A New Sacrificial Corrosion Protection Mechanism for High Performance Zinc/Aluminum Flake Coating Systems and Applications

Shusaku Ishikawa
Senior Technical Manager, Engineering
Yuken America Inc.

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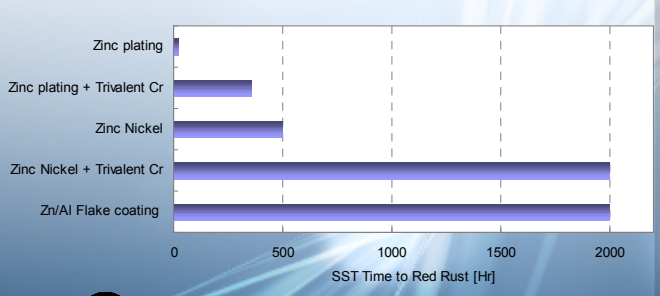
Introduction

Zinc/Al Flake Coating with High Corrosion Protection Performance

→ Popular in Automotive and Construction Industries



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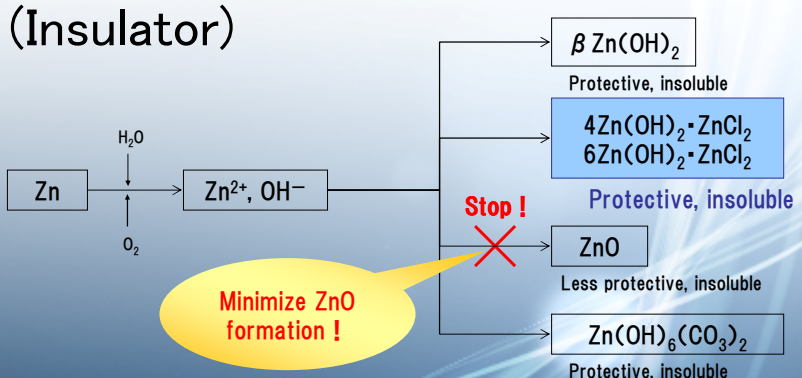
Important to Form Basic Zinc Chloride (Insulator)



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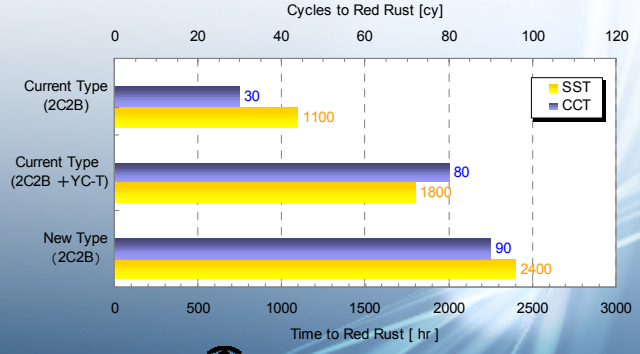
Introduction

Investigation:

Corrosion Product on Coating Film

Relationship with Corrosion Resistance

New & Current Product Comparison



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Experiment (Sample)

■Test Samples

Table 1. Summary of Zinc/Aluminum Flake Coating Systems

Sample	Base Coat		Top Coat	
	Main Components	Thickness [μ]	Main Components	Thickness [μ]
B-1	Zn, Al, Si	8 - 10	No topcoat	-
B-1 + T	Zn, Al, Si	8 - 10	Si, O	1 – 2
B-2	Zn, Al, Si	8 - 10	No topcoat	-
Zn-Ni Alloy	Zn, Ni (17%)	8 - 10	No topcoat	-

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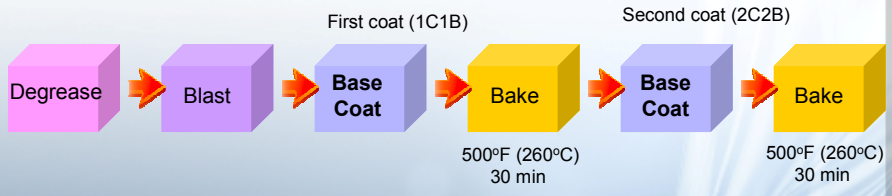
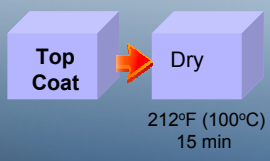
Experiment (Process)

■Coating Process of Base Coat



■Top Coat Process



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Experiment (Evaluation)

■Corrosion Protection Evaluation

1) CCT:

Salt spray (5% NaCl, 50℃) 17 hrs → dry (70℃) 3 hrs → salt spray (5% NaCl, 50℃) 2 hrs → natural dry (25℃) 2 hrs

2) SST: 5% NaCl, 35℃

3) Salt water immersion test: 5% NaCl, 25℃, exposed to the atmosphere

■Corrosion Product Evaluation

X-ray diffractometry (XRD)

■Surface Condition Evaluation

SEM-EDS

■Time-Dependent Changes in Natural Potentials

Natural potentials measured in 5% NaCl solution

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Results and Discussion (Corrosion Resistance) - CCT -

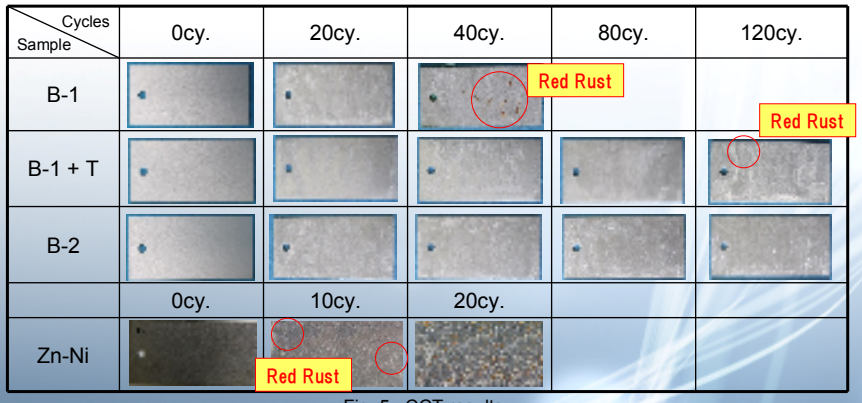

Fig. 5. CCT results

Corrosion Resistance: B-2 > B-1+T > B-1 > Zn-Ni

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Results and Discussion (Corrosion Resistance)
- SST -

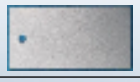
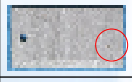
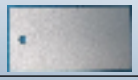
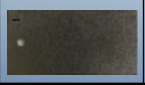
Hours / Sample	0h	1000h	1500h	2000h	2500h
B-1			 Red Rust		
B-1 + T				 Red Rust	
B-2					
	0h	250h	500h		
Zn-Ni			 Red Rust		

Fig. 7. SST results

Corrosion Resistance: B-2 > B-1+T > B-1 > Zn-Ni

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Results and Discussion (Corrosion Resistance)
- NaCl Immersion Test -

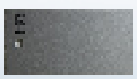
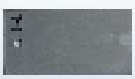
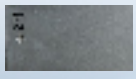
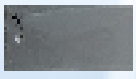
Hours / Sample	0h	24h	240h	480h	720h
B-1					
B-1 + T					
B-2					
Zn-Ni					

Fig. Salt water immersion test results

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Results and Discussion (XRD NaCl Immersion Test)

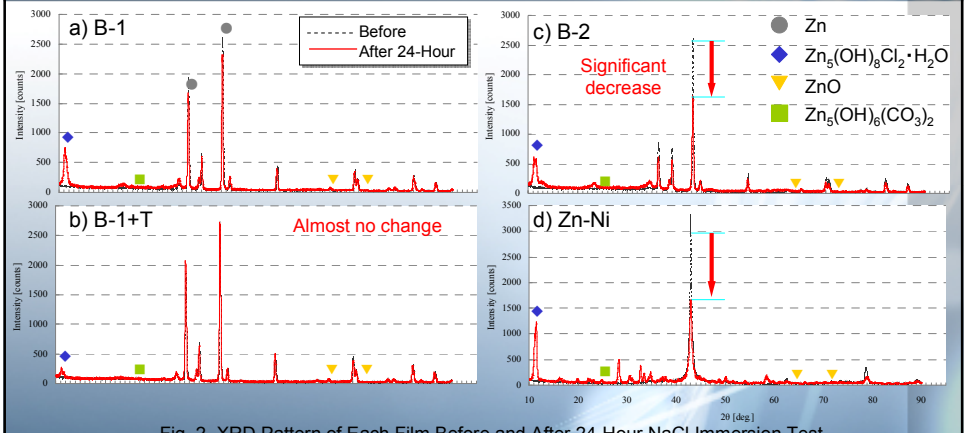

Fig. 2. XRD Pattern of Each Film Before and After 24-Hour NaCl Immersion Test

Basic Zinc Chloride Was Mainly Formed in B-1, B-2 and Zn-Ni.

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Results and Discussion (XRD Intensity Changes) - NaCl Immersion Test -

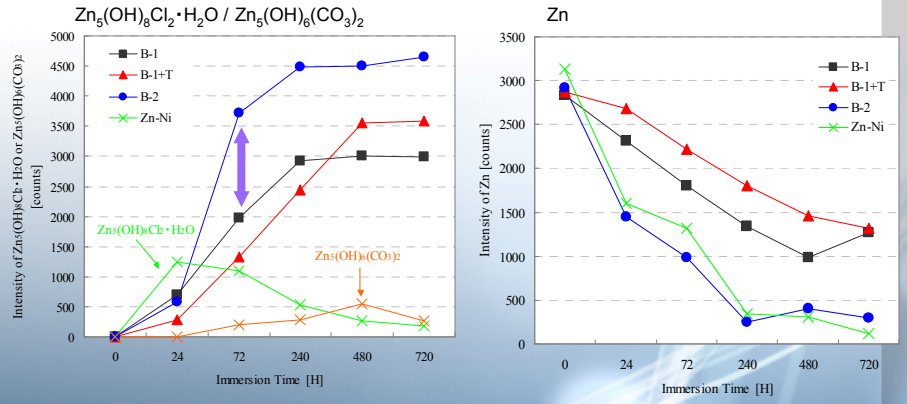

Fig. 4. XRD Intensity Changes of Corrosion Product and Zinc (NaCl Immersion Test)

Basic Zinc Chloride Intensity Change:
B-2 > B-1 > B-1+T > Zn-Ni

Results and Discussion (XRD Intensity Changes) - CCT -

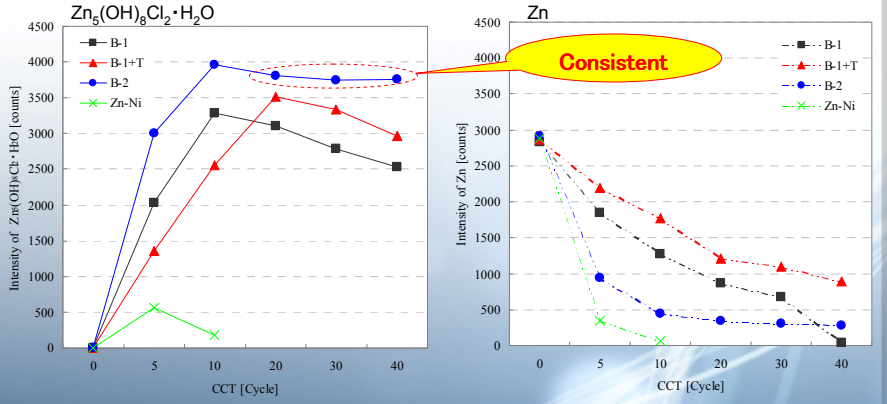

Fig. 6. XRD Intensity Changes of Corrosion Product and Zinc (CCT)

Basic Zinc Chloride Intensity Change: B-2 > B-1 > B-1+T > Zn-Ni

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Results and Discussion (XRD Intensity Changes) - SST -

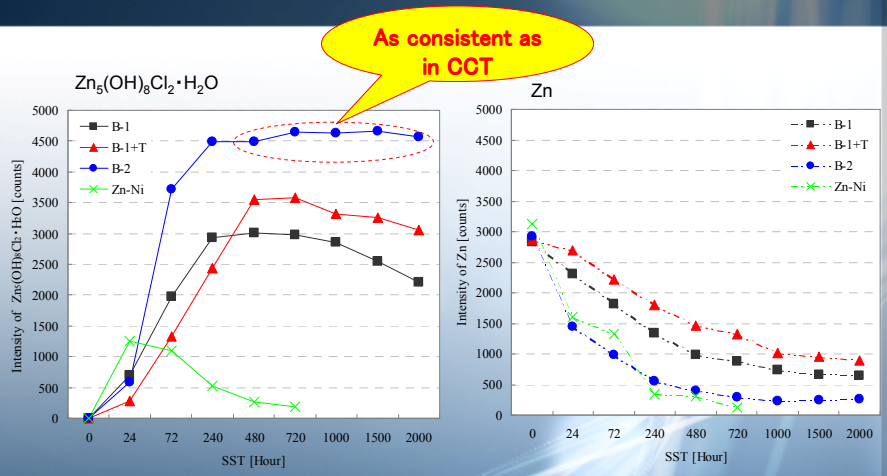

Fig. 8. XRD Intensity Changes of Corrosion Product and Zinc (SST)

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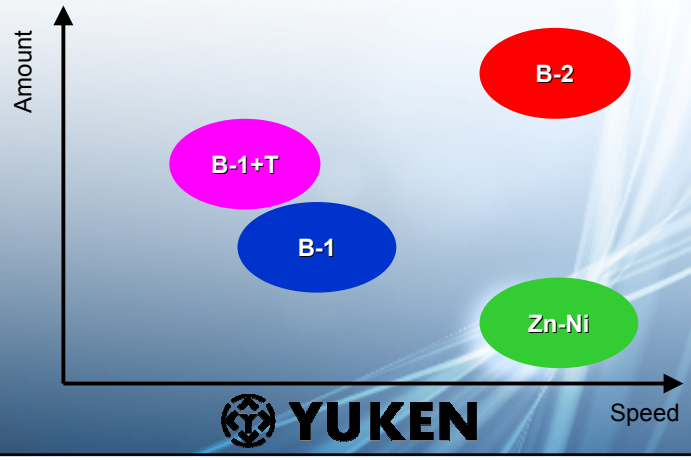
XRD Trends in Salt Water Immersion Test

■ Basic Zinc Chloride Formation on Each Film in Immersion Test



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Results and Discussion (SEM Image)

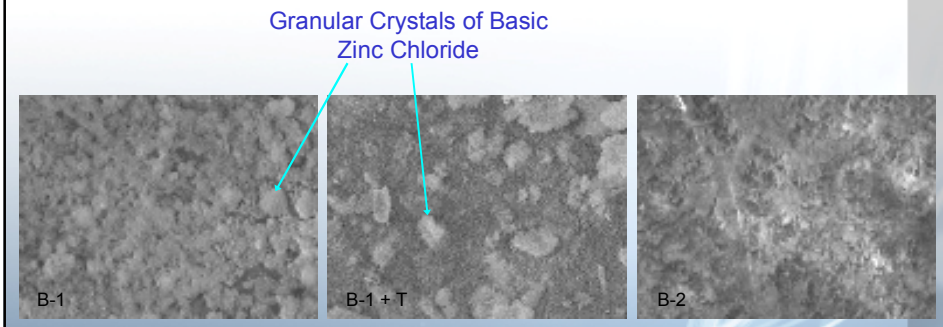

Fig. 9. SEM Image of Each Film After 240-Hour SST

Granular Crystal Ratio: B-1 > B-1+T > B-2

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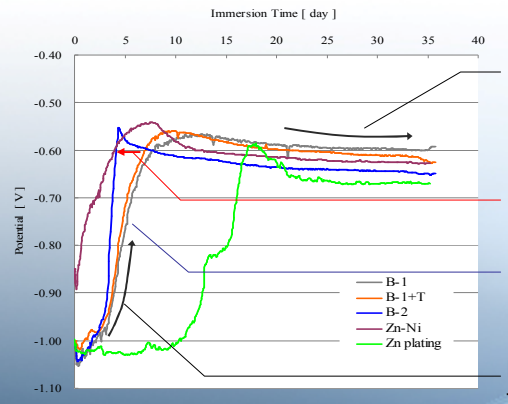
Results and Discussion (Natural Potential)



Potential was stable with basic zinc chloride.

B-2 formed basic zinc chloride at early stage.

Characteristic in between Zn-Ni & Zn plating

Potential increased with formation of basic zinc chloride.

Fig. 10. Time-Dependent Change in Natural Potential of Each Film

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Results and Discussion (Pattern Diagram)

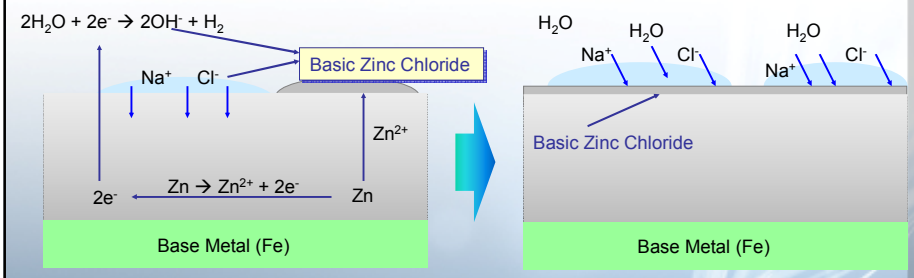

Fig. 11. Corrosion Protection Mechanism of Zn/Al Flake Coating

Corrosion Reaction Controlled by Basic Zinc Chloride

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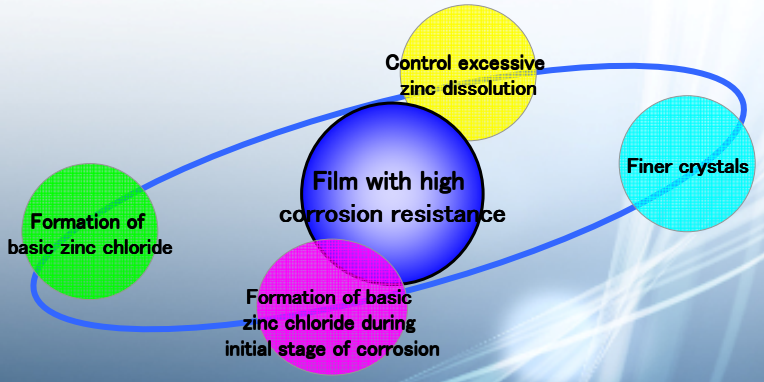
Summary

■ Important Factors for Achieving High Corrosion Resistance



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Thank you for your attention!

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