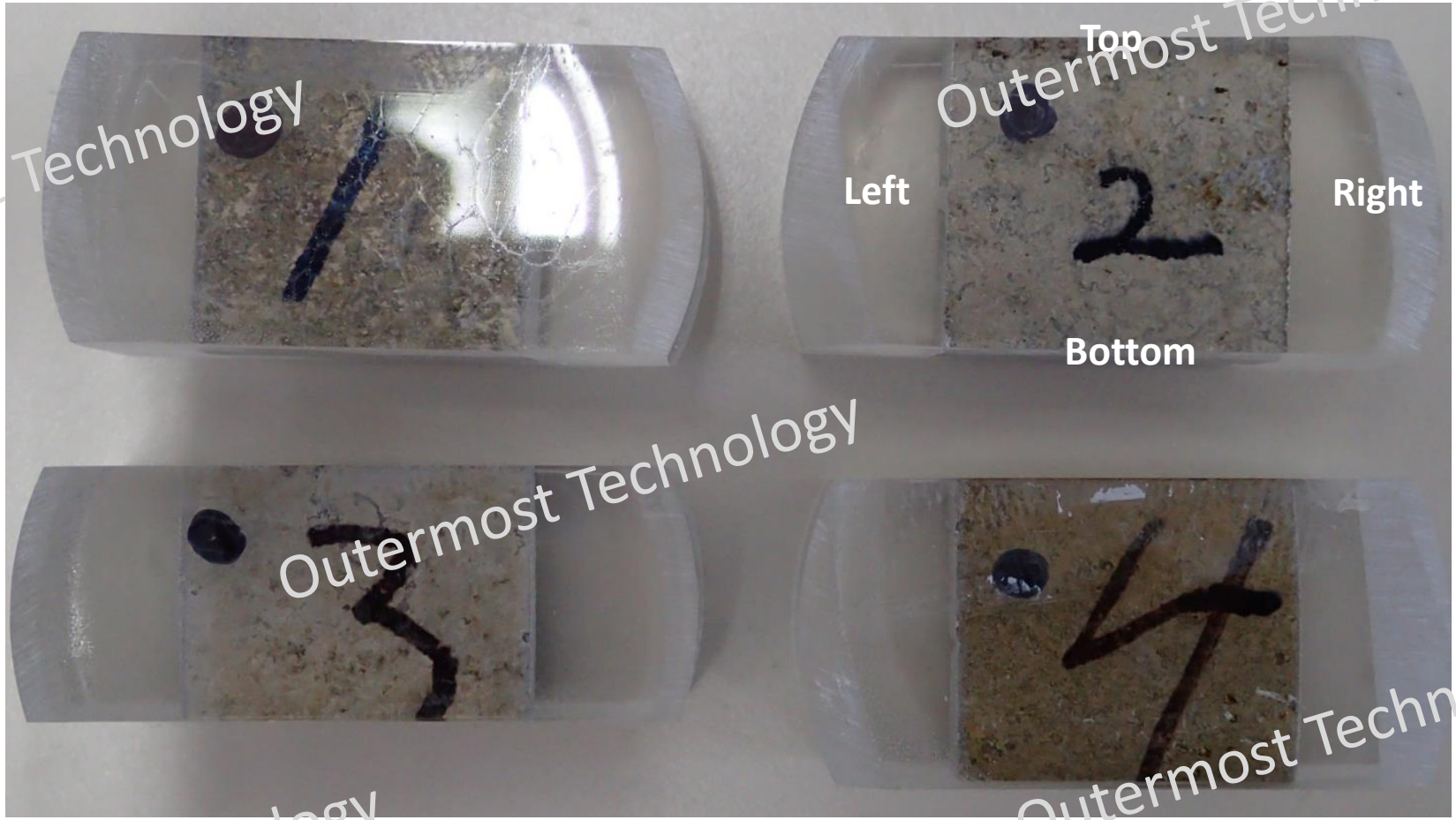
- The average thickness is ~ X um.
- The piece has Oxygen and Zinc enhanced layers on both sides, whose thickness is about X% (~ X um) of the whole thickness.

Sample Preparation – Water Jet Cutting



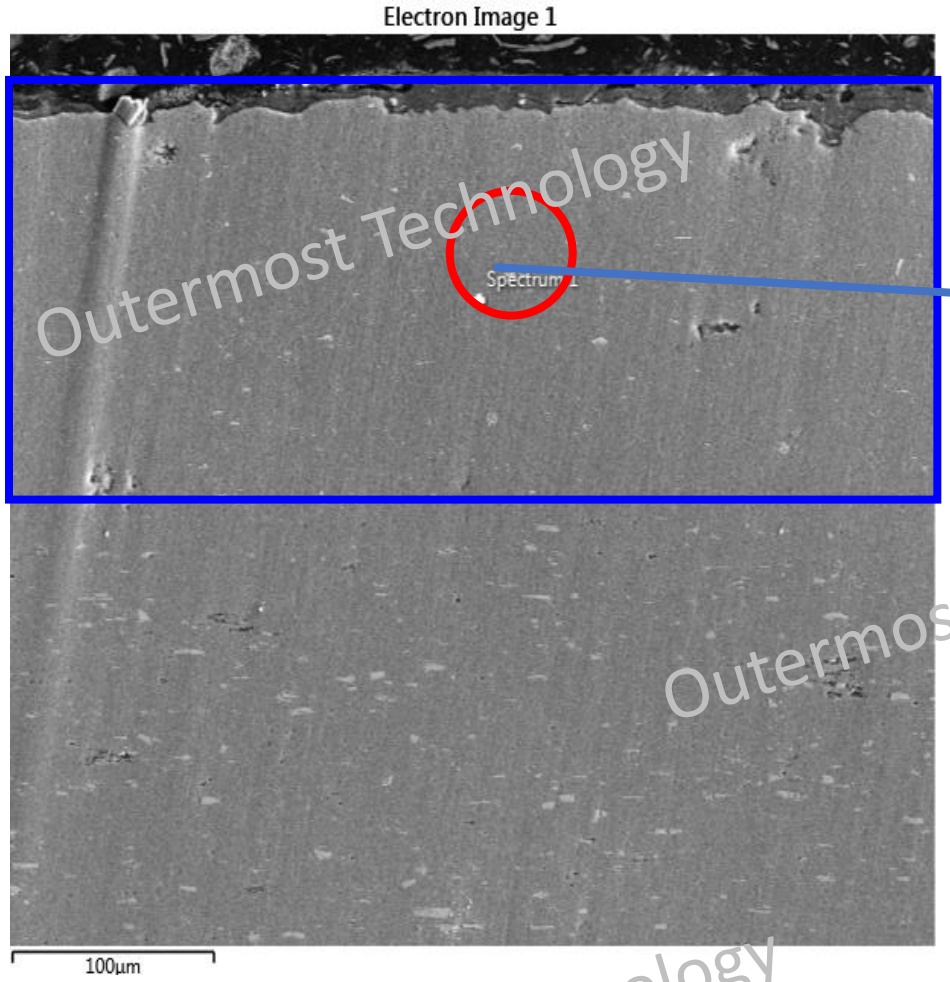


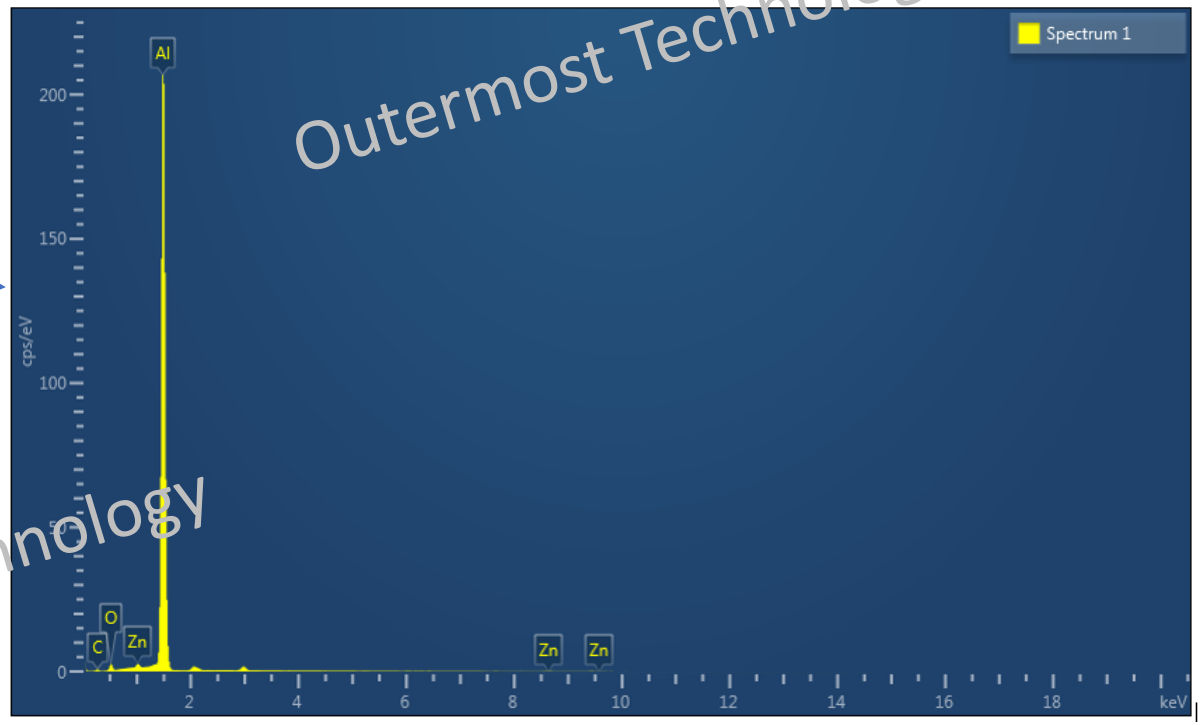
Sample Preparation - Molded



Top & bottom sides were polished after molding

Composition Analysis by SEM/EDS – Point Analysis (Edge)

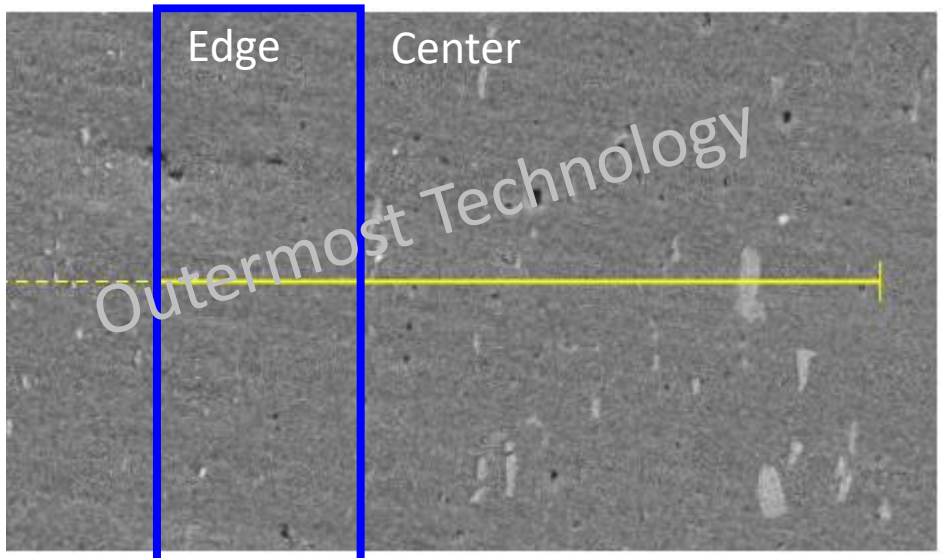


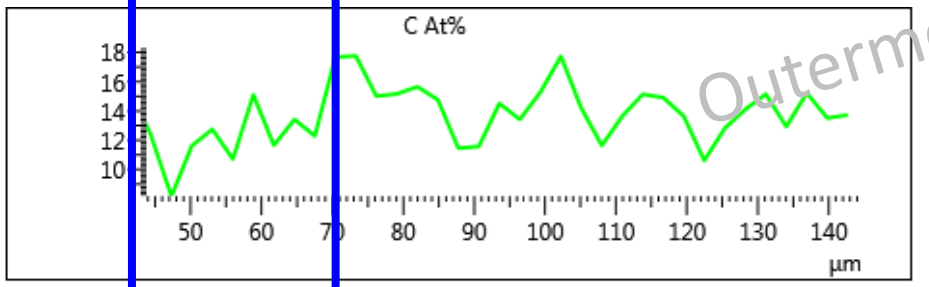


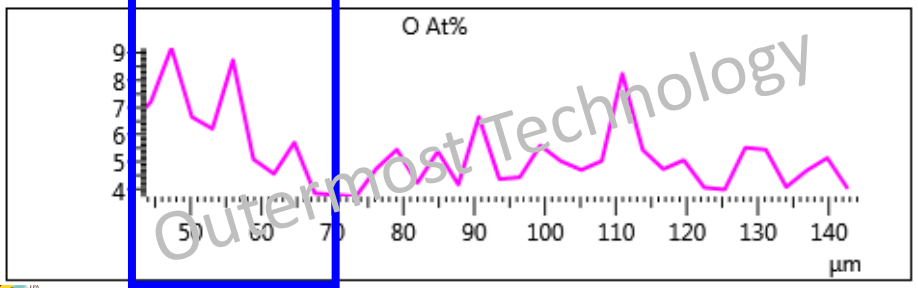
Spectrum 1								
Element	Line Type	Apparent Concentration	k Ratio	Wt%	Wt% Sigma	Standard Label	Factory Standard	Atomic Percent (%)
C								
O								
Al								
Zn								
Total:								

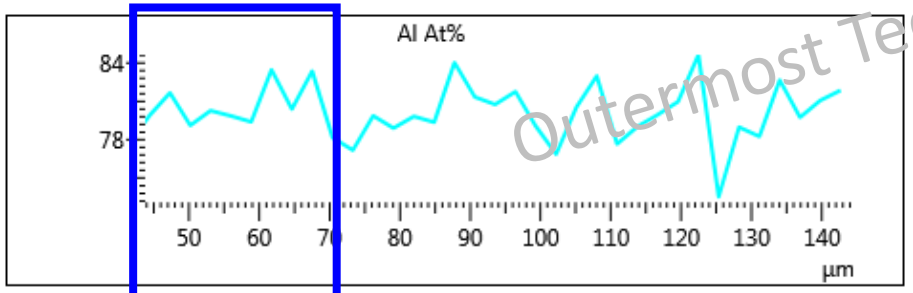
- The edge area is mostly Oxidized Al with carbon.
- XPS-analysis is expected to provide clear bonding states of Al.

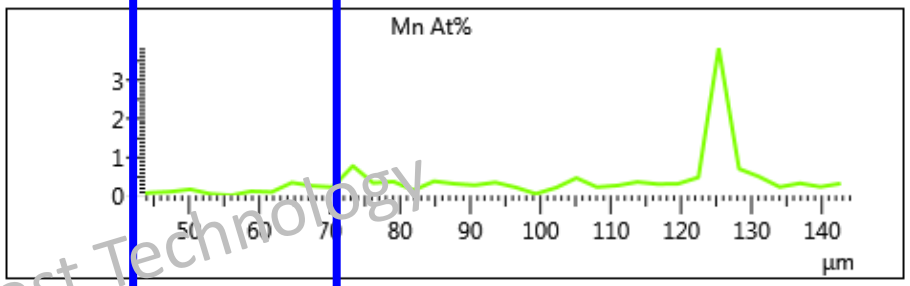
Composition Analysis by SEM/EDS – Linescan (1)

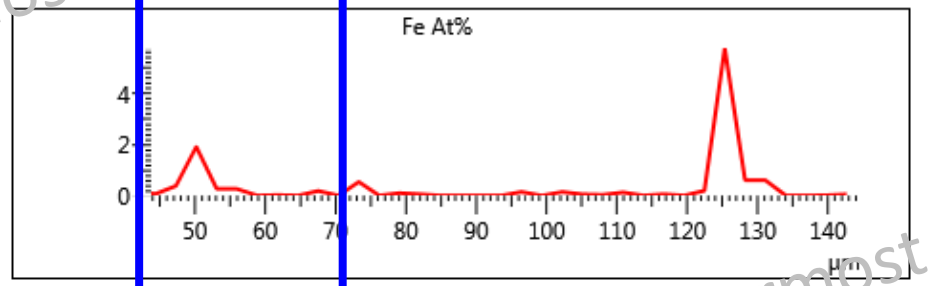


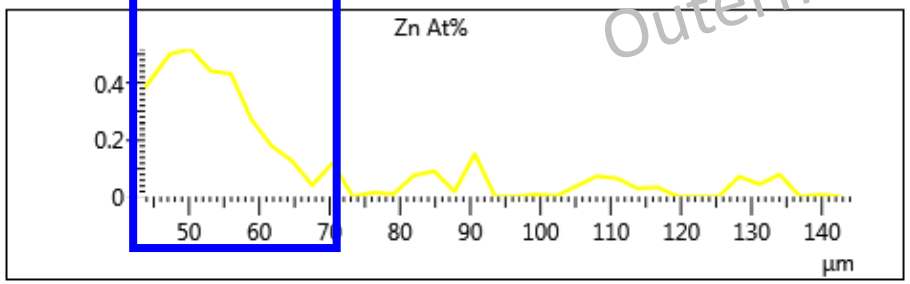








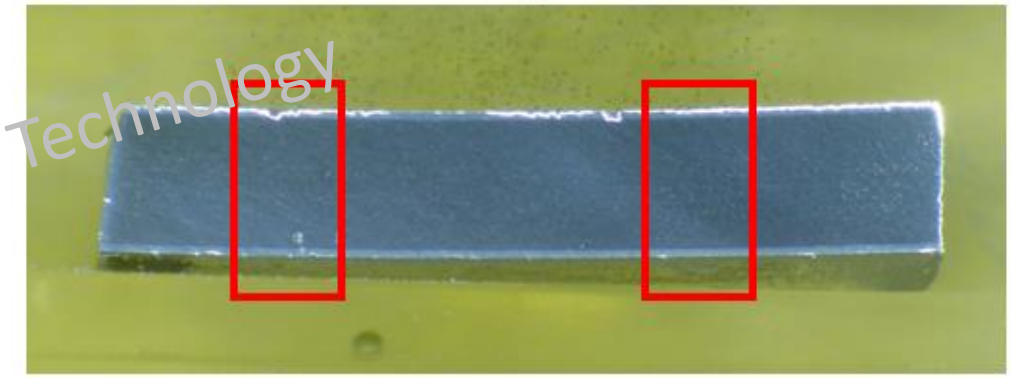




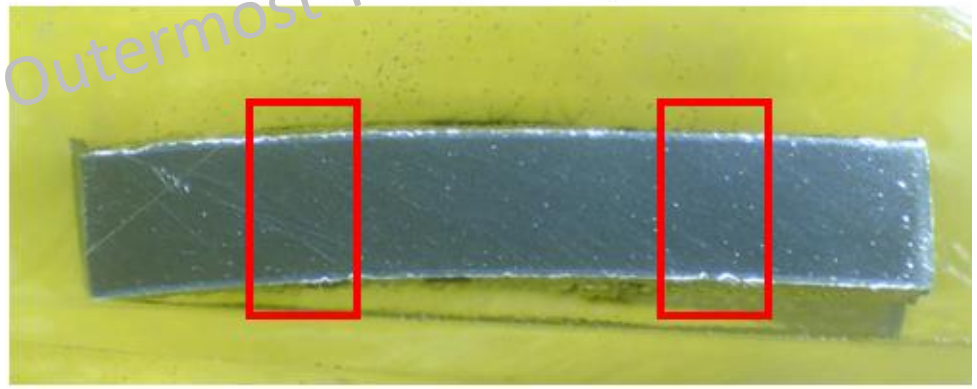
- The edge area has more oxygen, and Zn, while the center (or bulk) has more carbon compared to the edge.
- The spikes are from the white chunk which is Al with more Mn and Fe than its surrounding.

Thickness Measurement - Top

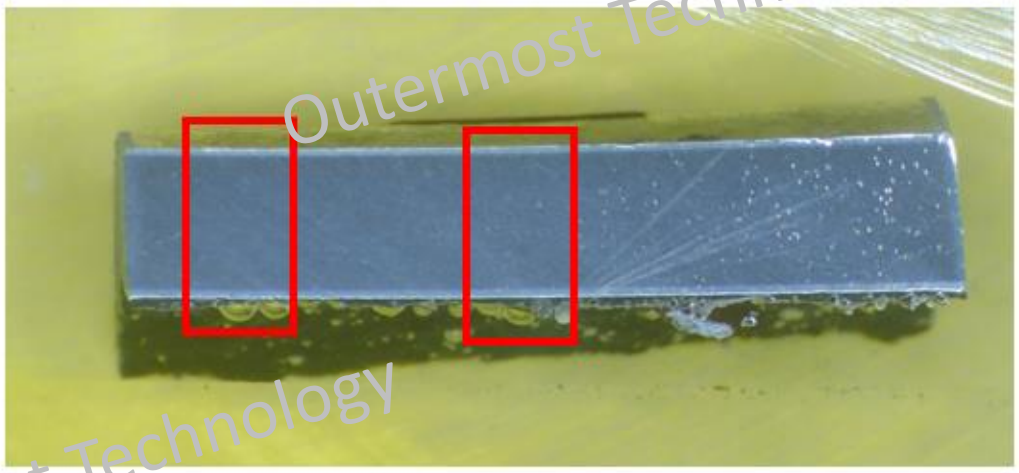
#1 Sample



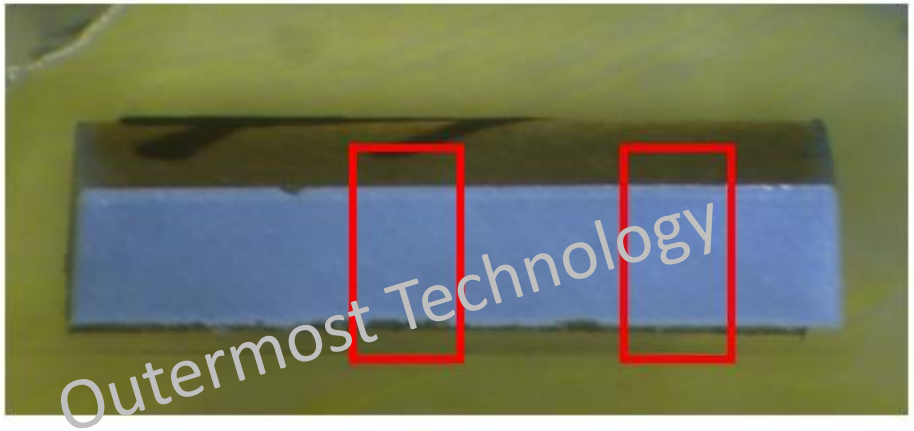
#2 Sample



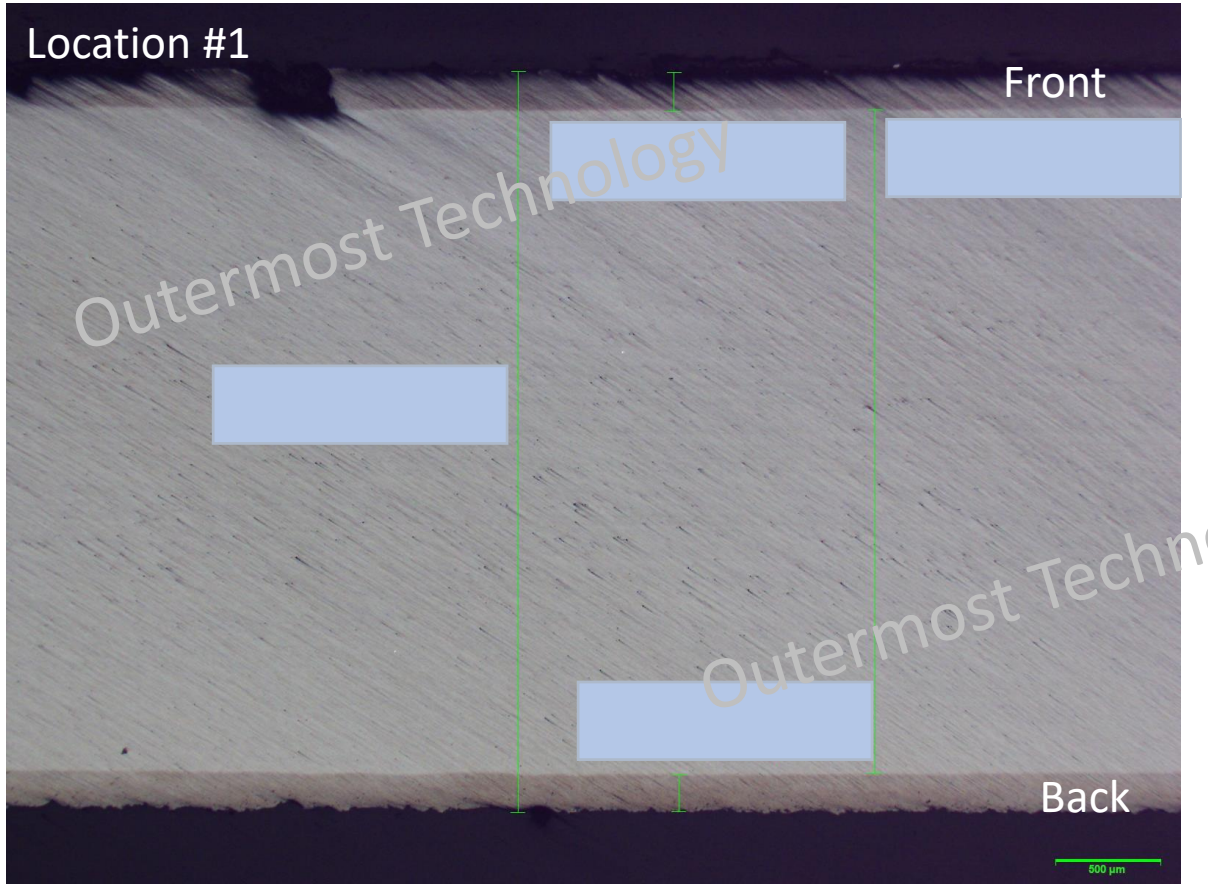
#3 Sample

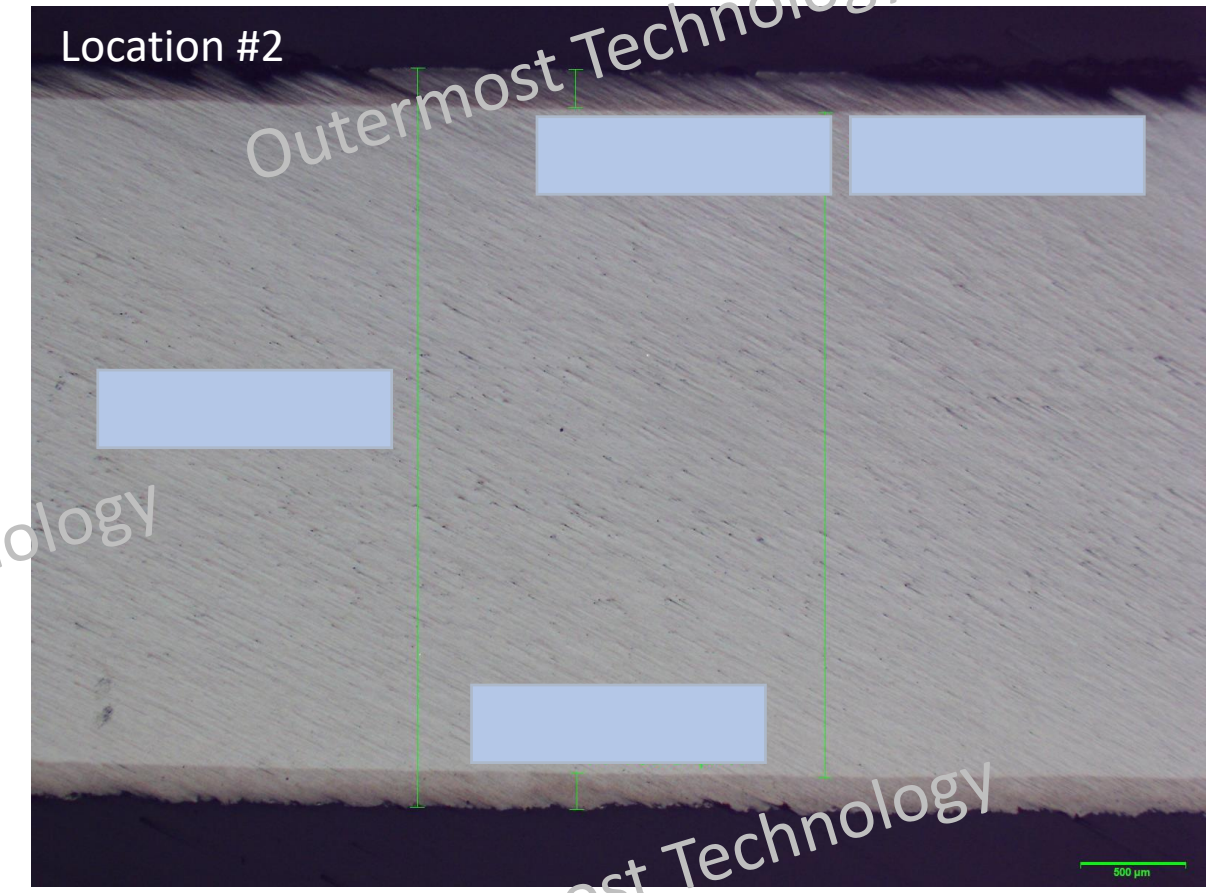


#4 Sample



Thickness Measurement – Top, #1

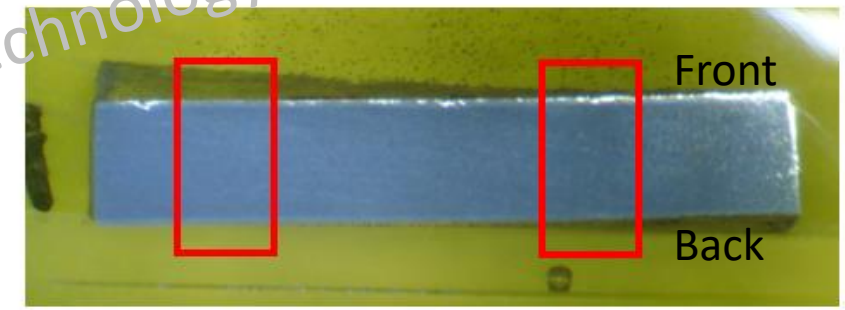




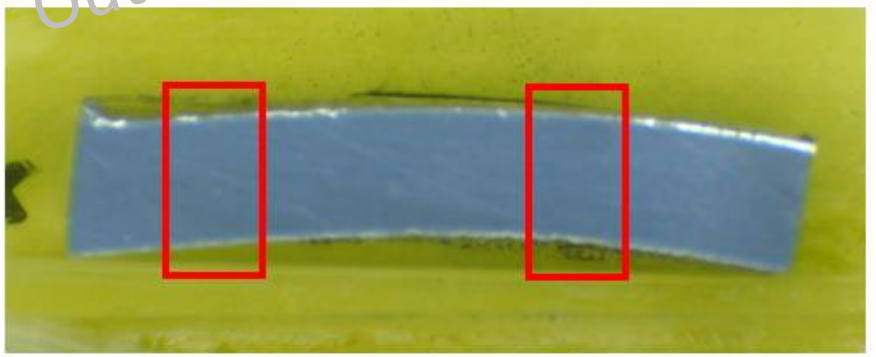
Top, #1				
Location	Total (um)	Al-Buik (um)	Zn-Enriched-Front (um)	Zn-Enriched-Back (um)
1				
2				
Average				
Stdev				

Thickness Measurement - Bottom

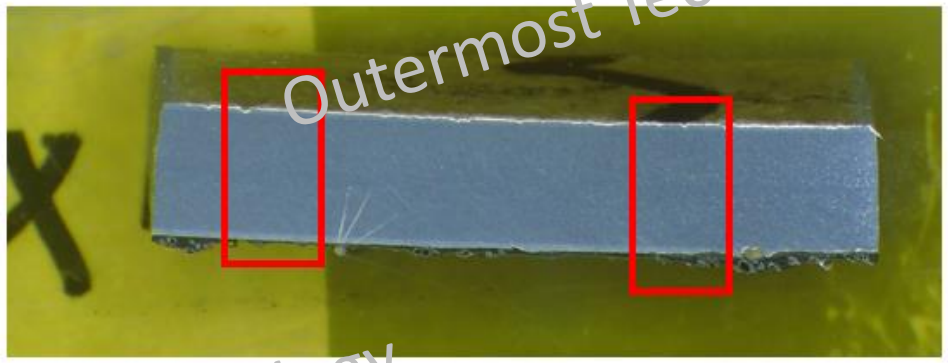
#1 Sample



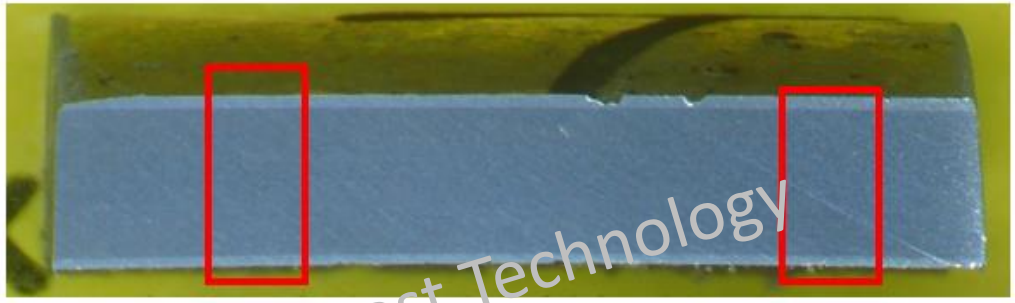
#2 Sample



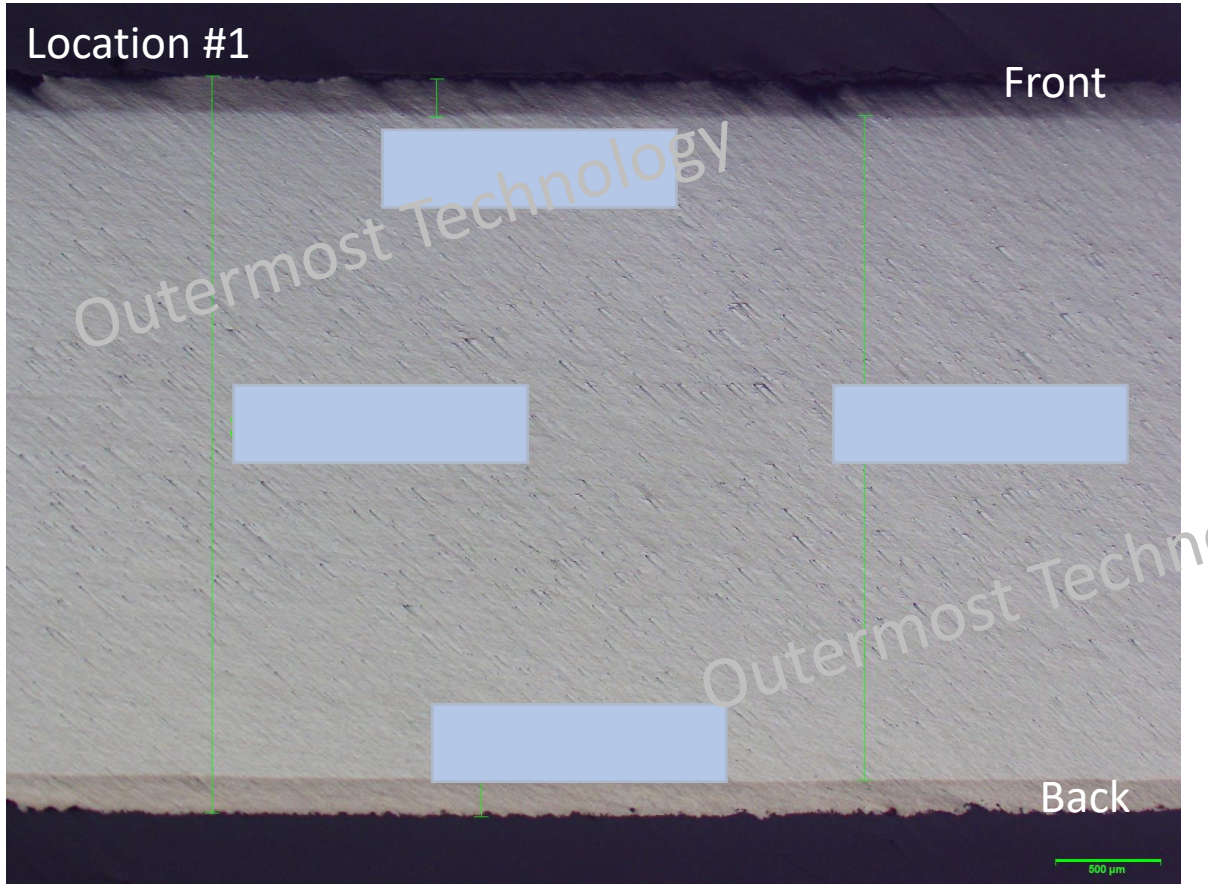
#3 Sample

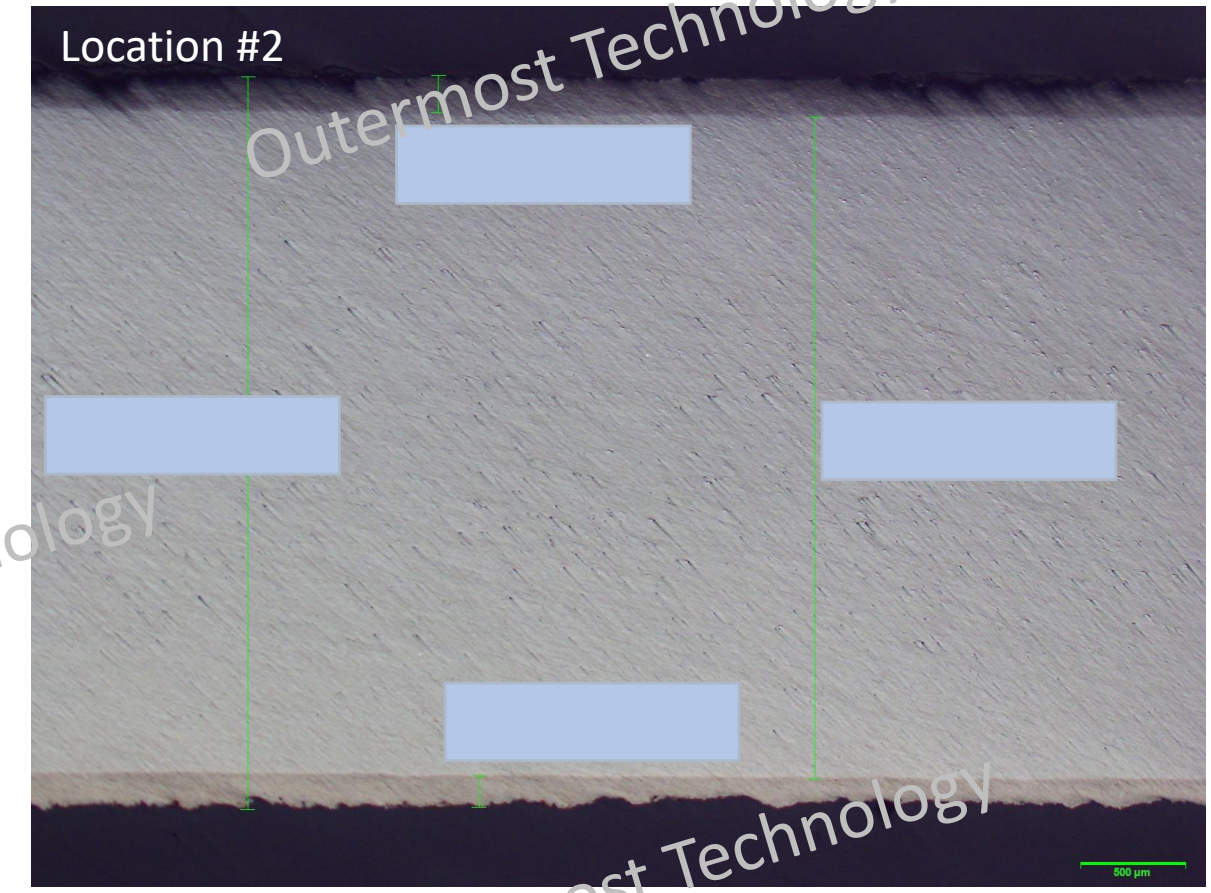


#4 Sample



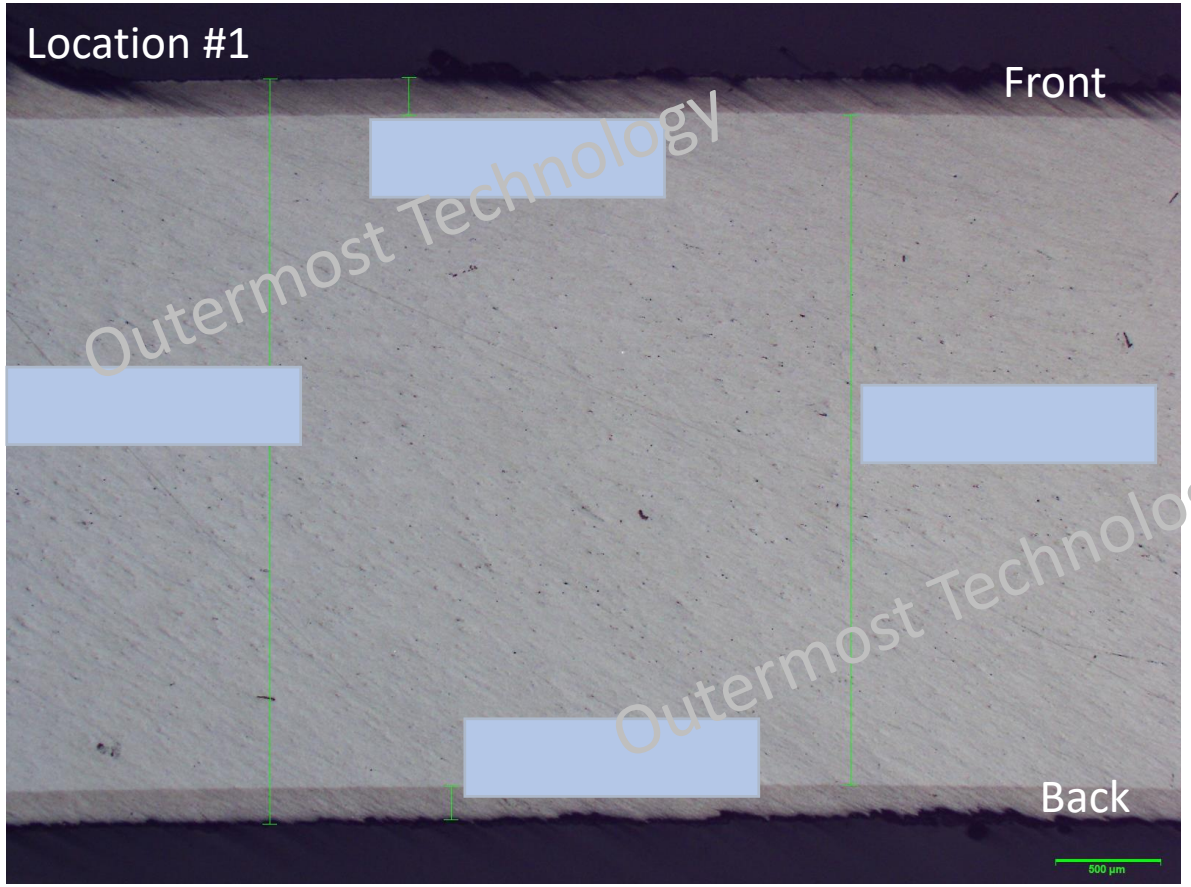
Thickness Measurement – Bottom, #1

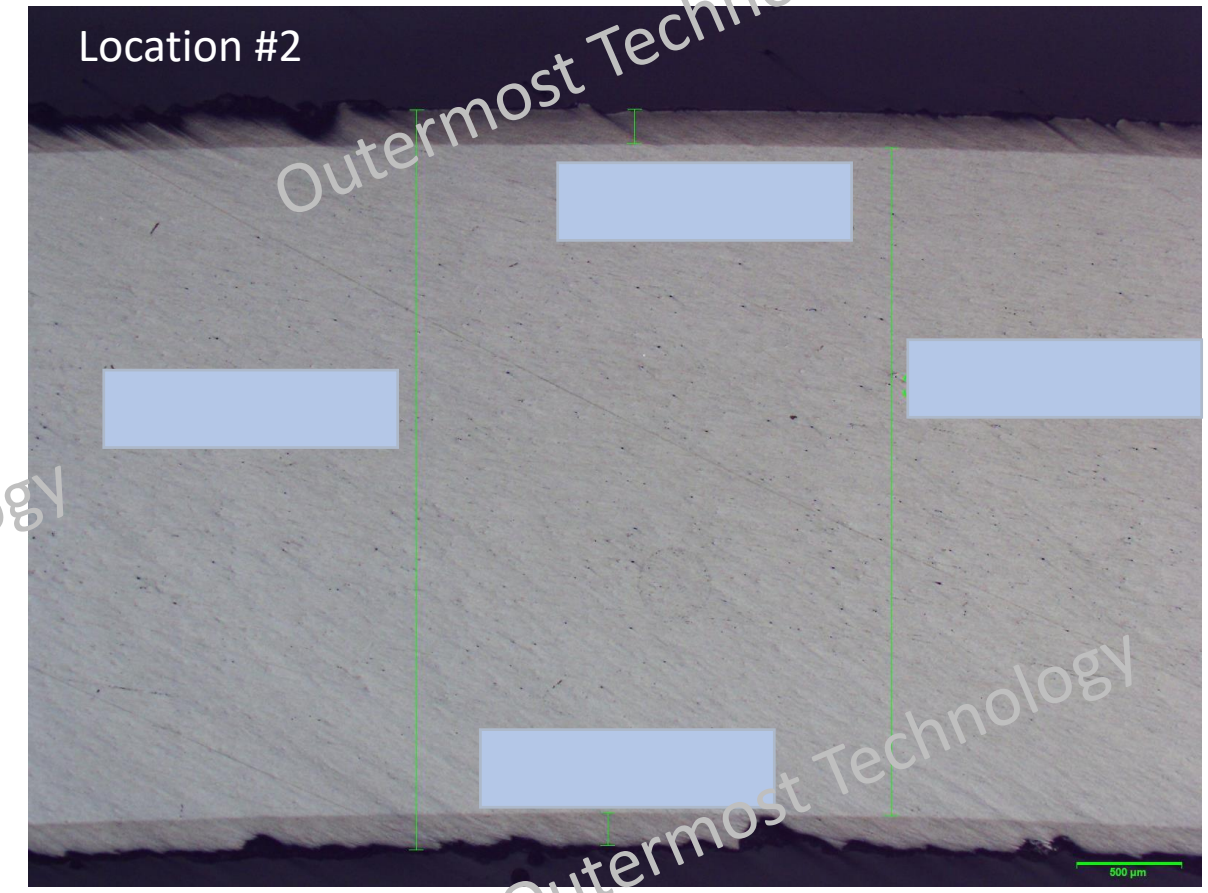




Bottom, #1				
Location	Total (um)	Al-Buik (um)	Zn-Enriched-Front (um)	Zn-Enriched-Back (um)
1				
2				
Average				
Stdev				

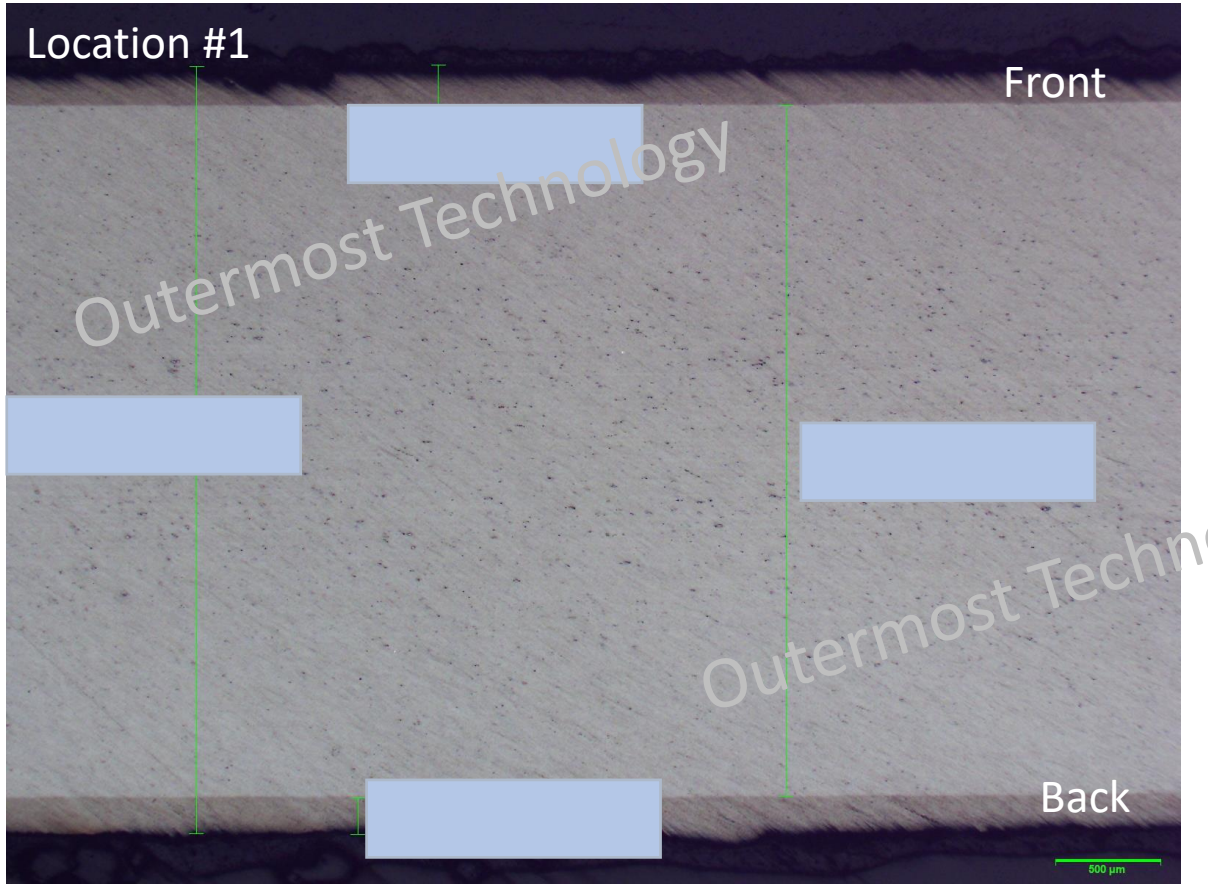
Thickness Measurement – Bottom, #2

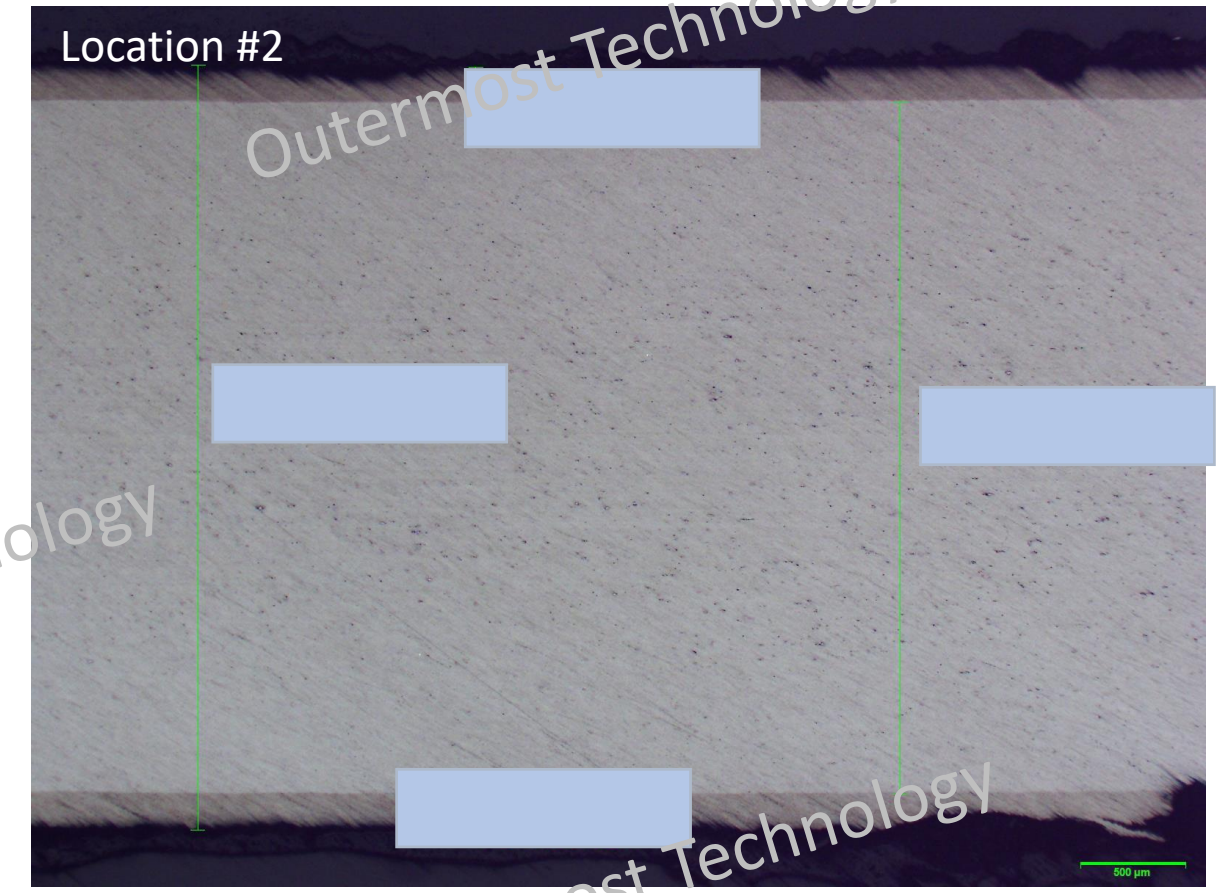




Bottom, #2				
Location	Total (um)	Al-Buik (um)	Zn-Enriched-Front (um)	Zn-Enriched-Back (um)
1				
2				
Average				
Stdev				

Thickness Measurement – Bottom, #3





Bottom, #3				
Location	Total (um)	Al-Buik (um)	Zn-Enriched-Front (um)	Zn-Enriched-Back (um)
1				
2				
Average				
Stdev				

Thank you!

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