100 % Electrostatic Application of Metallic Basecoats

Dr. Bernd Biallas, Franz Stieber

BASF Coatings AG, Münster, Germany

Summary : Paint Application by electrostatic high rotation atomizers is the most efficient way of applying spray paint to car bodies in automotive OEM paint shops. Only the 2nd coat of metallic base coats usually is applied by pneumatic atomizers. The reason for this is due to color/design and process stability questions, both resulting from differences in atomisation and droplet deposition mechanisms of the two paint atomizing processes. The results in an applied metallic film are explained. A path towards a process is outlined, considering not only the spray process itself , but the whole process chain incl. :

- design
- the repair processes
- the manufacturers of plastic parts for the body
- the paint manufacturers in terms of paint reformulation and test equipment

The success of this process depends on the careful evaluation of the paint shop targets and the consideration of the total process chain.

Keywords : metallic base coats, atomization, efficiency, paint process

Introduction

In today's application of spray paints to car bodies, 2 processes of atomization are used .

First, pneumatic atomization, usually for interior parts of the body and for the second coat of base coat on the exterior surface.

Second, atomization by electrostatic high rotation , usually for application of primers, clear coats, solid top coats and the first coat of metallic basecoats on the exterior surface.

The driving force towards electrostatic atomization is due to transfer efficiency reasons. Pneumatic atomization at the average will achieve about 40 % of transfer efficiency, while electrostatic atomization reaches about 80 %. This means advantages in paint consumption, amount of waste and emission.

Differences in color shade from both ways of applying paint result from the atomization processes taking place : pigmentation is touched severely. So in order to find solutions for reaching high transfer efficiencies, the principles of atomization have to be considered first.

 CCC 1022-1360/00/$ 17.50+.50/0

Atomization

Both by pneumatic atomization and electrostatic atomization droplets in range of about 2 µm to 70 µm are created. The fundamental differences between both methods, however, are the droplet deposition mechanisms on the target. In pneumatic atomization, there is a straight forward movement of droplets, with speeds up to 12 m/sec to 15 m/sec. A high flow of atomization air also is directed towards the target. At the target, this air flow is turned around, carrying many droplets with it. Due to their inertia, mainly big droplets are deposited, the small ones are lost and form the overspray. These small droplets contain less effect pigments like aluminium flakes and are enriched in resin. A separation of the paint takes place in the spray fan.

In electrostatic atomization, the droplets leave the bell radially. Shaping air and electrostatic forces turn around the droplets towards the target, missing, however part of the bigger ones, that are lost as overspray. Unfortunately, they carry many effect pigments. Velocities are much lower, about 4 m/ sec, and in the middle of the spray fan even flow back was observed.

As a consequence, the pigmentations of the films created by the two different application techniques differ very much. Films from pneumatic atomization contain much more effect pigments than those from electrostatic atomization, see Figure 1.

The change in pigmentation also has been studied by Inkpen [1].

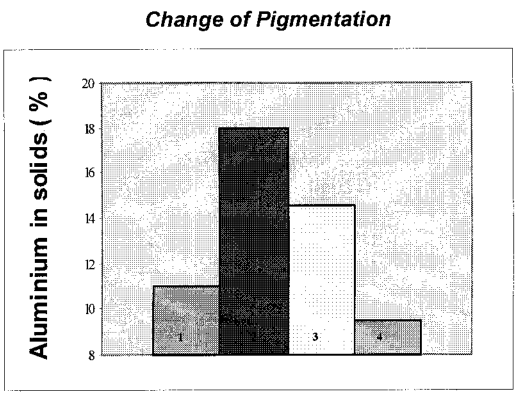

Figure 1. Aluminium content in 1 = wet sample, 2 = pneumatic applied film (270 ml/ min), 3 = pneumatic applied film (540 ml / min), 4 = electrostatic applied film (30.000 l/ min)

Microscopic investigations make transparent the different coverage with aluminium.

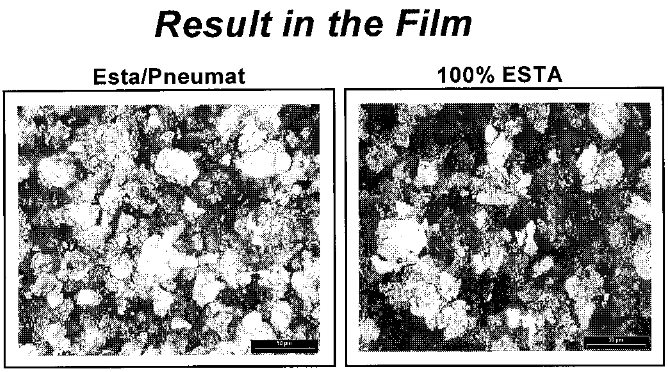

Figure 2. Microscopic view of metallic films : 1= applied by electrostatic plus pneumatic atomization (2 coats) , 2 = 2 coats electrostatic atomization.

But it is not only the amount of aluminium that varies. Also the particle size distribution of the aluminium flakes is changed [1] , making a compensation by reformulation more difficult.
Furthermore there is a change in color pigments : many colored metallic base coats contain pigments of different density. Due to the centrifuge effects described above, it is obvious that a change will occur here as well.
Also kinetic energies must be considered. Due to different droplet sizes and velocities, kinetic energy of droplets hitting the target from pneumatic atomization is about 50 times higher than that from electrostatic atomization. As a consequence, the parallel orientation of the metallic flakes can be influenced.

Consequences for metallic colors

It has been found, that turning towards 100 % electrostatic application, different metallic base coats react in different ways. Changing typical parameter of atomization, they react in different ways according to their pigmentation, see figure 3.
For some colors, for example dark metallics with low aluminium content, fine tuning of the parameter of an electrostatic bell will be sufficient to achieve the same color as from pneumatic

application. Modern atomizers offer a progress in terms of color matching.

For other base coat colors, just mere optimization of application parameter will not be sufficient - new pigmentation is required.

When turning towards 100 % electrostatic application, these will probably be the most cases.

A coordinated optimization of application parameter and reformulation will lead to satisfactory results. For a third group of base coat colors, however, it remains very difficult to achieve color match in all angles. In this cases, the acceptable tolerances for color match will decide about the feasibility of this process.

ESTA 100: effect on colours

Influence of:	Silver	Black (Alu / Mica)	Green (Mica / Alu)
RPM 50.000 → 75.000 1/min	effect improves ●●● ↑	lightness unaffected ○ →	lightness decreases (effect inverted) ●● ↘
SA 200 → 350 Nl/min	effect improves ●● ↗	lightness increases ●● ↗	lightness indifferent ○ →
Flowrate 80 → 160 ml/min	effect decreases ●●● ↓	lightness decreases (visibly darker) ●●● ↓	lightness decreases (visibly darker) ●● ↘
Stages (flash time) 1 stage → 2 stages	effect improves ●● ↗	lightness unaffected, chroma improves; ● ↗	Indifferent ○ →

Strength of influence: ○ ● ●● ●●

Figure 3. Response of different colors on changes in atomization.

Investigations of the films produced by pneumatic atomization and electrostatic atomization have shown, that it is not just color itself that changes. Taking into consideration the processes described above, it is understandable that also hiding power of a film applied by electrostatic atomization is lower – due to lack of effect pigments, that to a great extend are responsible for hiding properties. This means that defects resulting from the mechanisms of electrostatic atomization must be compensated by higher pigmentation in the paint leading to higher cost for pigmentation.

Other process qualities that are effected are metallic effect and sand mark coverage.

Figure 4 gives an overview on what was observed when moving towards electrostatic atomization.

From this experience it can be stated that when turning towards 100 % electrostatic application, each individual color has to be analyzed separately. And for each individual color a fine tuning of the application parameter and the pigmentation and formulation has to be adapted in order to compensate these defects.

Observations in the wet film

- Less aluminium pigments
- less pigments with high density
- change in particle size distribution of al-flakes
- poorer orientation of plakes

Consequences in dry film

- P/B - ratio lower
- stronger color
- less hiding power
- less sand mark coverage
- Haze
- poor metallic effect

Figure 4. Observations in wet and dry films applied by electrostatic atomization compared to pneumatic application.

Paths towards ESTA 100

An option towards 100 % electrostatic atomization of metallic base coats is that this process is considered as the master. All other processes like design and color development, the application for plastic parts, the repair processes in the factory and after sales and the paint production / tinting operations have to accept that and take care of that. This process has to start with the introduction of new colors, where right from the beginning of color development those colors are created by application via electrostatic atomization. Here mainly design is involved, since ESTA-100 – colors look different.

This means the target can only be achieved by coordinated action of all partners involved.

A second option exists, when existing colors are to be transferred towards electrostatic atomization. Additionally to option 1 color match towards other lines / plants has to be considered. So each individual color of the color program has to pass an „ ESTA 100 – assessment".

Process considerations

A typical metallic base coat line will use a 2 – coat application of the base coat. It has been found out, that going towards 100 % electrostatic application, a 2-coat – process is favorable as well with respect to color match.. This means that the pneumatic zone can be used for electrostatic application.

Process comparison
(e.g.: base coat line 4.5 m/min)

Parameter criteria	standard bell+air	bell	bell + bell (on recipro, robot)	bell + bell (two full stages)
no. of machines, atomisers	9 bells + 6 guns	9 bells	9 bells + 2/3 bells	9 bells + 9 bells
booth length	8 + 5 m 13 m	8 m	8 + 5 m 13 m	8 + 8 m 16 m
investment and costs	+/-	+	+/-	-
maintenance, housekeeping, cleaning	+/-	+	+/-	-
TE % (example)	75% + 40%	65 - 75%	75% + 65%	75% + 70%
base coat consumption (example)	100 % +/-	80 % +	80 % +	80 % +
paint dump (rinse, purge, colour change	+/-	+	+/-	-

Figure 5. Process advantages and constrains.

The higher the number of atomizers, the higher the losses for purging. The feasible and right solutions very strongly depends on line speed that is to be realized.

Besides the topcoat line, repair processes have to be considered in detail. Using special tinted paint in the topcoat line, pneumatic repair of body parts is hardly possible. Spot repair with special repair material was found to be feasable.

Plastic parts often are painted at a different place. Also these paint processes have to be considered in order to achieve color match between hang-on parts and the car body.

Last not least the paint suppliers have to prepare themselves for this way of base coat application in development and paint production. To exploit the advantages of a more efficient basecoat paint application in the car assembly process the color development effords will increase substantially.

Conclusions

The tasks that have to be done when turning towards electrostatic atomization for metallic base coats can be deducted very clearly from the basic physical mechanisms taking place during atomization, droplet transportation and droplet deposition.

The benefit of high transfer efficiencies can only be gained by joined effort and contribution of all parties involved in the process chain.

References

[1] Stuart Inkpen , „ Electrical and Mechanical Mechanisms for Color Variation in the Spaying of Metallic Paints“, Massachusetts Institute of Technology, 1986