PAINTING TPO FASCIAS IN EUROPE

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In Europe, 98% of the bumper **fascias are** made of thermoplastic materials, TPO being the most utilized with 85% of the market.

The first applications **started in** the **late** 70's with molded-in-color Polypropylene fascias, then the mid 80's **saw** the start and rapid growth of painted bumpers which now represent 65-70% of the market.

The object of this paper is to present an analysis of the European market of painted fascias, through Plastic Omnium SA the market leader and "new comer" in the US, with special reference to design, product and process.

Introduction of Plastic Omnium Company

Plastic Omnium SA is positioned **as** the number two company in Europe for thermoplastic processing by injection molding.

The sales volume for 1995 is forecasted at 1.35 Billion US Dollars, 50+% outside of France including 8 % in the US.

More than 9,000 employees worldwide, located in 50 plants including 7 in the US.

The automotive segment, represented in North America by Plastic Omnium Industries Inc., account for more than 70% of the activity of the group.

Plastic Omnium Industries (POI)

Market leader in Europe for exterior trim applications, including bumper systems, body panels and other ornaments, with **a** daily production of more than 50,000 parts including 20,000 bumper systems.

Over the past 10 years more than 20 million fascias have been delivered.

POI owns a total of 24 paint plants, 12 of those being essentially used for TPO fascias. The newest painting installation is located in its new production site of Anderson, South Carolina.

Every day 13,000 fascias are body color painted in these plants. POI has been producing for **a** year now, the first TPO horizontal body panel (tailgate cover) delivered body color painted for the GM-Opel Tigra assembled in Spain.

"History" of the Painted TPO Fascias

Until the early 70's all bumpers were metallic.

1971- First plastic bumper with the Renault 5, in SMC

1975 First thermoplastic bumper with the Fiat Ritmo, in Thermoplastic Olefin TPO, grained and of course molded-in-color in black, using carbon black for UV stabilization.

At this time, painting TPO is considered impossible. Some development work done in Japan in the late 70's / early 80's shows some merging technologies capable of "eliminating" the problems of this non-polar material.

1985 After many attempts to mold-in-color "colored fascias" with limited success, Europe sees its first grained fascias body color painted using flame treatment as surface activator. From here the market would explode and moved constantly to more and more paint.

1995 85% of the bumper fascia business is TPO, 65 to 70% of those are painted most of them on smooth surface (no grain).

Trends- The fascias are getting larger integrating the front grille, wrapping around the head lamps, and moving toward the hood. The "0 gap" concept is common place on new developments. All of this emphasizes the necessity to produce extremely high quality parts for cosmetic purposes and color matching, without forgetting the functionality of the product.

Painting TPO Fascias

a) Substrate

EPDM modified PP is the most used material. Reactor grades and compounded TPO share equally the market.
Percentage of EPDM in the PP range from 5 to 30%.
Percentage of mineral filler (talc, mica,..) ranges around 15%.
Flexural modulus range from 750 to 1300 Mpa (109-188 kpsi).
Melt Flow Index range from 6 to 20 gm/10 min.
A high volume of fascias are “partly painted”, using a molded-in-color, usually black or dark gray, UV stabilized material. A grained area, un-painted, is used to simulate a rub strip design over **a** smooth painted surface.
Trends: higher flexural modulus and Melt Flow Index, lower Coefficient of Linear Thermal Expansion. Some extensive research and development programs are targeting a “directly paintable TPO” by adding functional polar groups, special rubbers and other additives.

b) Product Design

* The product must be designed for painting:
* Deep and narrow pockets and recesses are limited or avoided
* When ribs or tabs are needed, the product has a feature line or groove to hide any potential sink marks.
* When masking is required, a feature line is created. This line is always kept away from the limit of the grain (when applicable).
* Etc...
* The design and development of the product must be process driven.

c) Molding

The molding process, the mold design, and mold construction have a considerable impact on the quality of the painting, in terms of performance (adhesion,...) and cosmetics.
Many setups are used such as multi gates (up to 10) with fast dynamic injection phase (from 5 to 10 sec) and on the other end, long thick gates (up to 1.5 meter long) with a slow injection phase (up to 25 sec). New mold design with sequential injection are used also.
All systems have their weaknesses for paint application, knit lines, potential material “delamination” around the injection points, etc...
Control of mold temperature, slide / insert adjustment are critical parameters.
Mold release agents are prohibited.
Mold, machine, and operator cleanliness is essential.
Silicon free environment is compulsory
One thing is certain; **a bad molding will never be better after painting.** “Molders” (up-stream) have understood their impact on painting (down-stream). The mentalities have

changed by considering a fascia production site as one production line, which differs from a few years ago, when a molding shop sent parts to the paint shop, sometimes not even on the same site....

d) Paint Plant:

Outside of the carmakers themselves, there are no “large” paint plants in Europe. The reason is mainly due to logistic / plant location philosophy. Small plants (low investment) are located near the carmaker’s plant, for sequencing delivery and transportation cost reduction.
Paint plant capacity is anywhere between 500 and 3,000 fascias per day. Low production outputs are usually hand sprayed.
The typical construction is from 1 to 3 spray booths with 1 sometimes 2 ovens.
Small plants mean as well less V.O.C. generated per site, resulting in little or no V.O.C. control required.

e) Degreasing / Power Wash

This process seems to be widely used in the USA for “historical reasons”: Mold release agent for RIM molding,....
The large majority of the painted fascias in the EEC are not power washed. A simple Tack Wipe or IPA Wipe is the norm.
The philosophy is: Don’t clean a clean part! Many preventive actions are implemented in the working environment, process and material flow.
Power wash is a high capital investment, uses a lot of space in the plant and is a process with no added value on the product.

f) Paint Bucks

Due to the low bake system **(180^{0}F / 8O^{0}C),** all paint bucks are made of very simple wire frame construction, sometimes as simple as a “coat hanger”.
The result is lighter construction, inexpensive, easy to clean and store, and longer lasting.
When the plant is equipped with robots or reciprocators, an in-line checking fixture will control the quality / accuracy of every paint buck prior to loading the part. If any “out of spec” distortions are encountered, the paint buck will be removed from the track and repaired.

g) Surface Preparation / Treatment

Until finding a new generation of directly paintable TPO, a surface preparation is compulsory.
Several systems have been developed:

* Corona Discharge
* Plasma
* Adhesion Promoter

* Flame Treatment
* Combination of Systems (Flame + Adh. Pro.)

It is clear that paint adhesion is the critical point of TPO. Also clear is that the mechanism of adhesion with all the parameters involved is a complex system.
Flame treatment with or without Adhesion Promoter is the most widely used process, due to it's low capital investment / performance ratio.
The combination Flame+Adh. Pro. looks as a "belt and suspenders" concept, but in reality it widens the application window and provides an extremely robust process !.
The critical parameters of Flame Treatment are:

* Gas (Propane) / Air ratio, usually 5:1, and flow rates.
* Distance Flame / Fascia.
* Speed of the burner over the fascia.

The surface tension of a typical TPO will change from 30-32 to 48+ Dynes/cm2.
One of the criticisms of Flaming is the difficulty / limitation of flaming deep pockets and air openings. By experience, if we start experiencing problems in these areas, we will also have problems applying the paint with satisfactory quality (film build,...).

Adhesion Promoter: Most of the solvent adh. pro. (conductive) are robot sprayed and not baked (application wet /wet of the base coat).
The chemistry of the EEC adh. pro. vs US types shows differences in terms of minimum baking temperature. Most, if not all systems are low bake **(18O^{0}F / 80^{0}C).**
Around 80% of the adh. pro. are 1K, 20% are 2K.
The trend is waterborne application with infra red heated flash because of their low or zero V.O.C. impact and somewhat competitive pricing.

h) Base Coat

Waterborne base coat are starting slowly but most applications (95+%) are solvent.
The V.O.C. impact of the waterborne products is not what we should expect and the prohibitive pricing will not help to speed up the process.
Few high solid base coats are available.
Companies are living the same challenges as in the US:

* Converting solvent plant to **H_20.**
* Mixing products
* Premium ($)
* Learning curve

About 80% of the base coats are 1K, and 20% are 2K. Most of the 2K are used when there is no Adhesion Promoter (Flame -> base coat).

I) Clear Coat

The large majority of the clear coats are 2K urethane, applied "wet on wet" over the base coat. The products range from rigid to "semi flexible", few flexible clear coats are used. OEMs privilege durability instead of flex / impact resistance, and part suppliers appreciate their "finnessability".
The film build requirement is typically 30-35 microns (1.2-1.4 mils) compared to the 40-50 microns (1.6-2.0 mils) in the US.

As the V.O.C. emission generated by the clear coats is the greatest in the paint plant, it is usually the first place to be equipped with abatement systems, such as rotary concentrators with thermal oxidizers . . .
A lot of research and development is being done over powder coating, but is still limited to steel application. Utilization on TPO may take quite a while before being successfully used.
As mentioned earlier, the baking operation of the top coats is at low temperature in indirect gas fired convection ovens. Typical process is 30min at 180^0F / 80^0C part temperature.
The system used for the finesse operation will depend on the type of clear coat used. Softer clear coats will / may require “cryogenic polishing”.

j) Assembly / Packaging

Very few fascias are delivered “as is”. Full bumper systems are more representative of the market, including the assembly of beams, shock absorbers, side brackets, fog lamps, head lamp washer nozzles, grilles, etc....
As all these assembly operations are done after painting, it is obvious that a great deal of care is used In the way of handling the parts and in the design of the holding fixtures.
The design of the packaging is crucial. Returnable containers without any bag or any other pieces is the norm. Again, cleanliness is a focus, even in the warehouse, the trucks trailer and at the customer docks. Proximity plants / short delivery distances help a lot in that matter.

Challenges / New Developments

The speed of technologic changes is extremely high in the profession and is not specific or limited to the European market.
Painting TPO fascias is a technology in which the progress is:

* fast because it is recent.
* Numerous because of so many parameters involved.
* from various origins (material, equipment suppliers, users, customers, competitors,...)
* from various locations around the world (USA, Japan, Europe)
* risky, technically and financially, because of all the above.

The origin of the change can come from either an evolution in one component of the paint system, or a technological “jump” which brings new radical solutions.
These changes can affect:

* The substrate / part to be painted (material, process, appearance)
* One of the elements of the paint process, either in the formulation or in application:
    - Cleaning / degreasing.
    - Surface treatment / adhesion promoters
    - Primers
    - Base coats
    - Clear coats

The application equipment: mixing units, distribution and circulating, spraying equipment (guns, electrostatics, bells,..), automatization (reciprocators, robots,...).

Note that the changes can come from a technical improvement, but as well from external requirements (new colors / appearances, new product specifications/performance,....)
Technological “jumps” are possible and the consequences could be to partially or totally replace the painting application. Numerous subjects are being developed with more or less success:

- In mold coating.
* In mold dry paint film.
- In mold paint technology (co-injection).
* Film transfer.
- High gloss molded-in-color.
* Etc, . . .

The fast evolution of fascia designs, materials, processes, equipment, requires lengthy and costly validatations on improved or new systems.
The “fire power” of the major system / service suppliers attract many Tier 2 suppliers for using their novelties before spreading them into the market. This is a strength for the service supplier but necessitates careful step by step experimentation to analyze and verify systematically all aspects and impacts of the “novelty”; not just those claimed by the supplier who sometimes forgets the “not so positive” aspects,....

Conclusion

Even after more than 10 years of experience painting TPO fascias in Europe, it is still a new profession and very complex.
To manage this complex system, it is necessary to master every “link of the chain”, as the chain will only be as strong as its weakest link.

Moreover, the evolutions are fast, from international origins and generate noticeable risks, on the technologic aspect, quality and costs. This brings the optimization of the chain to an even higher complexity.

In the present industrial context, the fascia / service supplier is the only one to master the complete chain for many different customers and markets. This gives him the best assets for managing the profession. But, painting remains a complex and uncomfortable job, therefore a high risk specialty for world-wide specialists / experts.

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