



ArcelorMittal

Enamelled steel

A traditional material for modern living



Cover: metro station Sint-Katelijne,
Brussels (Belgium)

Right: "Rathaus" metro station,
Fürth, Nürnberg (Germany)



A combination of two noble materials, an all-round winner in the long term



"Heysel" metro station, Brussels (Belgium)

The pharaohs of Egypt and the kings of Persia prized enamel as a noble, corrosion-resistant material, and this is borne out by the fresh and remarkably well-preserved jewellery and pottery discovered by archaeologists.

The ancient Chinese also appreciated the advantages of this material, and still carry on this tradition today with their cloisonné enamel work.

Closer to home, the tradition was handed down by the craftsmen of Byzantium and Limoges, and in the 19th century, the technical qualities of industrial enamelling were discovered.

A traditional material for modern living

Enamelling steel is a high-tech process using highly sophisticated materials and state-of-the-art techniques. Enamelled products are now used in many different domains, particularly in architectural and decorative applications.

Enamelled steel is a material that meets very modern criteria of longevity, aesthetic qualities, hygiene and respect for the environment.

Longevity

Enamelled steel is resistant to:

- Corrosion, chemicals, detergents, solvents, acids
- Pollution, exposure to the weather, saline atmosphere, water, steam
- Fire, heat, cold (from -60°C to $+450^{\circ}\text{C}$)
- Abrasion, scratching.

Enamelled steel is an excellent dielectric, and ultraviolet rays have no effect on its colour or gloss.

Aesthetic qualities

- Enamel can be coloured in the mass in an almost unlimited range of colours.
- Screen printing presents no problems, so that all imaginable motifs can be reproduced.
- A wide range of surface textures can be produced.

Hygiene

Enamelled steel:

- Prevents the proliferation of bacteria.
- Does not absorb odours.
- Is safe for contact with food.
- Is very easy to clean.

Respect for the environment

Enamelled steel is a combination of two clean, recyclable materials, and is itself fully recyclable.



Enamelled bathtub



Fixing system for enamel panels (Signaux Girod, France)



Pavia University, Pavia (Italy)

Architecture

Enamelled steel can be used in the interiors of public places, such as stations, airports, metro stations and other buildings:

- As a wall-covering and for false ceilings, partitions and lifts
- As a non-flammable and easy-to-clean material
- In clean rooms in hospitals, where its anti-bacteriological properties, moisture resistance and ease of cleaning are invaluable.

Enamelled steel can also be used as a cladding for buildings, since it is weather and UV resistant, lightweight, and can offer virtually unlimited scope for decoration.

Communication

Enamelled steel is an ideal solution for indoor and outdoor signposting and communication. Its surface will not be damaged by urban pollution, the weather, UV or graffiti. It is fire resistant and the wide scope for decorative possibilities makes it the best possible material for the most sophisticated graphic creations.

Industry and domestic appliances

The excellent properties of enamelled steel, and in particular its hygienic qualities and resistance to aggression from multiple sources, make it an ideal choice for domestic applications such as cooking appliances, pots and pans, bath tubs and hot water boilers.

There is also a role for enamelled steel in industrial processes, even in the most corrosive environments. Thanks to its resistance to chemical products, fermentation and extreme temperatures, it can be used for silos, chemical reactors, cisterns, reservoirs for water purification stations and heat exchangers.

Range of steels for enamelling

	Direct-on enamelling	Two-coat/ one-fire enamelling	Conventional enamelling	One-side enamelling
Solfer® / Solfer®+	■	■	■	
Solfer® CA		■	■	
DC01EK / DC04EK / DC05EK			■	
DC06EK / DC07EK		■	■	
HC300EK			■	
S240EK / S300EK *				■

(*) Hot rolled steel grades



Chemical storage tanks, Antwerp (Belgium)



Interior pressure vessel of the Ariston boiler, made with HC300EK

Enamelled pan rests on a gas hob



HC300EK – thinner steel for boiler applications

ArcelorMittal's Global R&D division for Industry in Ghent has specifically developed HC300EK in response to customer demand for thinner steels for enamelling applications. This product is an example of a successful co-engineering project with the Ariston Thermo Group, one of the world's leading producers of boilers and water heaters.

Until the development of HC300EK, the lowest feasible thickness limit was 1.55 mm. With HC300EK, Ariston was able to reduce its boiler wall thickness below this limit.

HC300EK is usually supplied in coils, ready for processing at our customers' premises. Depending on the enamelling process used, HC300EK can be shot-blasted or pickled. In some cases, only degreasing is required before enamelling. Uncoated steel can be supplied for applications that require painting, such as the outer casings of hot water boilers.

The enamelling process

The enamelling process produces an everlasting fusion between the steel and the enamel. The process consists in the application and subsequent firing at high temperature (830 °C) of one or more layers of enamel applied by various methods (dipping, spraying, coating, pneumatic or electrostatic spraying, electrophoresis) on to the carefully prepared surface of a panel. Firing at a high temperature generates a strong, indestructible fusion between the enamel and its substrate, which together form a new, stable material.

Steel

ArcelorMittal is the leading European producer of steel for enamelling, renowned for the quality of its products. When manufacturing steel for enamelling, each step of the process must be controlled very closely.

It is a high-tech product, which has to meet the EN 10209 standard, and this requires constant monitoring of chemical analyses and manufacturing conditions to achieve perfect control of the metallurgical properties of the steel.

Steel for enamelling must withstand the stress generated during firing and subsequent cooling of the enamelled parts without deformation. Moreover, to obtain a good surface finish after enamelling, gas emission during firing should be minimised and the steel should contain hydrogen traps to prevent the formation of surface faults like fish scale.

ArcelorMittal offers the widest range of steel grades specially designed for the enamelling process:

- Decarburised steel for direct-on enamelling: Solfer® and Solfer®+
- Surface-decarburised steel specially intended for the two-coat/one-fire enamelling process: Solfer® CA
- Steel for conventional enamelling
- Titanium steel for enamelling
- New structural cold rolled steel for boiler applications with guaranteed mechanical properties after enamelling: HC300EK
- Ready-to-Enamel: ArcelorMittal has developed Ready-to-Enamel coating, which is applied on cold rolled enamelling steel grades to simplify processes in our customers' workshops: no reoiling before forming, enamelling without surface treatment (degreasing), and the possibility of reducing firing temperature and/or firing time. Ready-to-Enamel is compatible with current enamelling processes: ground-coat and two-coat/one-fire.

Enamel

Enamel is a mixture of non-organic vitreous materials (quartz, sands, feldspars, clays etc) and fluxes (borax, soda ash etc) coloured with various metal oxides. This mixture is fused at a high temperature of about 1300 °C, cast and then cooled rapidly and crushed, thereby forming "enamel frit", which is then ground to produce enamel.

Credits

Cover: Philippe Vandenameele
The other pictures: PolyVision / Centro Italiano Smalti Porcellanati / Tom D'Haenens / Jean-François Octave / Thierry Valfort / Giancarlo De Carlo / Ariston

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