



Environmental Impact and Manufacturability of Magnelis® (Zinc Aluminum Magnesium) Coated Steels for Solar Mounting Structures

ArcelorMittal

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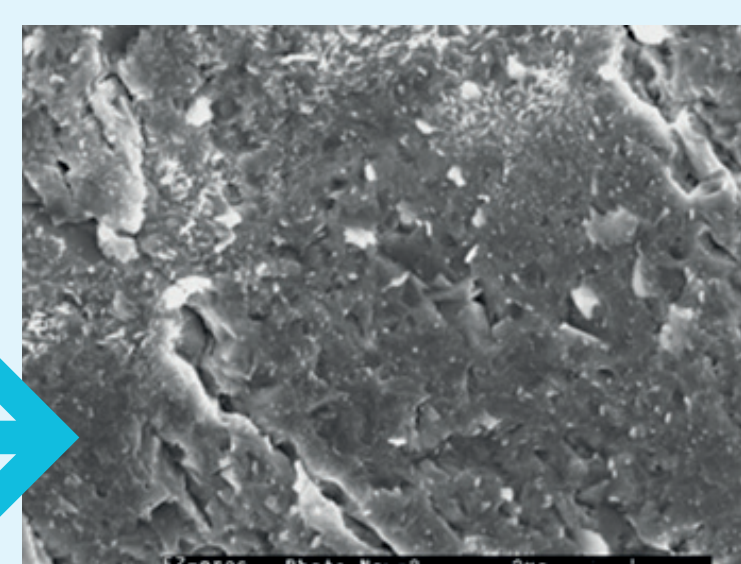
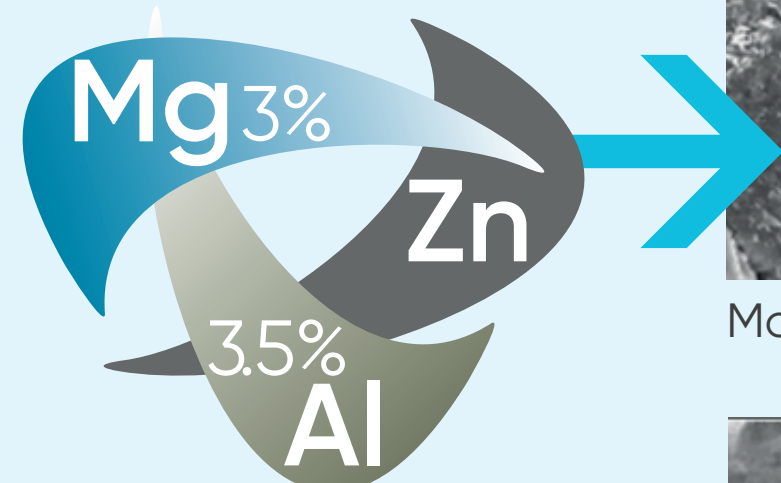
Goal

To compare the environmental footprint and processing of alternative materials to Magnelis® (Zinc Aluminum Magnesium) metallic coated steels along with the manufacturability of galvanized to Magnelis® coated steels and determine which offers **better environmental benefits/simpler processing** and **better manufacturability** for solar mounting structures.

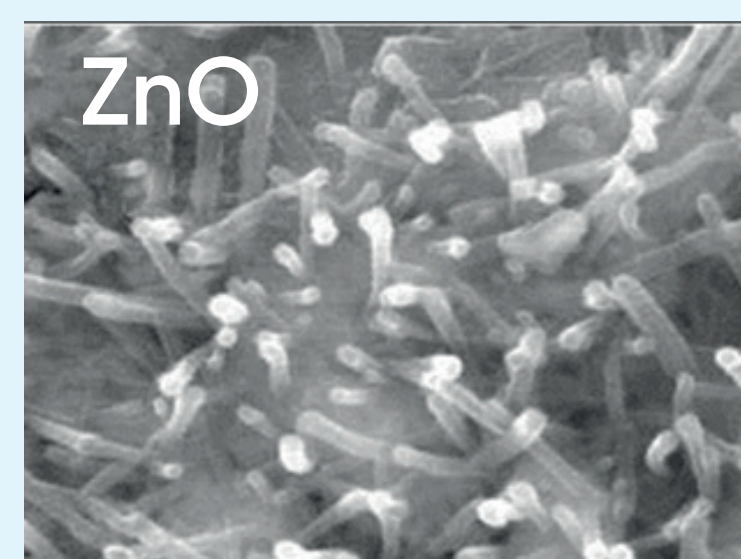
Results

The right composition with exceptional corrosion protection, sustainability and manufacturability

- 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) and 3.5% Aluminum (Al) ensures compact & stable barrier corrosion products that significantly reduces the corrosion rate and requires less metallic coating than Galvanized for equivalent performance and has less zinc runoff.
- The Mg and Al in the Magnelis® coating also results in a harder coating with a lower coefficient of friction than Galvanized coatings resulting in better forming, less tool wear, and a more resilient coating.
- Production of Magnelis® results in less energy usage/CO₂ generation than alternative materials such as Aluminum and Stainless steels. Magnelis® coated steels are 100% recyclable contributing to even less emissions when used as scrap to make new steel products.



Magnelis® – compact & stable structure

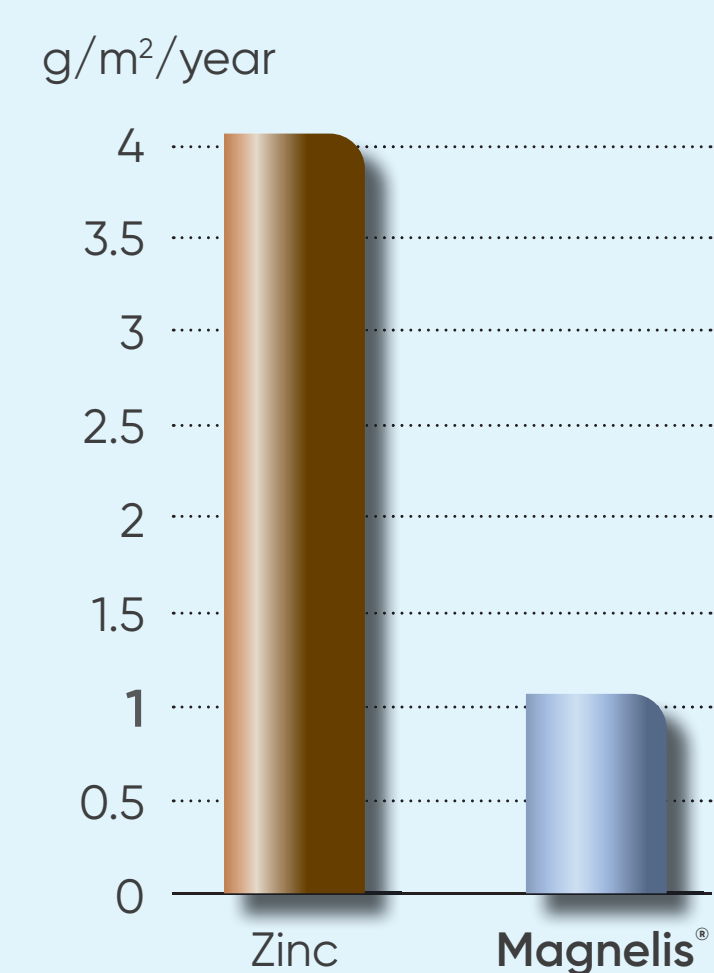


Galvanized – porous structure

Environmental benefits

Zinc runoff rate*

Magnelis® considerably reduces zinc runoff into soil.

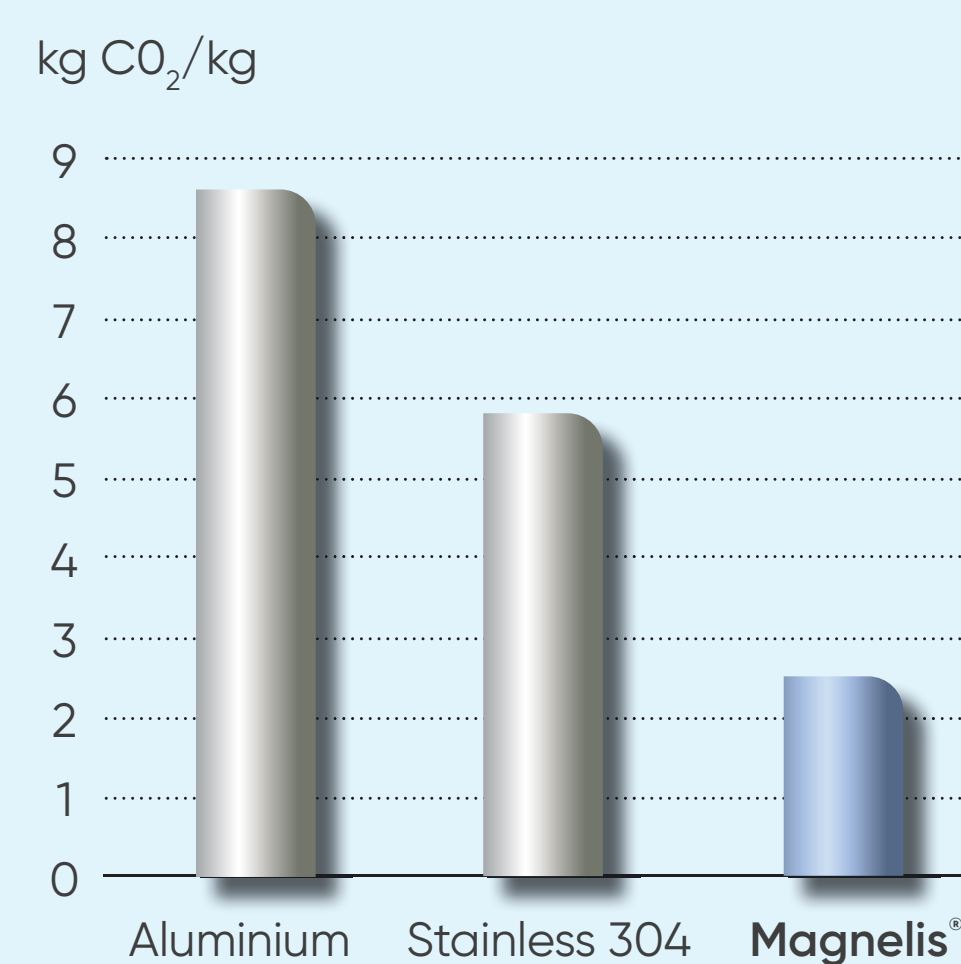


* the rate of dissolution of a material from its surface into the soil. Source: French Corrosion Institute

- At equivalent protection, Magnelis® uses less zinc and energy in production than pure zinc (Galvanized or ElectroGalvanized) 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 aluminum.
- Magnelis® is 100% recyclable, does not contain any harmful elements, is REACH compliant, and an environmental product declaration (EPD) is available online.

Production impact on CO₂ emissions

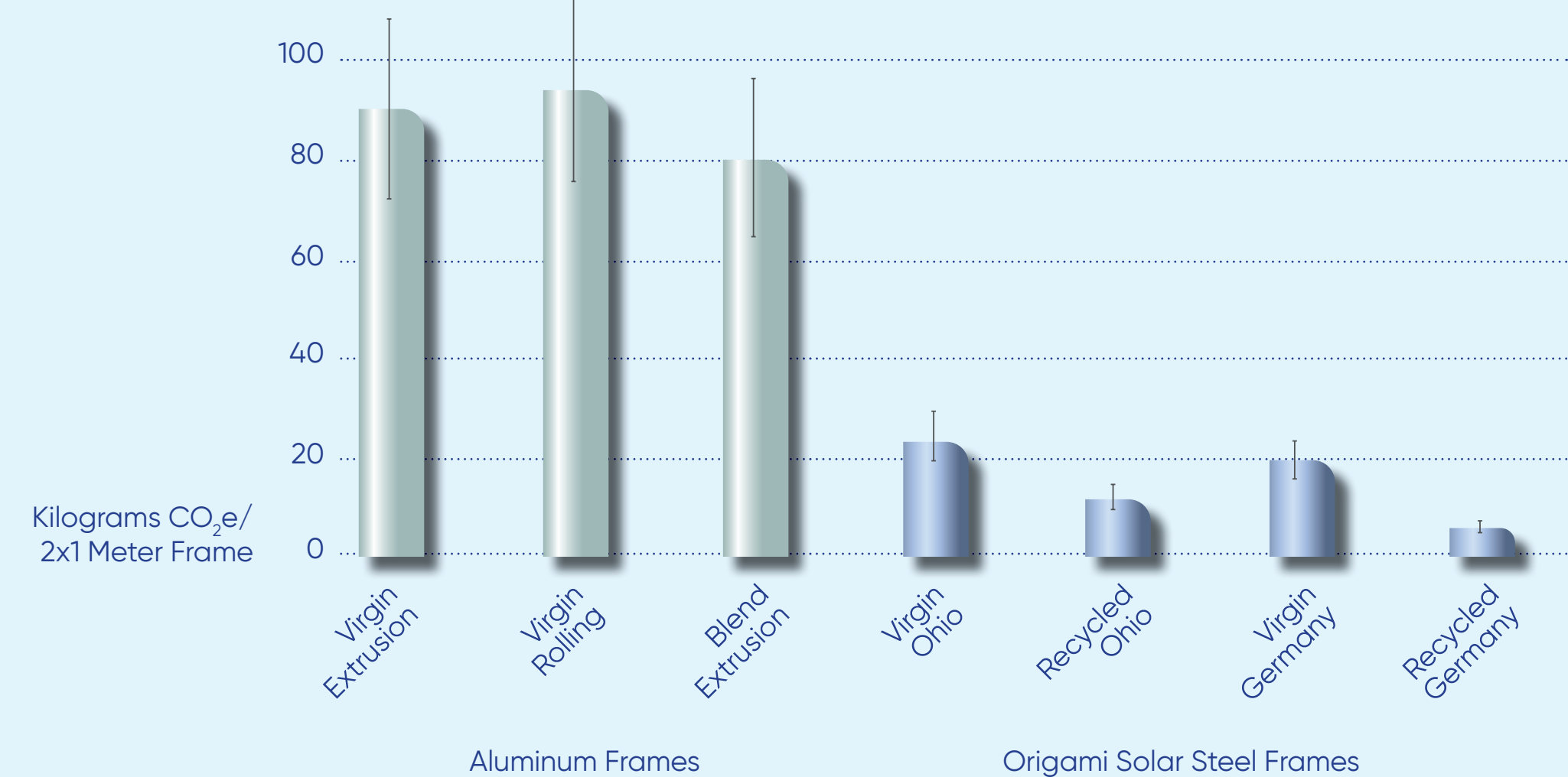
CO₂ emissions for the production of Magnelis® are much lower than for aluminium, a difference that is not compensated by aluminium during the use phase, even when aluminium parts are lighter than steel parts.



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



Green House Gas (GHG) footprint for Aluminum vs. Origami Steel 2m x 1m Solar Module Frame



Source: Boundless Impact Research & Analytics – Origami Solar Environmental Impact Report

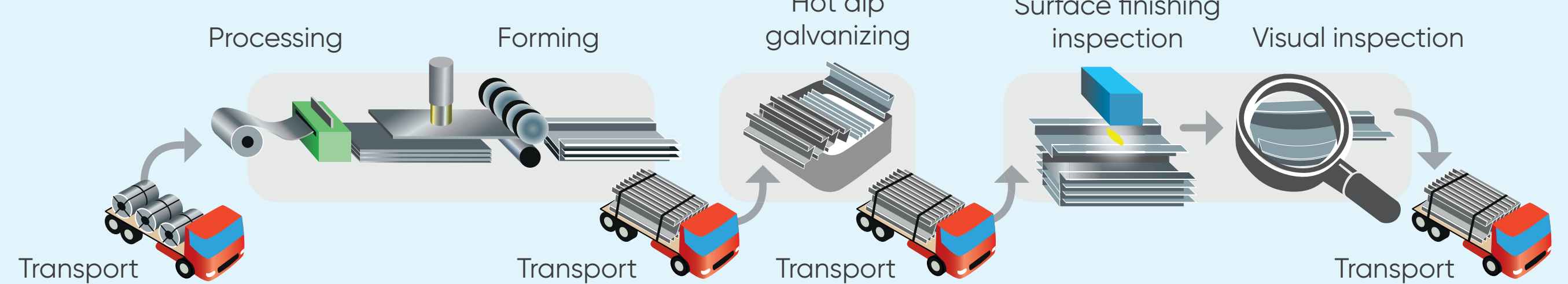
Legend/Info:

- Aluminum: Virgin 100% new, Blend includes new with 15% recycled originating from China
- Steel: Virgin 100% new, Recycled 100% recycled originating from Ohio for the US market and Germany for the EU market
- Cradle to grave analysis
- Germany CO₂ generation is lower than Ohio due to larger % of renewable energy and more reliance on train transportation

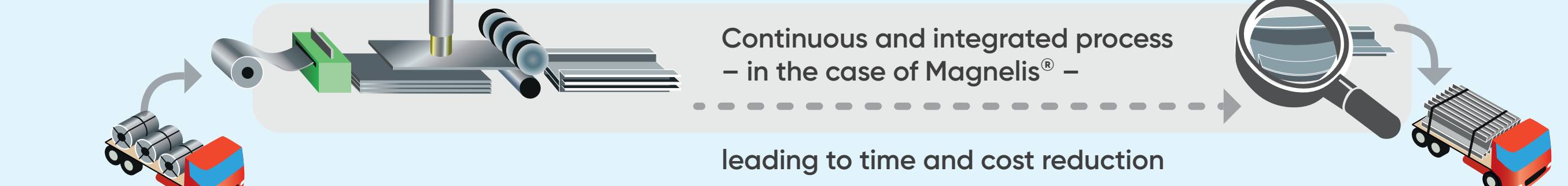
- Virgin steel & recycled steel frames from Ohio result in 73% and 87% less CO₂ generation than aluminum virgin extrusion frames.
- Virgin steel & recycled steel frames from Germany result in 79% and 93% less CO₂ generation than aluminum virgin extrusion frames.
- The use of Magnelis® for steel solar module frames and roof top solar (instead of aluminum) can result in significant CO₂ reductions, support higher loads, and offer a cost-effective alternative.

Supply Chain Management & Transportation – Manufactured Parts

Batch/Post Galvanized process



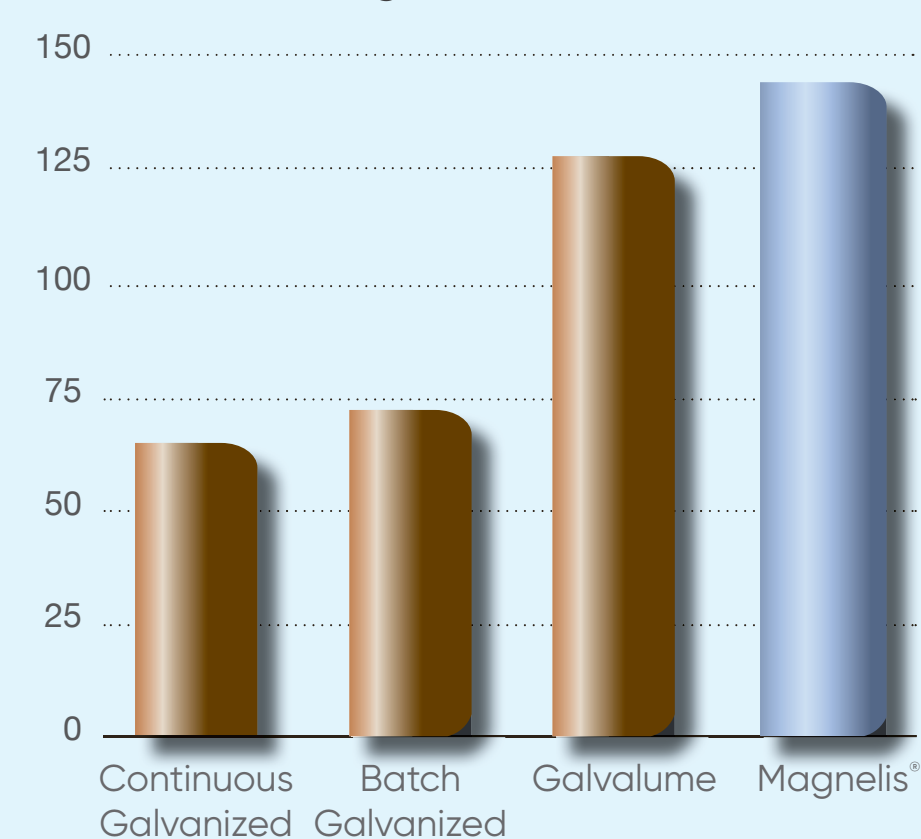
Magnelis® process



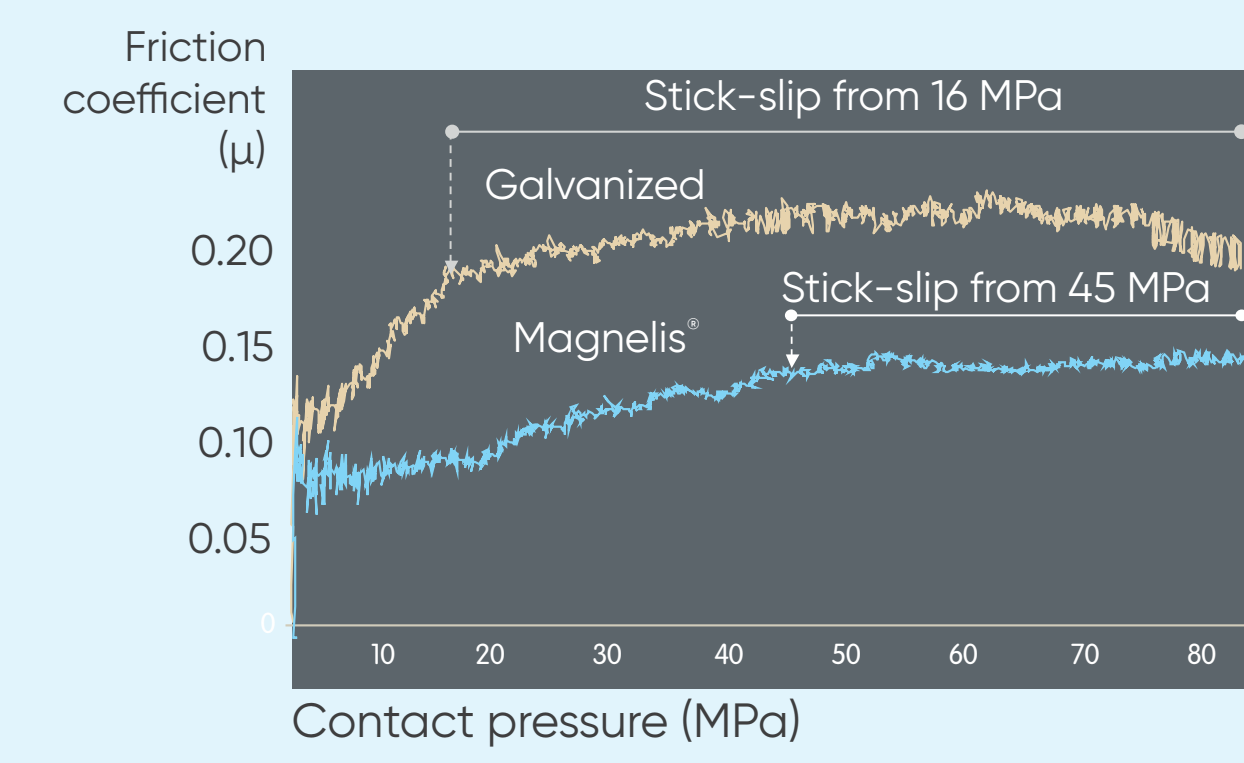
- Magnelis® allows substantial savings in lead time and costs by reducing processing and transport steps (and subsequent CO₂ generation)
- The use of Magnelis® can avoid the need for post-painting leading to additional cost savings and productivity improvements

Improved manufacturability

Metallic Coating – Hardness Vickers (HV)

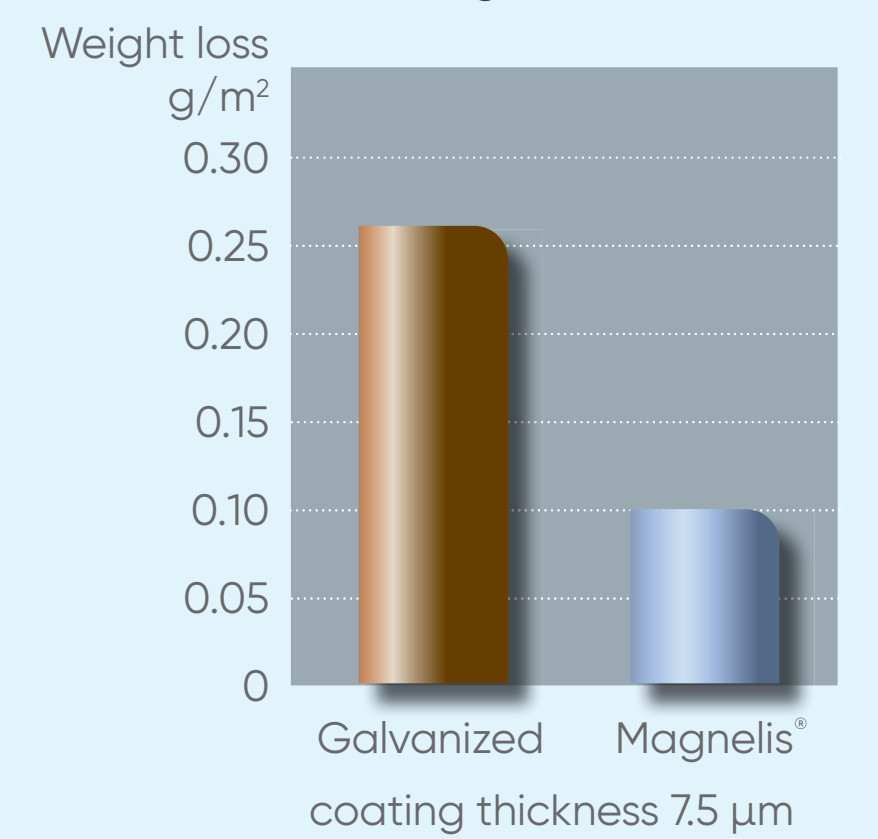


Coefficient of Friction Test*



* Note: Oil used Fuchs 4107S in excess

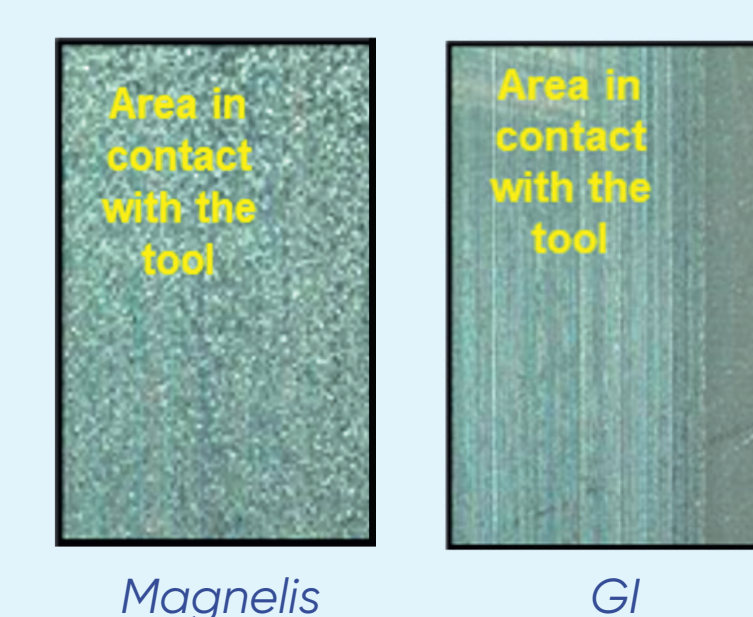
Powdering behavior



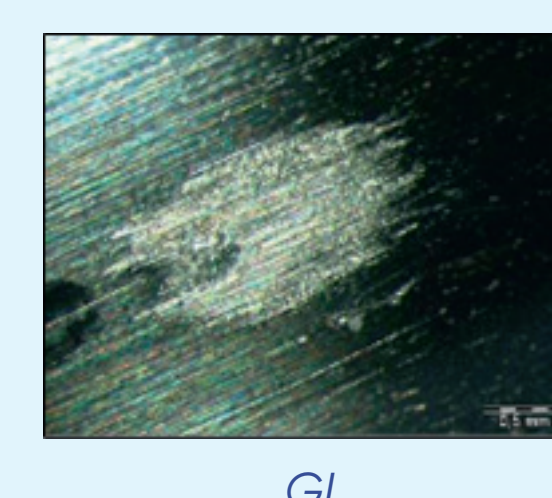
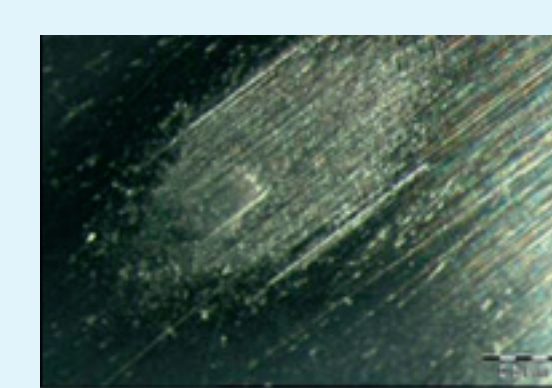
- Magnelis® is a harder coating than Galvanized and Galvalume coatings offering more abrasion resistance.
- Even though Magnelis® is a harder coating, its low friction coefficient and low powdering behavior results in excellent drawing, rolling, bending & punching with less tool buildup.

Profiling/Bending – Tooling and Corrosion Performance

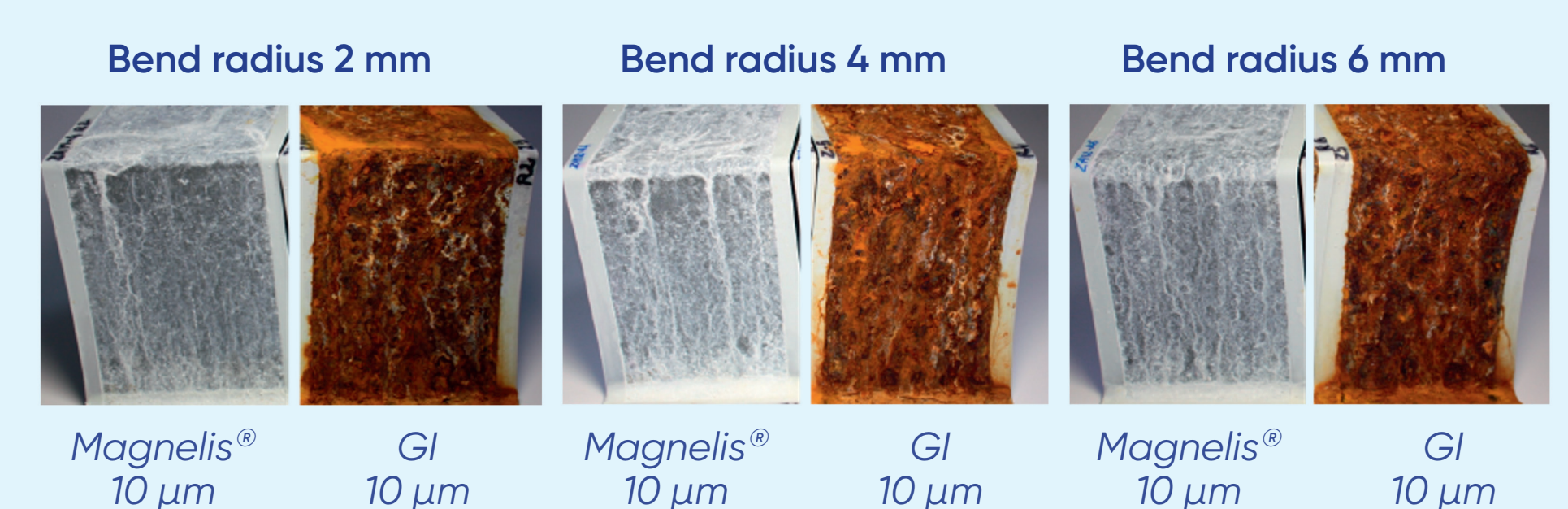
Galling/friction test



Zinc pickup – tool wear test



Accelerated corrosion testing – 10 cycles VDA 621/415



- Magnelis® harder coating, lower coefficient of friction, and no zinc pickup results in better roll forming/profiling than galvanized (GI) coatings.
- Accelerated corrosion of formed parts shows no corrosion on Magnelis® flat and formed areas vs. 100% red rust on all areas of galvanized parts at the same coating thickness.

Outcomes

Compared to aluminum, Magnelis® (Zinc Aluminum Magnesium) metallic coated steels result in **≥73% less CO₂ generation** for solar module frames, have **~4 times less zinc runoff** than galvanized, and **less processing requirements** (processing & shipping) than batch galvanized parts. In addition, Magnelis® is a harder coating than galvanized, has a **lower coefficient of friction** resulting in **excellent formability** with less tool pickup, and **better corrosion performance**. Thus Magnelis® coated steels are a great choice for the fabrication of solar mounting structures, electrical cabinets/cable trays, and transmission towers for fixed ground, tracker, rooftop, and floating solar panel installations.



For additional information, please visit ArcelorMittal's booth #7033 in the second floor ballroom.