CORROSION TECHNICAL BULLETIN 6

BLUESCOPE

AUGUST 2013 | Rev 4

This issue supersedes all previous issues

Development of aluminium/zinc/magnesium alloy coating for next generation ZINCALUME® steel with Activate™ technology

INTRODUCTION

In 2013, after 17 years of testing and development, BlueScope Steel introduced its patented Activate™ technology. This technology is used in the coating of next generation ZINCALUME® aluminium/zinc/magnesium alloy coated steel ("AM") and next generation COLORBOND® prepainted steel to make them more durable and more resilient than the established ZINCALUME® aluminium/zinc alloy coated steel ("AZ") and the established COLORBOND® steel products.

PURPOSE

As AM supersedes AZ from August 2013, the purpose of this Technical Bulletin is to outline the primary differences between AM and its predecessor AZ. A wide variety of test methodologies have been used for assessing and understanding accelerated and long-term coated steel performance and durability. These methods are also briefly introduced.

AZ VS. AM

AZ had been manufactured by BlueScope Steel since 1976. The coating composition of AZ was approximately 55% aluminium, 1.5% silicon and the balance zinc.

AM provides performance benefits as a result of coating structure and composition changes that facilitate enhanced durability in most environments. The coating composition of AM is approximately 55% aluminium, 2% magnesium, 1.5% silicon and the balance zinc.

COATING STRUCTURE

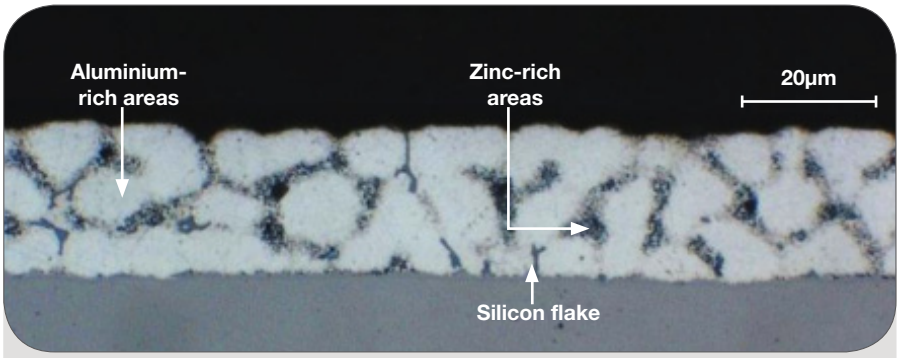
The microstructure of the AZ coating typically consists of aluminium-rich areas (dendrites) in a zinc-rich matrix (interdendritic regions). Needle-like particles of silicon are also present within the zinc-rich regions. A thin alloy layer of Zn-Al-Si-Fe is formed at the steel interface which bonds the coating to the base steel.

The microstructure of the AM alloy coating also contains aluminium-rich areas in a zinc-rich matrix. However, the zinc-rich region also contains fine particles of magnesium-zinc ($MgZn_2$) and magnesium silicide (Mg_2Si). Careful process control ensures that most of the magnesium silicide is positioned towards the bottom portion of the coating layer (close to the base steel), while most of the magnesium-zinc is positioned towards the top portion of the coating layer. This positioning is an important factor in enabling the improved corrosion resistance of the AM coating.

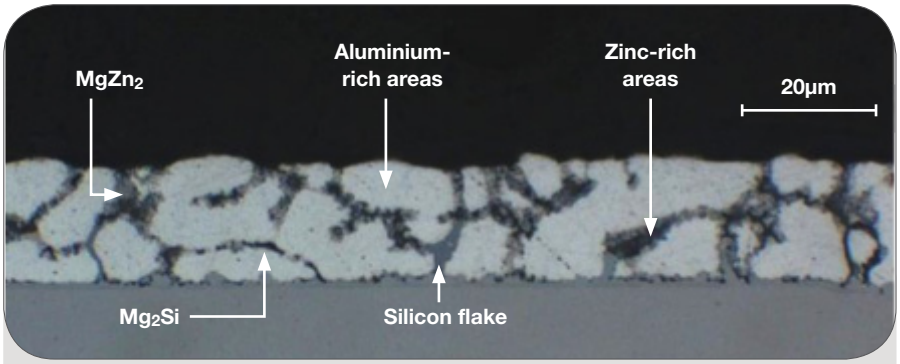
CORROSION PROTECTION MECHANISMS

A key purpose of the metallic coating on any coated steel product is to protect the base steel against corrosion. The AM coating protects the base steel more effectively than AZ because it uses more efficient corrosion protection mechanisms. This is illustrated in *Table 1*.

Figure 1: Typical microstructures of AZ and AM coatings in cross-section.

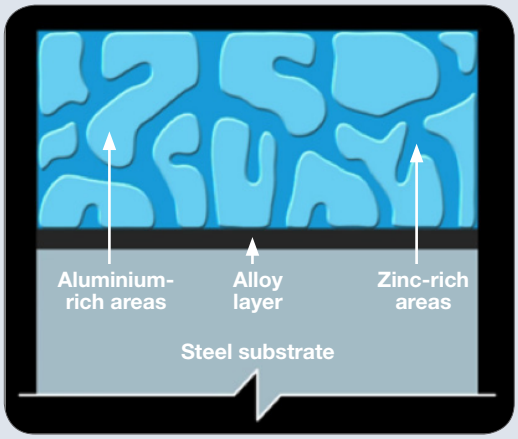
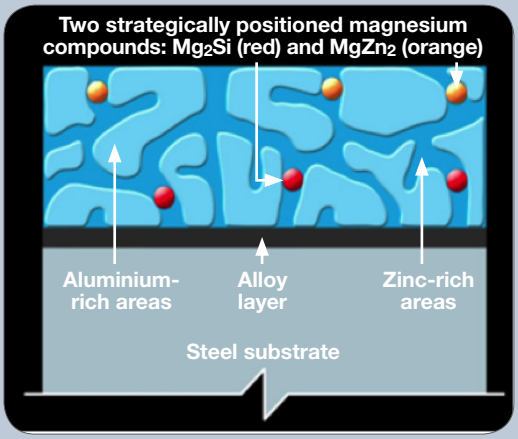
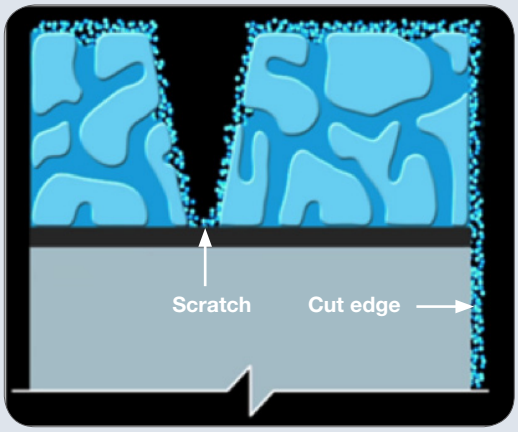
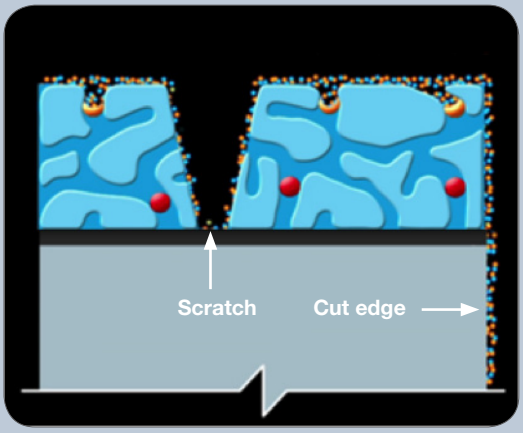
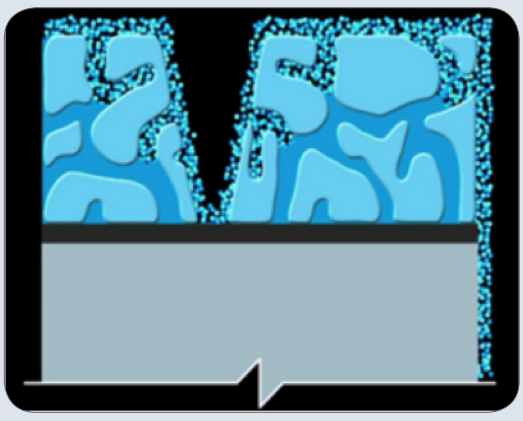
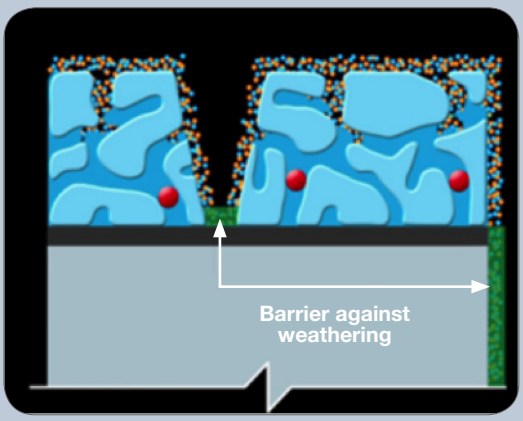


ZINCALUME® steel AZ150 (superseded)



Next generation ZINCALUME® steel AM125

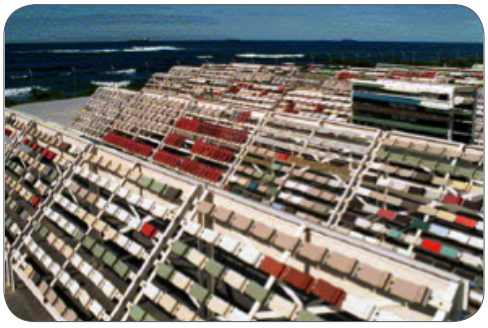
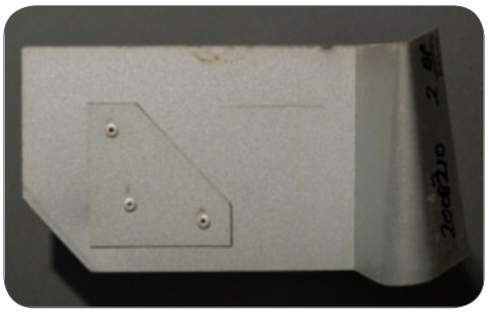
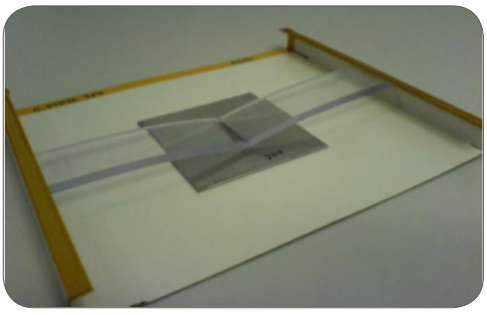
Table 1: Comparison between corrosion protection mechanisms of AZ coating and AM coating over a period of time.

ZINCALUME® aluminium/zinc alloy coated steel (superseded)	***Next generation ZINCALUME® aluminium/zinc/ magnesium alloy coated steel with Activate™ technology***
1. The entire metallic coating firstly provides barrier protection to the steel.	*1. The entire metallic coating firstly provides barrier protection to the steel. Magnesium compounds ($MgZn_2$) are positioned in the metallic coating to activate at the start of weathering, when they are most vital for sacrificial protection.*
	
2. At cut edges and scratches, the zinc-rich interdendritic region, which is exposed to the atmosphere, corrodes preferentially providing sacrificial protection to the steel base. The resulting corrosion product then fills the cavities in the coating and inhibits further corrosion.	*2. At cut edges and scratches, corrosion of the zinc-rich interdendritic region provides improved sacrificial protection to the steel base due to the presence of the magnesium compound $MgZn_2$. Magnesium silicide (Mg_2Si) particles in the interdendritic channels act as additional barriers to slow corrosion and restrict corrosion pathways to the steel substrate.*
	
3. The aluminium-rich dendrites provide barrier protection while the zinc-rich region corrodes. Once the zinc-rich region has been exhausted, the aluminium-rich dendrites corrode slowly to provide some sacrificial protection.	*3. The aluminium-rich region is modified to provide improved sacrificial protection of the steel base and resist red rusting for longer in more severe environments. It is also more efficient, so less aluminium-rich region is consumed to provide the improved sacrificial protection.*
	

CORROSION ASSESSMENT & TESTING REGIME

BlueScope Steel has been active in the research, development and commercialisation of coating technologies over many decades. This has led to the development of expertise in assessing and understanding accelerated and long-term performance and durability of coated steel, as well as the relationship between these assessments. The scaled testing regime taken by BlueScope Steel allows assessment of various factors, including environmental influences and component specific phenomena, which can affect the life of coated steel. Examples of the test methodologies employed in the development of AM are included in *Figure 2*.

Figure 2: Examples of tests performed at various stages of assessment in a scale-up approach.

Test Stage	*Assessment Examples*	
1. Accelerated testing	*a) Panels in cyclic corrosion test* 	*b) Panels in continuous salt spray corrosion test* 
2. Standard outdoor	*a) Marine outdoor assessment site (Bellambi Point, Australia)* 	*b) Acid rain outdoor assessment site (Chengdu, China)* 
3. Sophisticated panels, including interaction assessment	*a) Sophisticated panel incorporating rivets, scribe marks, overlap panel and a 0T bend, allowing interactions and other factors to be assessed* 	*b) Dissimilar metals panel, with one metal held in contact with the coated steel and then exposed outdoors prior to assessment* 
4. Installed applications	*a) Assessment structure comprising various building components (Bellambi Point, Australia)* 	*b) Walling, roofing and garage door installed on functioning Coast Guard building (Lake Illawarra, Australia)* 

SUMMARY

BlueScope Steel has undertaken extensive research and testing in order to develop the AM coating for next generation ZINCALUME® steel with Activate™ technology and next generation COLORBOND® steel with Activate™ technology. The development process has resulted in a thorough understanding of the fundamental corrosion protection mechanisms of AM as well as its performance in a variety of service conditions and building applications. For more information on the performance of AM in service, please refer to **Technical Bulletin TB-10** *Cut edge and bend protection of next generation ZINCALUME® aluminium/zinc/magnesium alloy-coated steel and COLORBOND® prepainted steel with Activate™ technology.*

RELATED BLUESCOPE STEEL TECHNICAL BULLETINS

Technical Bulletin TB-10

Cut edge and bend protection of next generation ZINCALUME® aluminium/zinc/magnesium alloy-coated steel and COLORBOND® prepainted steel with Activate™ technology.

If you have any questions regarding this Bulletin, please contact BlueScope Steel Direct on 1800 800 789.

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