



Magnelis® Zinc Aluminum Magnesium Coated Steels for Solar Mounting Structures

Richard Clausius – ArcelorMittal Global R&D

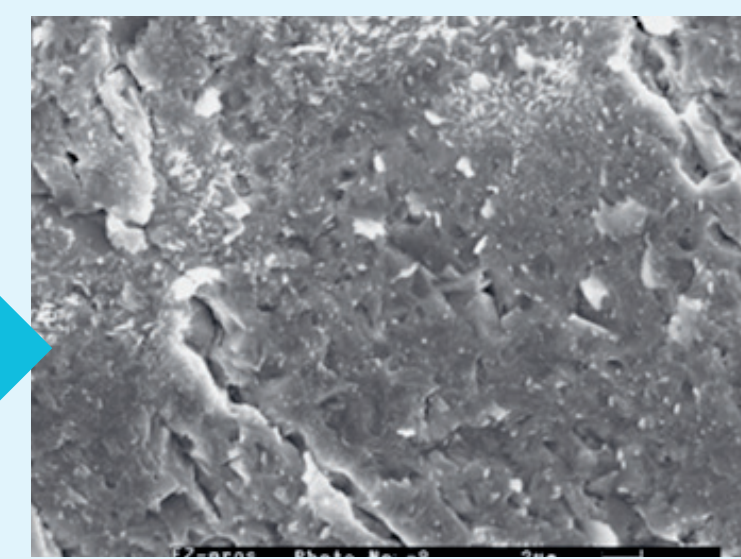
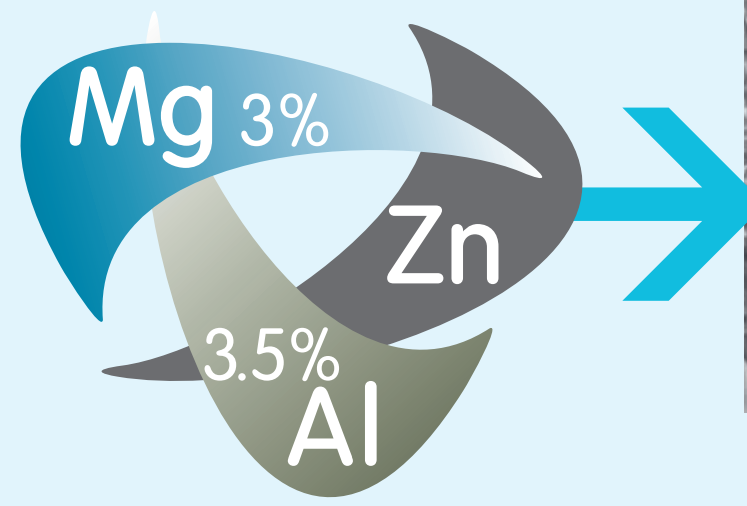
Goal

To show Solar Mounting Structures made of Magnelis® (Zinc Aluminum Magnesium) metallic coated steels offer **better corrosion protection/longer service life** and **better manufacturability** than equivalent galvanized steel coatings plus a **reduced environmental footprint** vs. stainless steel or aluminium.

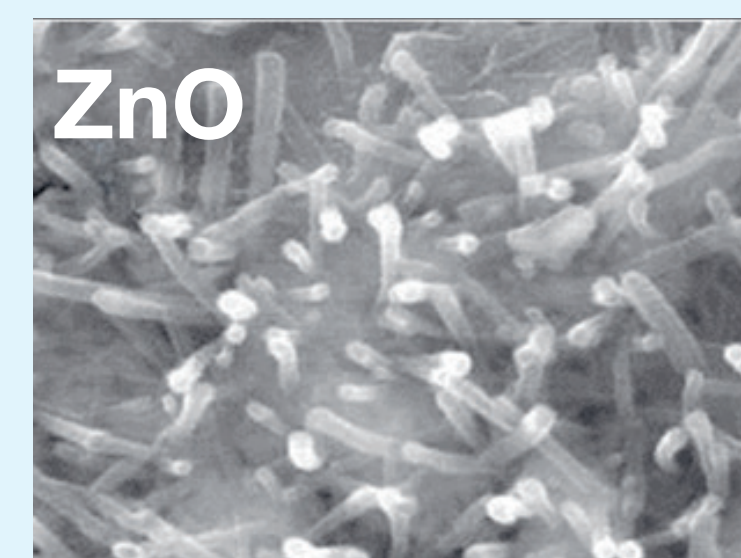
Results

Exceptional corrosion protection, the right composition.

- Zinc Aluminum Magnesium (ZnAlMg) coatings offer not only sacrificial, but barrier corrosion protection vs. only sacrificial corrosion protection with Galvanized (Zinc) coatings.
- 3% Magnesium (Mg) in the metallic coating ensures a stable barrier effect on the coating surface and significantly reduces the corrosion rate.
- 3.5% Aluminum (Al) helps develop stable compact corrosion products over a wide pH range.
- The Mg and Al in the Magnelis® coating results in the precipitation of compact and stable barrier corrosion products that strongly inhibits the oxygen reduction rate and therefore reduces the overall atmospheric and soil corrosion rates which results in longer service life than equivalent thickness Galvanized coatings.



Magnelis® – compact & stable structure

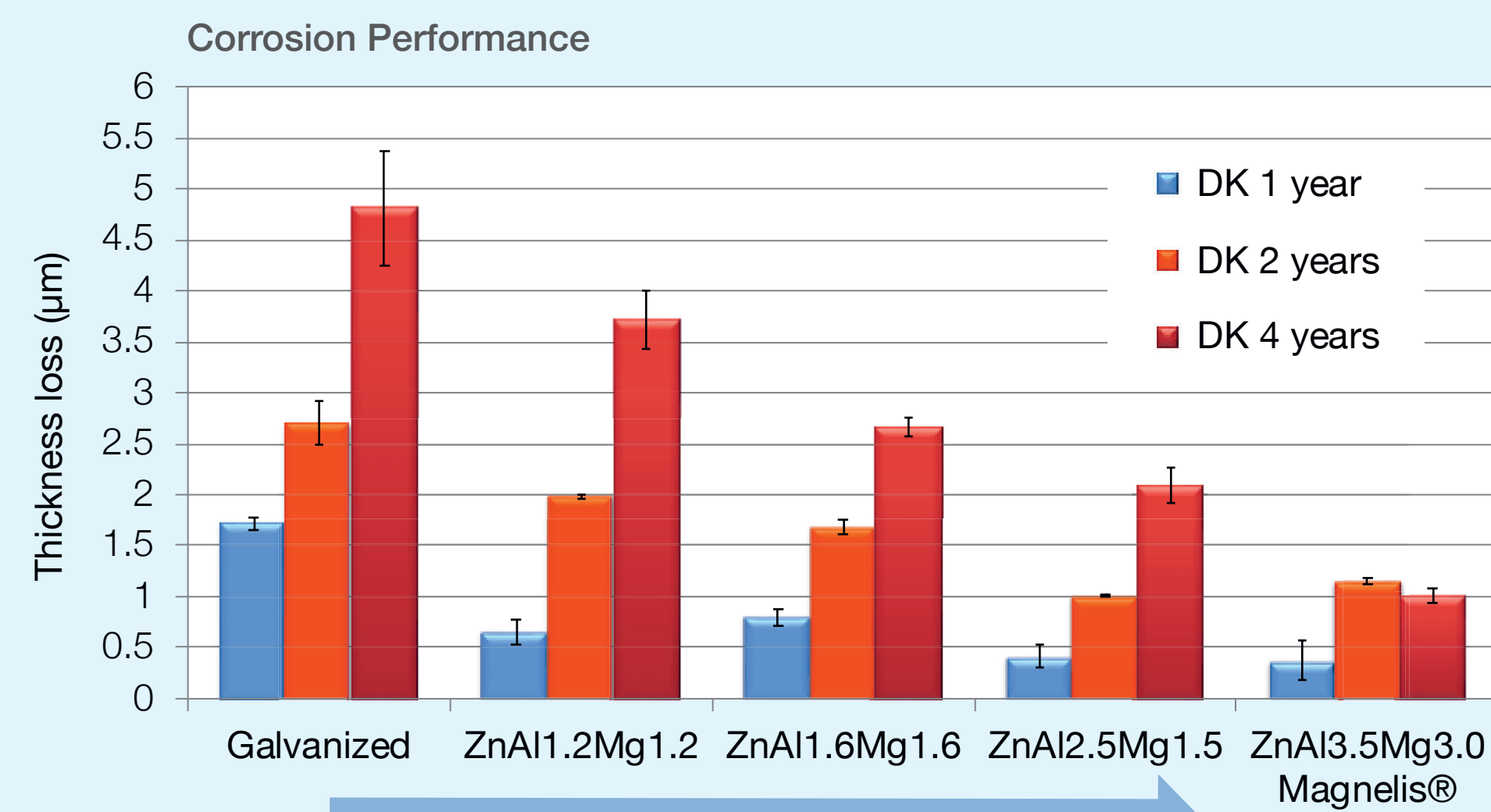


Galvanized – porous structure

Outdoor/seaside exposure in Dunkerque (DK), France (C3 rated)



- Coating mass loss at 1, 2, & 4 years
- Magnelis® composition shows better corrosion performance over lower alloy and pure zinc coatings.



Performance improvement

Cut edge performance

Magnelis® coating
steel substrate
red rust
white rust

3 mm thick steel structure, inland environment

Initial exposure period (up to several weeks)
The exposed cut end of the substrate is oxidised and forms red rust.

after 1 week

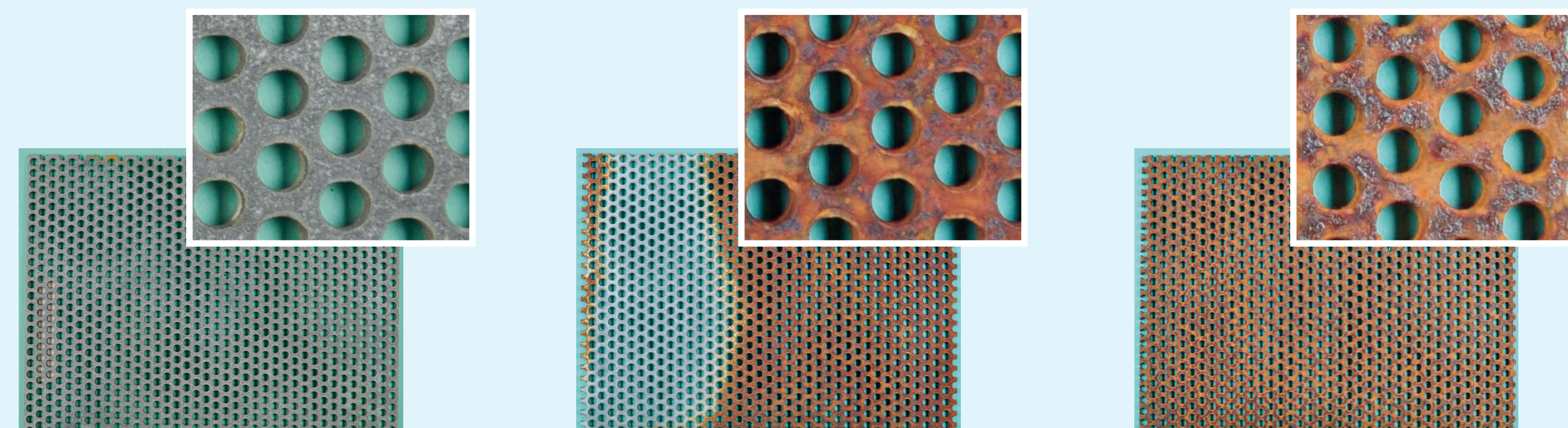
Subjected to rain and condensation

after 15 months
The zinc-based film containing magnesium on the coating layer migrates over the cut end.

after 25 months
Disappearing of red rust and increasing of white rust.

* Note: The speed of Magnelis® self-healing is affected by the environmental conditions. Corrosion and self healing of cut edges takes more time in less corrosive environments (ex. non-seashore)

2 mm thick R4T6 perforated panel C5 Marine environment after 5 years



Magnelis® 20 µm/side (ZMM250)

Galvanized 20 µm/side (G90 or Z275)

Galvalume 20 µm/side (AZ50 or AZM150)

- Magnelis® sample exhibit no red rust vs. significant surface and cut edge rust on Galvanized and Galvalume samples

Less coating needed and weld corrosion protection

1 day 24h SST 31/05/2011	8 days 192h SST 7/06/2011	17 days 408h SST 16/06/2011	29 days 696h SST 28/06/2011	Samples description
				↳ Magnelis® with 85% Zn-15% Al weld post coating
				↳ Magnelis® with Al weld post coating
				↳ Magnelis® without weld post coating
				↳ Galvanized without weld post coating
				↳ Galvanized with Al weld post coating

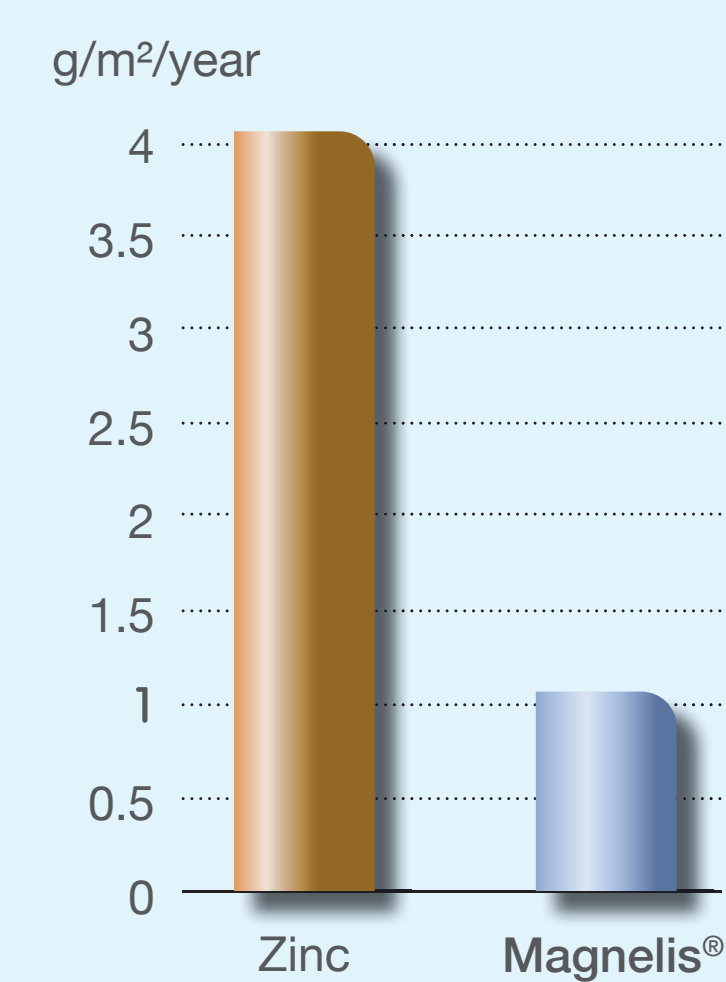
* Note: Samples were salt spray tested until they exhibited 5% Red Rust

- Magnelis® (10µm/side [ZMM120]) welded tubes are far more corrosion resistant than galvanized (20µm/side [G90 or Z275]) at half the metallic coating thickness while also offering self healing protection to the weld area.
- Magnelis® welded tubes without weld protection lasted 71 days and with weld protection 112 days (pictures not shown).
- The need for weld post coating depends on weld and heat affected zone size and metallic coating thickness.

Environmental benefits

Zinc runoff rate*

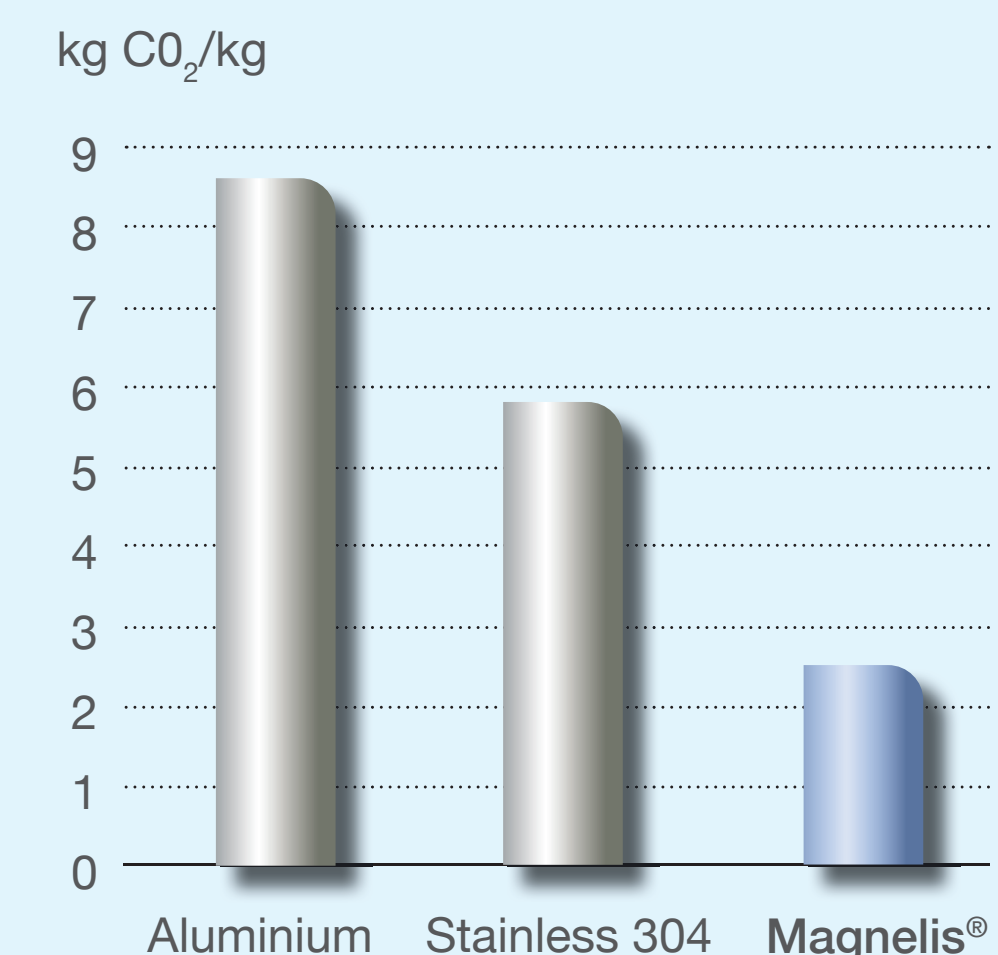
Magnelis® considerably reduces zinc runoff into soil.



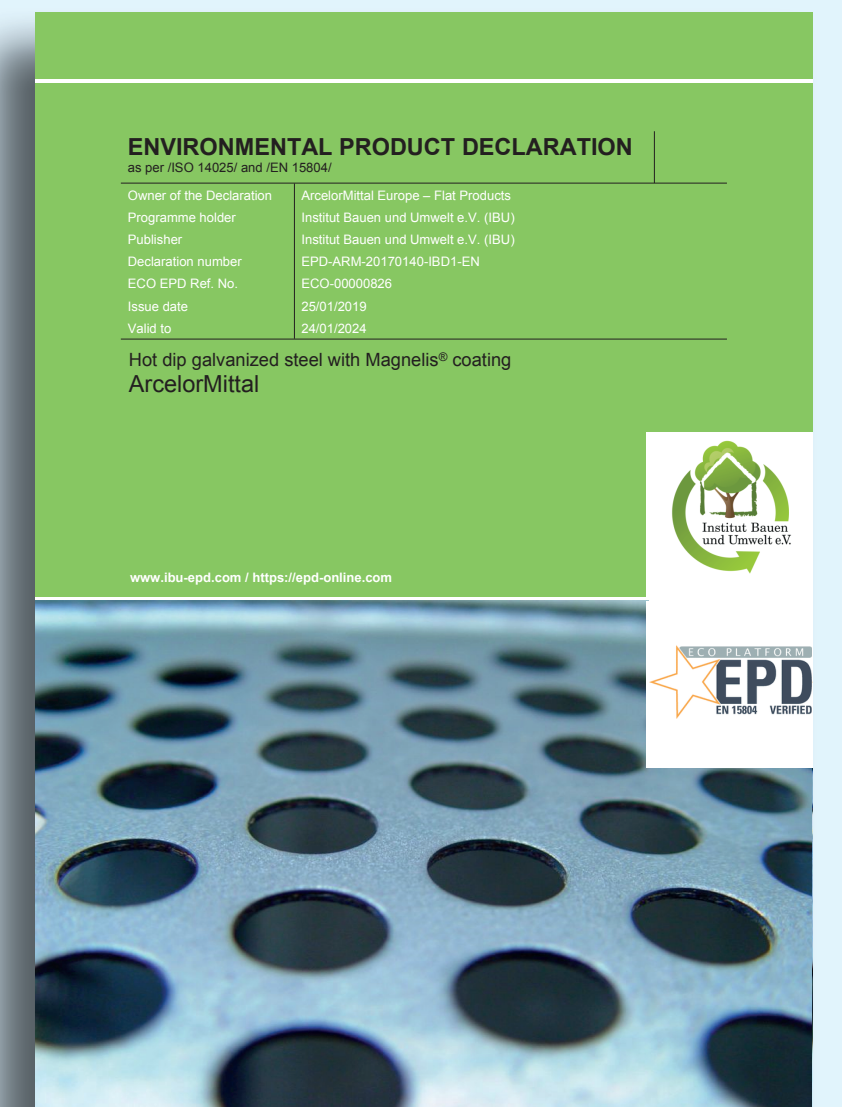
* the rate of dissolution of a material from its surface into the soil. Source: French Corrosion Institute

Production impact on CO₂ emissions

CO₂ emissions for the production of Magnelis® are much lower than for aluminium, a difference that is not compensated by aluminium during the use phase, even when aluminium parts are lighter than steel parts.



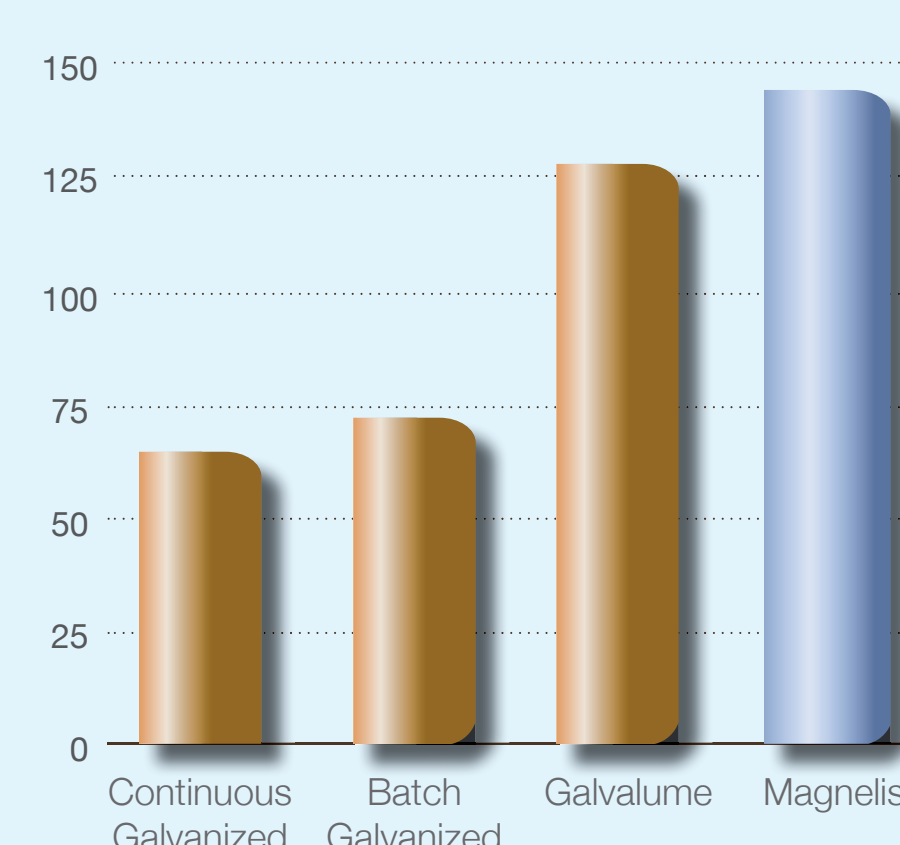
Sources: ArcelorMittal R&D, European Aluminium Association, World Steel Association, Eurofer



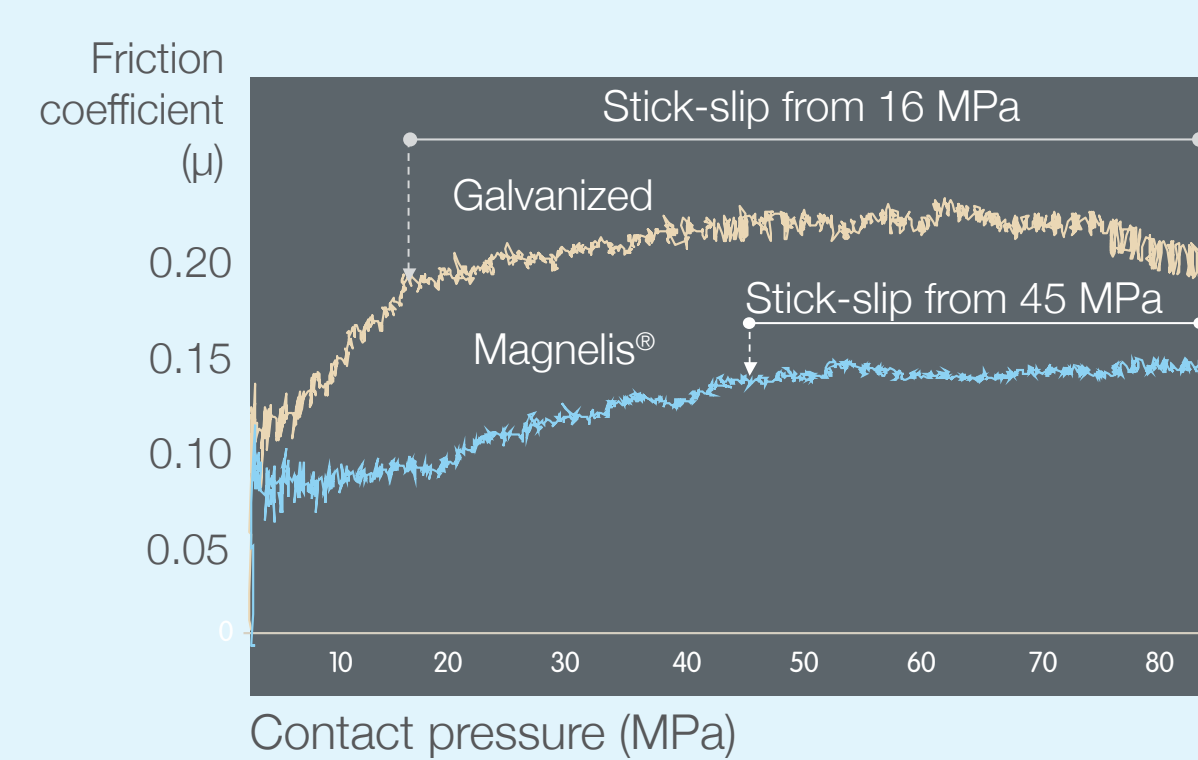
- At equivalent protection, Magnelis® uses less zinc and energy in production than pure zinc (Galvanized or Electroplated) coatings. Magnelis® also considerably reduces the amount of zinc runoff in soils or waters.
- Magnelis® production has a lower environmental impact (CO₂) compared to other highly durable materials such as stainless steel or aluminium.
- Magnelis® is 100% recyclable, does not contain any harmful elements, is REACH compliant, and an environmental product declaration (EPD) is available online.

Improved manufacturability

Metallic Coating - Hardness Vickers (HV)

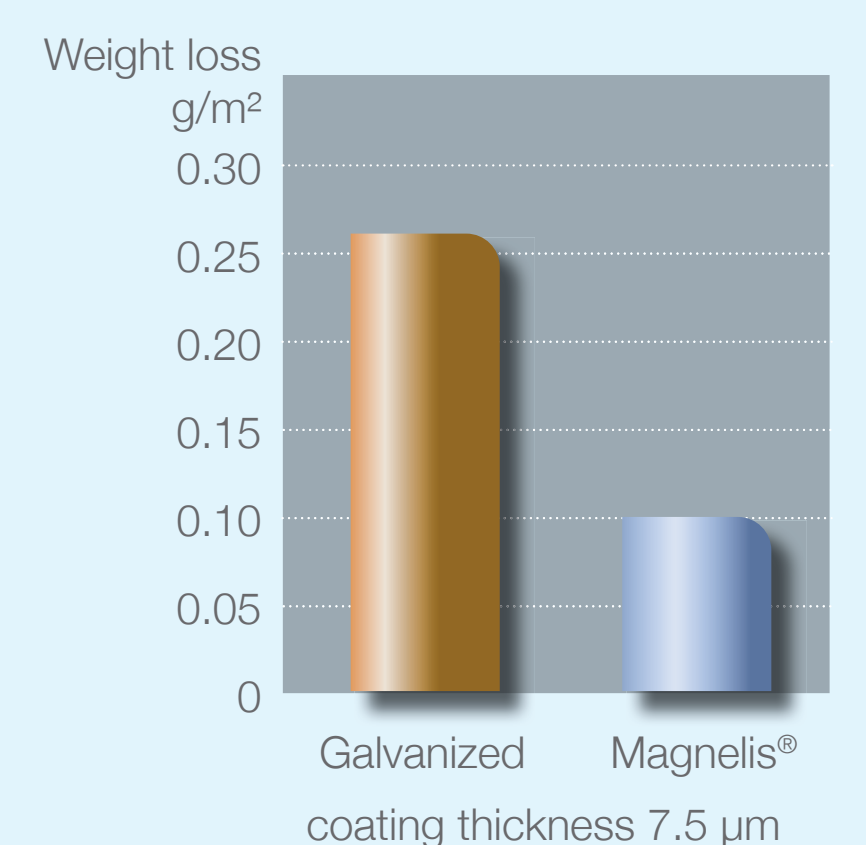


Coefficient of Friction Test*



* Note: Oil used Fuchs 4107S in excess

Powdering behavior*



- Magnelis® is a harder coating than Galvanized and Galvalume coatings offering more abrasion resistance.
- Even though Magnelis® is a harder coating, its low friction coefficient and low powdering behavior results in excellent drawing, rolling, bending & punching with less tool buildup.

Outcomes

Magnelis® (Zinc Aluminum Magnesium) metallic coated steels with their **exceptional corrosion protection, lower coating weight** requirements (for equivalent performance to Galvanized), **environmental benefits**, and **manufacturability** make them a great choice for the fabrication of racks, rails, framing, posts, tubes, mounting brackets, electrical cabinets, cable trays, cable brackets, & transmission towers used for fixed ground, trackers, rooftop, and floating solar panel installations.

