

PAINTING SMC: ADDING VALUE THROUGH A PERFECT FINISH

The appearance of a product, as well as the touch and feel, are key elements of a successful design and in many cases strongly influence the user's attraction to the product. The full range of SMC finishing options available today – from high-gloss, Class A finishes superior to painted metal, to matt and novel textured surfaces – supports the expansion of this versatile composite material into new applications and markets. In this second guide in our series, we find out how to achieve the highest quality finish on SMC parts and discover how state-of-the-art coating technologies can deliver significant cost savings over conventional processes.

WHY ARE SMC PARTS PAINTED?

Visible SMC components can be delivered in any colour the customer selects through the choice of pigments in the SMC formulation, and since SMC is a highly robust, corrosion resistant material a protective coating may not be required. For certain applications, however, the SMC surface is painted to meet enhanced functional and/or aesthetic requirements – to extend a component's chemical or UV resistance, for example, or to provide the smooth, flawless finish favoured by designers of consumer and automotive products. Examples of painted SMC parts include sanitary units such as shower trays and sinks, interior wall panels in trains, as well as truck front-end modules and car trunk lids which look exactly like their metal counterparts.

Selecting the right SMC formulation and following best practice design, manufacturing and finishing procedures the aesthetic quality of a painted SMC surface can match, and even exceed, that of a painted metal surface. Any paint finish – from classic white to chrome-effect – can be achieved, and matt, textured and even imitation carbon fibre effects are also possible, opening up new design possibilities.

Functional coatings that provide properties beyond decoration and protection are likely to expand the range of SMC finishing options available over the coming years.

SMC parts with tailored function and aesthetics will enable designers and OEMs to enhance and expand their offering in established markets for SMC such as automotive and truck, mass transportation, consumer and sanitary, as well as develop new applications in emerging markets such as electric vehicle infrastructure and 5G-transparent structures.

SMC AND BMC COMPOSITES

Sheet moulding compound (SMC) and bulk moulding compound (BMC) are fibre reinforced polymers, also known as composite materials. They consist of a thermoset resin (typically an unsaturated polyester), a fibre reinforcement, an inorganic filler, and various additives designed to improve processability and performance. Formulations can be tailored to deliver specific properties in the final product, such as fire resistance.

Because of its longer fibre length, SMC has greater flexural and tensile strength than BMC. It is ideal for the manufacture of large, fairly intricate parts which combine structural performance with a smooth finish. The ability to produce Class A painted surfaces has led to an increasing number of automotive applications for SMC. BMC is better suited injection moulding and the manufacture of smaller, more intricate parts. BMC applications include consumer appliances and car headlight reflectors.



HOW IS SMC PAINTED?

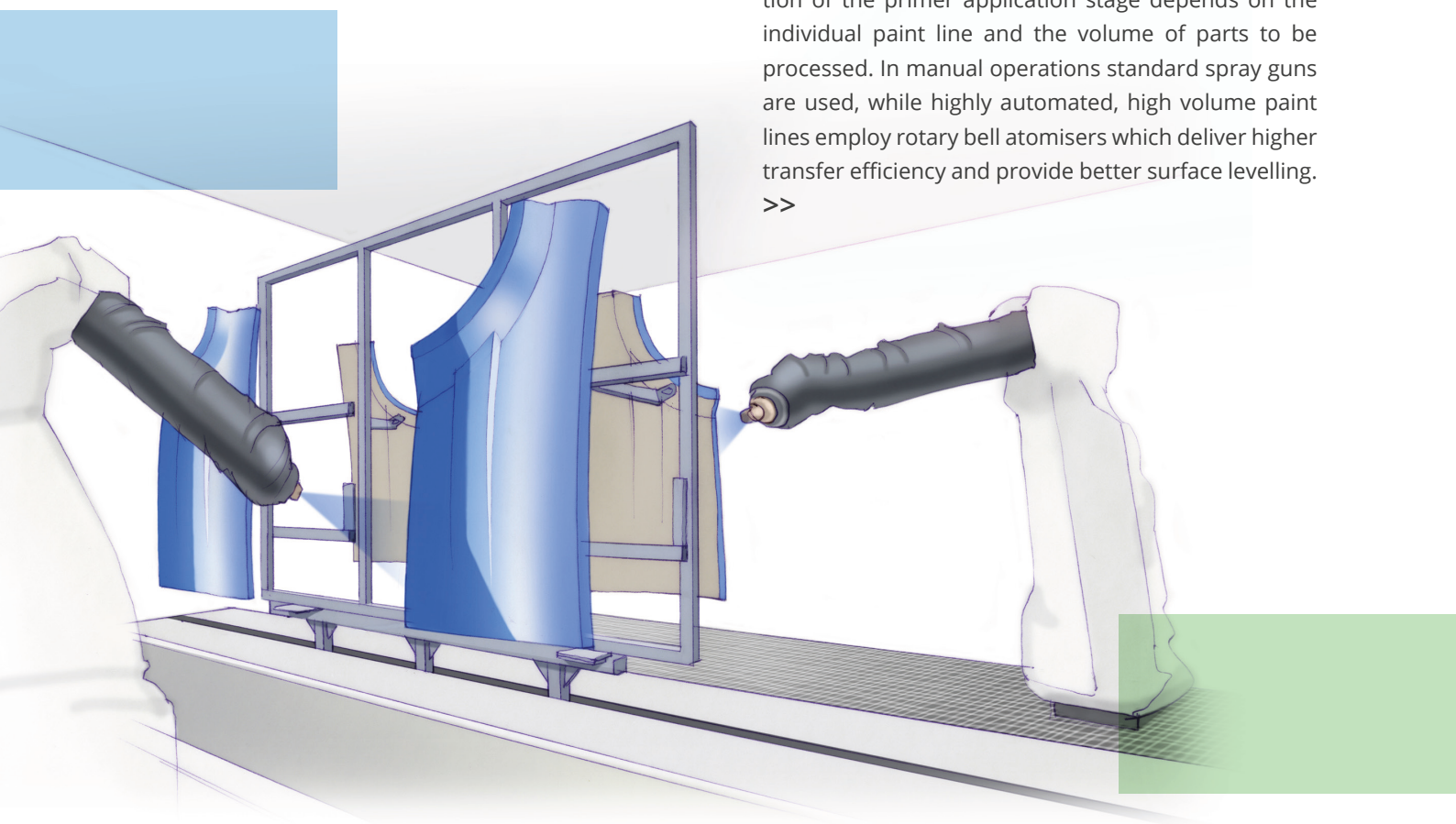
In the majority of cases SMC parts are painted using a conventional spray process. There are several steps in the process, many of which can be automated to increase throughput.

First, the SMC parts need to be thoroughly cleaned so that they are free from any oils or debris from the moulding process. This can be performed manually or in a power wash process for a better result. Highly automated paint lines in the automotive industry utilise robots to clean the surface.

Next, the primer is applied. It is crucial to get this layer right since any defects in the primer layer will be duplicated by the subsequent paint layers. The 14 µm-diameter glass fibres in the SMC formulation which result in the material's excellent tensile strength can also lead to 'print-through' on the surface of painted parts, which is generally not acceptable if an extremely smooth finish is required.

The primer must completely cover this uneven surface to create a level, defect-free finish on which the following paint layers can be applied. The level of automation of the primer application stage depends on the individual paint line and the volume of parts to be processed. In manual operations standard spray guns are used, while highly automated, high volume paint lines employ rotary bell atomisers which deliver higher transfer efficiency and provide better surface levelling.

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>> The primer is then dried and inspected for defects. If the surface smoothness does not meet the required standard the primer will require sanding. Since robotic sanders are expensive this is often a manual operation which could take 10-20 minutes to complete, depending on the size of the part. With most spray primers it is not possible to achieve a well levelled surface at thicknesses greater than 40 µm and an even thicker

layer of primer will be applied and then sanded until the surface is even.

Depending on the finish required, a basecoat will be sprayed onto the primer and followed by a clearcoat, or alternatively a topcoat will be applied directly over the primer layer. These final paint layers are dried and a further quality inspection carried out.

ARE SPECIAL PAINTS REQUIRED?

Choosing a suitable primer is essential. The primer formulation must ensure good adhesion to the SMC to avoid failure between the coating and the substrate, and it must be possible to apply the primer layer to a thickness of at least 60 µm without cohesive failure. The primer also needs to provide very good levelling to produce an extremely flat, smooth surface. For SMC, polyurethane primers are preferred since they are easier to sand than epoxy-based products.

The primer is followed by standard liquid coating layers, according to the customer's specifications. In the automotive industry the primer is often followed by a basecoat which gives the part its final colour, and then a clearcoat, which ensures a glossy, scratch-resistance surface. For truck parts the primer layer is generally followed by a topcoat, which provides both colour and protection.

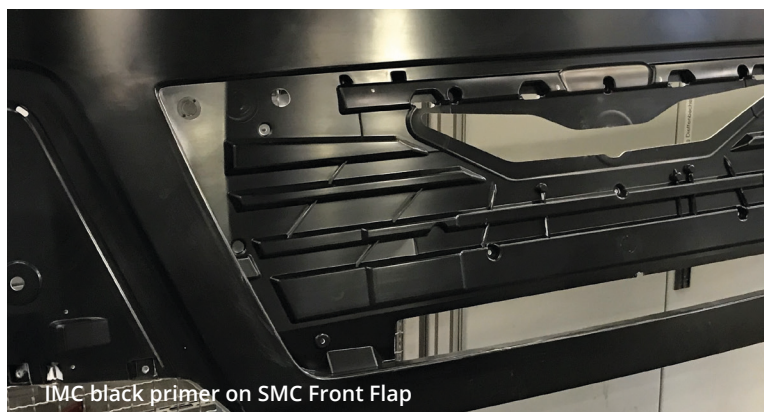
Suitable primers, basecoats and topcoats for SMC are available from a range of coating manufacturers.

ARE OTHER PAINTING TECHNOLOGIES AVAILABLE?

In-mould coating (IMC) is an alternative to spray painting which makes Class A SMC surfaces easier to achieve and may offer substantial savings in production time and costs.

In the IMC process a primer is injected at high pressure into the mould at the end of the moulding cycle – moulding and coating are essentially performed in a single step. This results in a part complete with primer layer on removal from the mould. The sealed, smooth surface is ready for application of standard liquid coatings. The elimination of the cleaning, primer application, drying and sanding steps of the conventional spray paint process significantly reduces labour and equipment costs.

A more recent development of the IMC process involves injecting a specialised liquid paint topcoat into the mould to produce a ready-to-use part direct from the mould. The SMC part is finished in a single operation, making a separate paint line unnecessary. There are some limitations with this topcoat IMC solution which need to be addressed when designing the part. The part should not have any vertical walls as a certain angle is needed to achieve minimum dry film thickness, and the external edges of the part will not be coated. Only solid colours are possible, and the quality of the final surface is always determined by quality of the mould surface.



IMC black primer on SMC Front Flap

3 TOP TIPS FOR PAINTING SMC

- Choose the primer carefully. The surface quality of the final part will be determined by this first layer.
- Consider the painting process when designing the part. Ribs and reinforcements behind the surface can create sink marks which are difficult to hide.
- Select a painting process which minimises sanding, rework and scrap.

Using IMC primers typically results in a higher quality finish than spray application. It enables a very regular thickness of paint (around 100-150 µm) to be deposited on the surfaces of the part, and provides excellent coverage of surface defects, good levelling, and better adhesion.

IMC is a well-established, robust technology, which has been developed by European SMC moulders over the past 20 years and is now being successfully implemented by leading automotive brands. SMC components complete with IMC primer can be built into the Body-in-White alongside metal parts and proceed through the e-coat and paint processes of the automotive OEM line without any issues.

HOW DOES PAINTED SMC COMPARE WITH PAINTED METAL?

The surface quality of a painted SMC part can equal, or even surpass, that of painted metal.

Using the correct SMC formulations and chromium-plated, mirror-finish moulds it is possible to obtain distinctness of image/DOI (gloss) and wavescan (surface texture) measurements on SMC finishes that by far exceed those of painted metal. By modifying the surface morphology of the mould it is possible to create matt effects and different textures, and even imitate the structure of carbon fibre, on the surface of the SMC part.



WHAT IS THE COST OF PAINTING SMC?

This can vary greatly and is dependent on the individual production line, level of automation, volume of parts, and the finish required.

Spray application is a flexible option which is highly suitable for both small production runs and (with automation) higher production volumes. Since standard liquid coatings are used the painting operation can be subcontracted to a wide range of coating companies. However, spray painting has a transfer efficiency of only approximately 75% and evaporation/drying of the paint can result in VOC emissions. Class A finishes are achievable but may require significant manual work. For a typical spray painting process the ratio of direct to fixed costs is typically 1:2.

A fully automated paint line is a significant investment.

IMC may offer a better total cost of ownership for high volume production of parts requiring superior quality finishes. Since IMC integrates part or all of the painting operation in the moulding process it is possible to significantly reduce both direct costs (energy for the drying ovens, labour etc.) and fixed costs (painting facilities can be downsized or eliminated). The investment required in additional equipment (typically of the order of €100,000) and high quality moulds could be recovered quickly for production volumes of 50,000-100,000 parts/year. Considering paint materials only, the cost of an IMC primer layer is <2€ per m²; the cost of an IMC high-gloss topcoat layer is approximately 4€ per m², but no additional process steps are necessary. Waste is reduced since IMC paints are 100% solid content, there is no overspray and close to 100% transfer efficiency is achieved. Whilst there are some part design limitations (outlined earlier), the IMC process supports manufacturers' efforts to improve quality, streamline production processes and reduce costs.



A COMPARISON OF SMC COATING TECHNOLOGIES

SPRAY PAINTING

Flexibility: Low to high production volumes.

Paint line consisting of several process steps.

Investment required in automation for higher production volumes.

Class A possible,
In some cases may require manual work.

Lower cost mostly for smaller series (reduced investment).

~75% transfer efficiency (high paint waste levels).

VOC emissions in all painting steps.

Painting operation can be outsourced.

IMC

High production volumes.

Downsizing/elimination of painting facilities (reduced number of process steps).

Investment required in additional equipment for injection of coating during moulding.

Better than Class A possible,
as well as textured effects. Easier to automate.

Lower cost mostly for larger series (investment can be spread over a larger number of parts).

~100% transfer efficiency.

No VOC emissions for IMC primer application;
VOC emissions for final paint layers.
No VOC emissions for IMC topcoat application.

Painting is partially/totally integrated in the moulding process.
Yet limitations exist for using topcoats in vertical parts.

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The European Alliance for SMC BMC
Sector Group of EuCIA
Blvd. A. Reyers 80
1030 Brussels
Belgium
www.smcbmc-europe.org
info@smcbmc-europe.org

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