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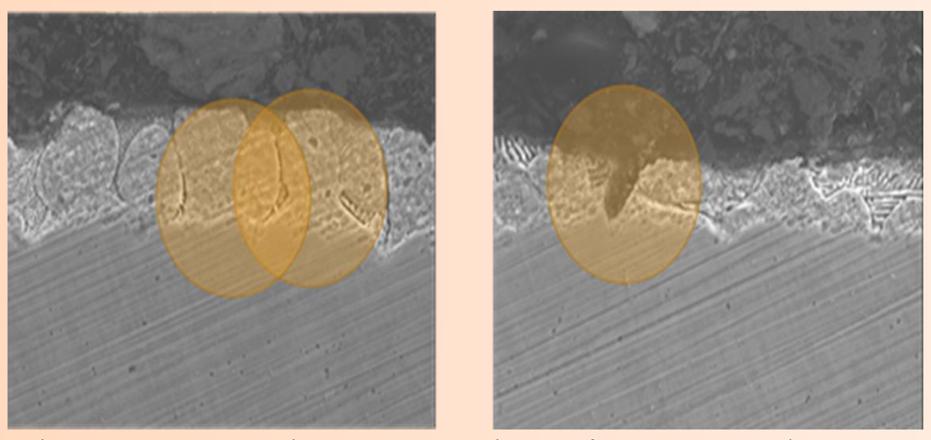
Improving Serviceability of Zinc Aluminium Magnesium Coating

The effect of cracking as a function of coating weight

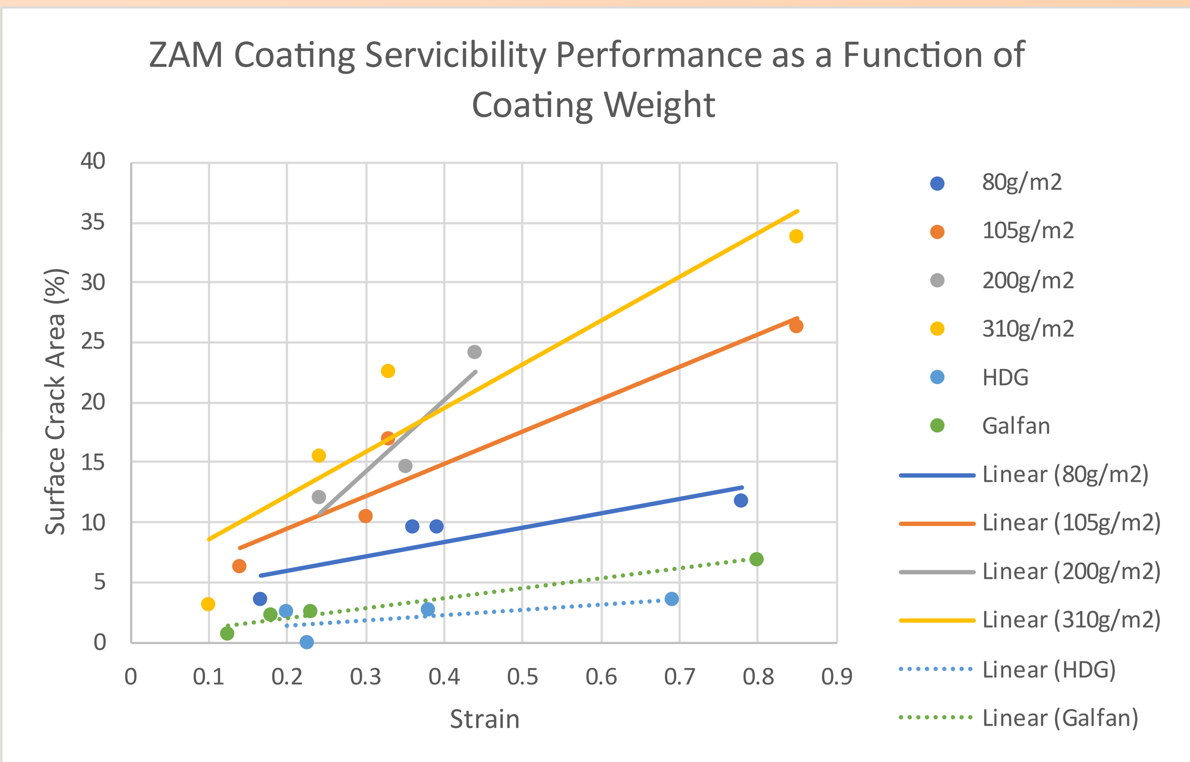
Background Information

It is understood that the binary eutectic phase of Zinc, Aluminium, Magnesium (ZAM/ZMA) coating is relatively brittle and is predominantly the genesis of cracks when coated sheet material, as highlighted in Figures 1 and 2. The cross-sectional images were taken from a ZAM coated sample that had been folded 180°, otherwise known as a 0T Bend. A greater understanding was required to understand the permissible strain of ZAM and whether coating weight influenced cracking. Four coating weights of ZAM have been strained since: 80g/m², 105g/m², 200g/m²0, 310g/m². Incremental bending strain has been applied to each of the four coating weights, before quantitative image analysis was undertaken.



Figures 1 & 2: Binary cracking of ZAM coating

Does coating weight influence cracking?



The graph compares the various cracked coating samples against applied bending strain. It's worth noting that bending strain is considerably greater than uniaxial strain. Trend lines indicate that generally, surface area and rate of cracking increases with ZAM coating weight when strained.

Corrosion Testing Constraints and Methodology

The SVET probe should ideally be positioned perpendicular to the surface. Research has identified that the accuracy of results is diminished as the probe is inclined to the surface. A maximum of 30-degrees to the sample surface has been recommended. Therefore, a maximum 45-degree bend has been used to compare cracking and subsequent corrosion resistance. A 6mm x 6mm coated surface area was exposed to 1%NaCl electrolyte.

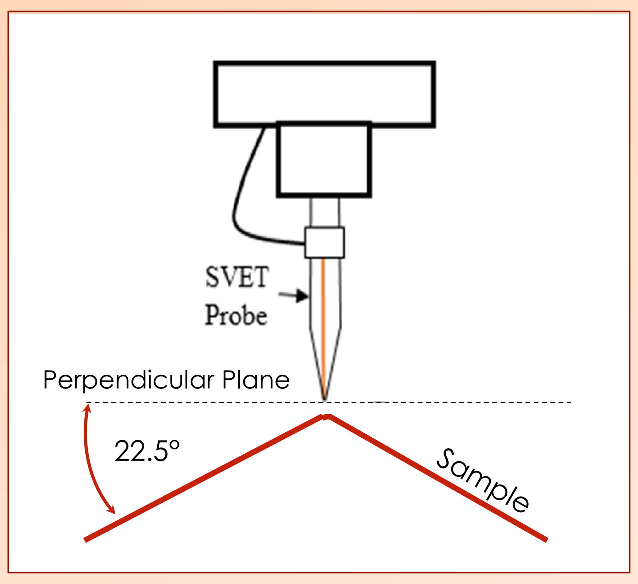


Figure 3: SVET schematic

What effect does cracking have on corrosion resistance?

After presenting the effects of surface cracking as a function of coating weight, shown above; further research was identified to understand how the cracking affected corrosion resistance. Subsequent electrochemical testing was undertaken of the bent samples to measure and compare the corrosion resistance properties. These samples were also compared to flat samples. Image analysis was used to quantify both strain and surface cracking of the samples. For the purposes of this research, the heaviest and lightest coating weights where analysed. Table 1 provides a summary of the results. It can be seen that the heavier coating weight cracked more at a similar elongation.

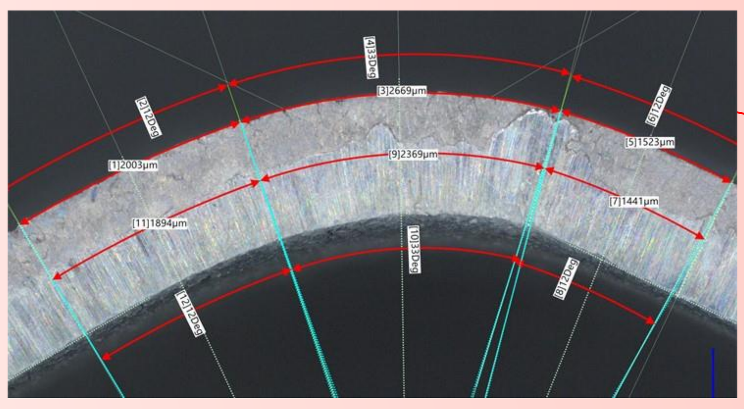


Figure 4: Bending strain measurement

Figure 5: SVET measurement

ZAM-80

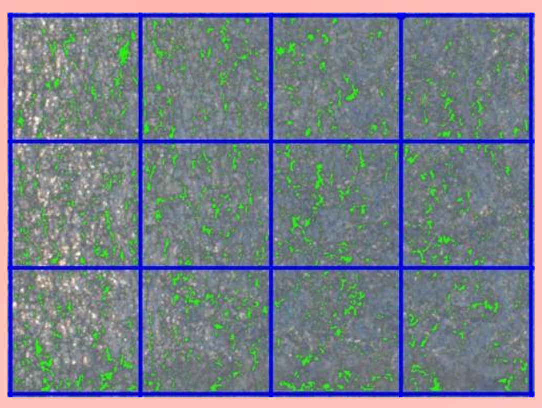


Figure 6: 80g/m² surface cracks

ZAM-310

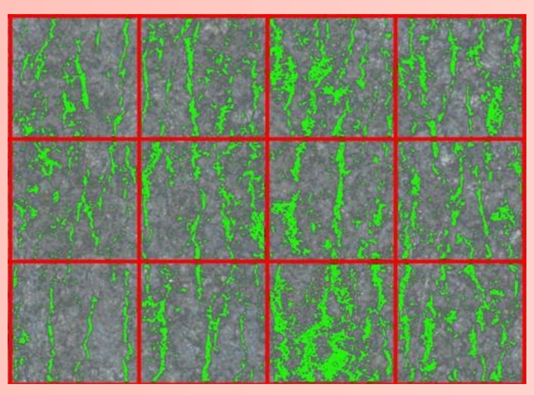
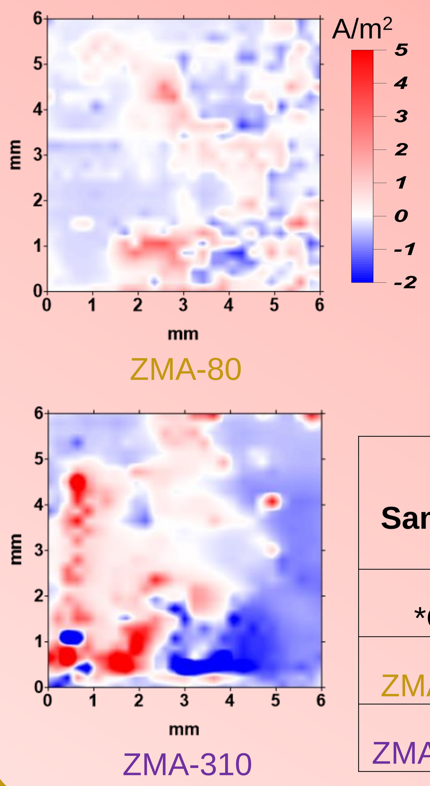


Figure 7: 310g/m² surface cracks

Table 1: Summary of results

Sample	Surface Elongation (%)	Crack Surface area (%)
ZMA-80	12.7	3.1
ZMA310	12.4	9.6

Scanning Vibrating Electrode Technique Results



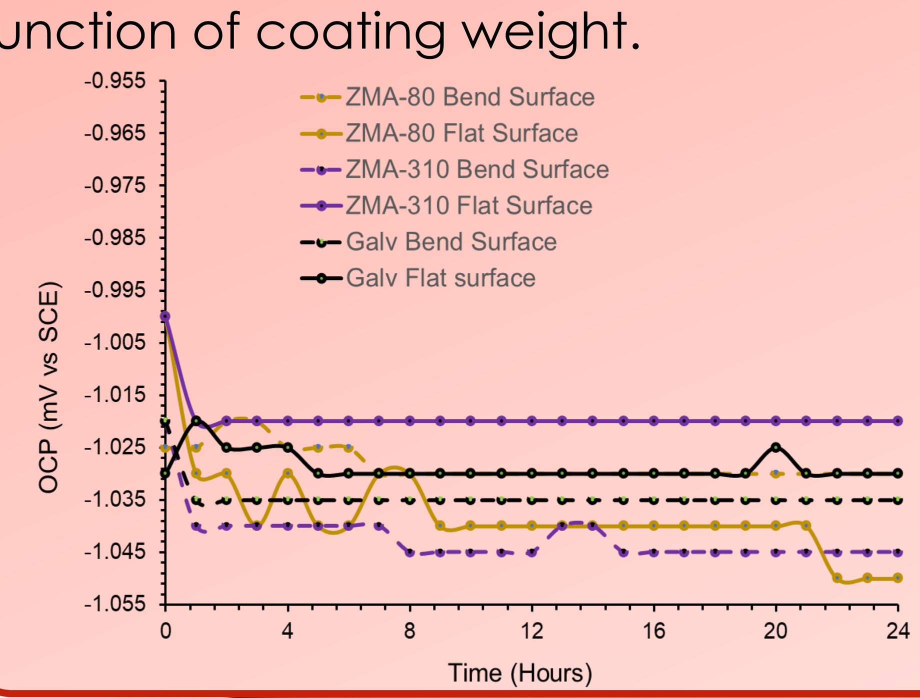
SVET testing was undertaken using the two samples and results were complied over a 24-hour period. The results have been presented and demonstrate that the metal loss due to corrosion is greater with each bent sample.

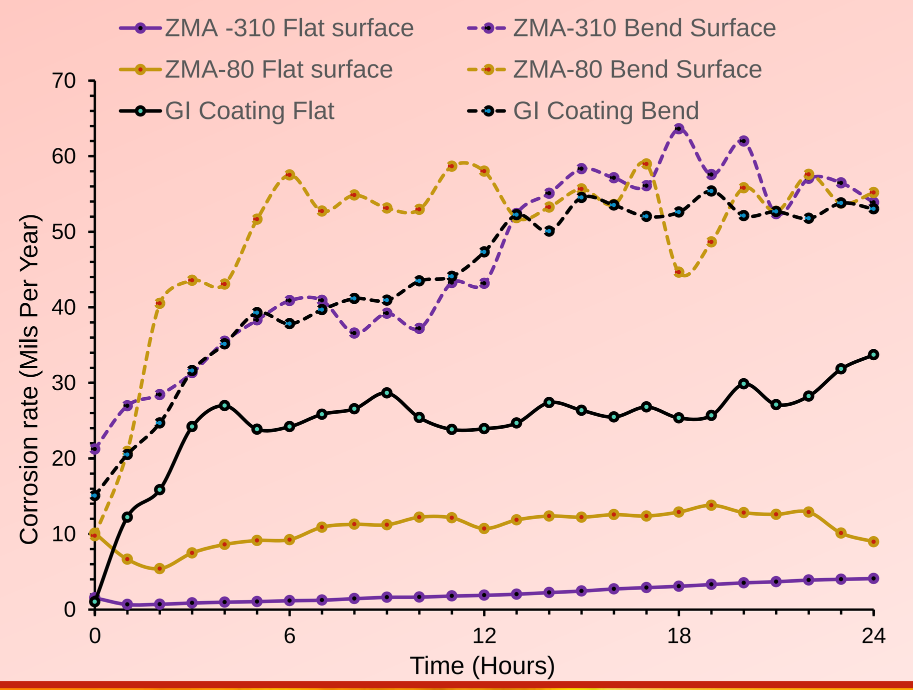
Table 2: Metal loss results summary

Sample	Flat Surface ($g.m^{-2}$)	45° Bend Surface ($g.m^{-2}$)	Increase in metal loss (%)
*GI	7.24	9.89 ± 0.34	36.60
ZMA-80	6.69 ± 1.75	11.39 ± 3.50	70.25
ZMA-310	2.40 ± 1.15	9.17 ± 0.41	282.08

Corrosion Thermodynamics and Kinetics Results

Open Circuit Potential and Linear Polarised Resistance test results show that the bent samples have a higher corrosion potential and rate of corrosion as a function of coating weight.





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