Plating on Plastics. Substrates and processes, state-of-the-art and future developments

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The beginning of commercial metal plating of plastic materials dates back to the sixties. This was the time when ABS (acrylnitrile-butadiene-styrole) was discovered as a basic material for an adhesively strong coating with outstanding moulding characteristics.

Today, electroplating of plastics is more than ever subject to change. While the electroplating of plastics, with usually ABS and ABC/PC blends as the substrate, is applied for decorative plating techniques in the industry, functional and decorative coating of innovative materials is increasingly gaining significance. This is a great challenge for platers, since the employed basic materials cannot be coated satisfactorily using the conventional techniques (e.g. through the use of chromium-sulfuric acid). Therefore, innovative systems and processes which take into account these new challenges had to be developed. This means, apart from conventional coating technologies, alternative processes are available today.

The nineties saw a revolution in metal-plating of plastics: The *Futuron* technology developed by Atotech for the first time allowed direct coating of plastic surfaces. The main edge of *Futuron* over conventional techniques is seen in the fact that all the steps inherent in electroless metal-plating become unnecessary. To date, these steps were absolutely necessary for the plating of a dielectric material. In the conventional process, electroless chemical nickel and copper baths were used after the plastic surface had been prepared and activated. The galvanic coating was then applied to the electroless chemical deposition.

With *Futuron* no electroless chemical metal plating is used. A potential source of error is thereby eliminated in the plating-on-plastics process.

So far chromic sulfuric acid has been used as the etching process on a large scale and many years later plating of ABS and ABS/PC is still based on the same principle.

By the use of alternative etching solutions it is now possible to apply adhesively strong coatings on a multitude of plastics which had been unplatable to date. An organic solvent is generally used as the swelling medium combined with a subsequent conditioning step. These process steps form the basis for adhesive metal plating.

Fig. 1 – Process Noviganth AK vs. Futuron

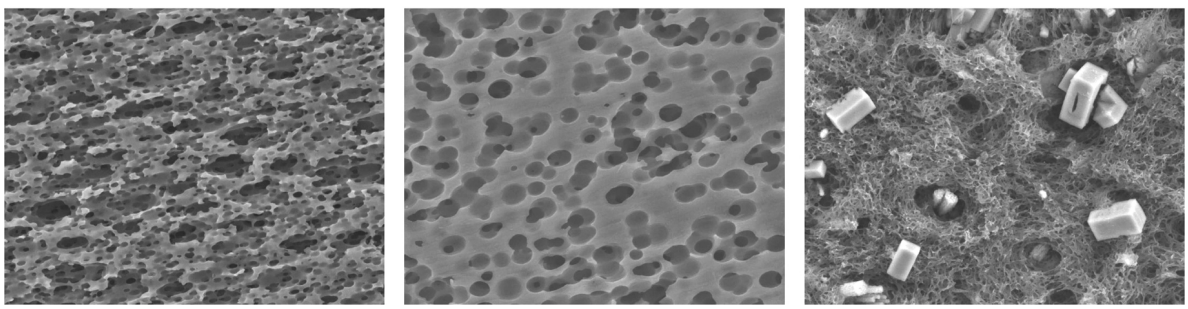

Fig. 2 – ABS and ABS/PC after the chromic-sulfuric acid, PA after swelling

A new generation

In recent years, polyamide (PA) has proved to be a plastic material suitable for a great variety of industrial applications.

Polyamide is inherently stronger and more rigid than ABS or ABS/PC. As a thermoplastic, polyamide can be readily processed from a liquid state.

Fig. 3 – Application examples sanitary industry

It has temperature stability from -30°C to around 110°C. In addition to this it has excellent low-friction behaviour and good thermal co-efficiency expansion characteristics with the metals that are later electroplated. Polyamide has high impact strength, a small amount of memory (elasticity), is abrasion resistant and vibration reducing[1].

The low fusion viscosity of polyamides makes them easy to work. Put simply, polyamides have outstanding physical properties, combined with low weight and also low manufacturing costs.

Polyamide is differentiated by the number of polar amid groups (PA 6, 11, 12, 66), which, at the same time, indicate the difference in the material compared to ABS-/ABS-PC blend plastics. Although the principal application of chromic-acid-etching solutions attacks Polyamide to a certain extent, it does not obtain the required decorative results. Another influencing variable are the fillers (in general, minerals such as glass fibers) which – depending on their condition – must be considered in the pre-treatment [2/3].

The elimination of chromic sulfuric acid as the etching solution and the short but reliable pre-treatment of new substrates with a new swelling and conditioning solution is a further advantage of this novel process. The sweller and the composition of the subsequent solutions must be carefully tuned, since only carefully optimized parameters ensure good metal plating, with good adhesion.

A process that is suitable for one type of plastic may be unsuitable for another, as each individual plastic material behaves differently. Even the slightest modifications within a plastic type may give deviating results at equivalent pre-treatment methods. Both various pigments and a diversity of fillers can influence plastic characteristics. Another influence not to be underestimated is the moulding of the plastic material prior to the plating process. The development of new processing technologies and equipment will lead to potential savings in terms of raw material and energy.

Atotech's new polyamide pre-treatment method, Noviganth PA, offers many benefits for the electroplater, as no chromic-sulfuric acid is needed. The system is distinguished among other things by its ease of use and short but reliable pre-treat-

ment. The Noviganth PA system is especially suitable for mineral filled polyamides which, for example, are used for door handles in the automotive industry. Thus, plating a strong but light plastic such as polyamide is seen as a contribution to the automotive industry's endeavours to reduce the weight and fuel consumption of vehicles.

Smoothness of the surface (e.g. "orange skin") in the plating of plastics plays an important role for appearance and adhesion of finished parts.

This swelling and conditioning steps should ensure uniform roughening and functionality of the surface. These steps form the ideal basis for the subsequent activation of the surface with precious metal ions, usually palladium-containing processes. Only an optimized pretreated surface will result in perfectly adhesive metal deposition. In an activation step, palladium will be adsorbed on the surface. The reduction step reduces the palladium, while a catalytic activation of the surface is generated on the plastic which can then be nickel-plated.

Conclusion

The present method shows that a highly adhesive and decorative coating of polyamides can be ensured. Apart from extending the spectrum for production with regard to the above plastics, further advantages are achieved with the modified pre-treatment of polyamides. For example, better coating results are obtained not only through the fact that chromic-sulfuric acid is no longer necessary technically, as in the case of conventional processes but also with respect to ecological concerns in the use of Cr(VI).

Atotech's processes have gained a worldwide reputation as proven methods for the metal plating of ABS, ABS/PC blends, PA, PC and other plastics and are qualified by many major automotive manufacturers. Besides the automotive applications, numerous major manufacturers in the sanitary industry have full confidence in these processes. The described systems are synonymous for highly adhesive, premium-quality and extremely decorative coatings. Users will truly benefit from these characteristics, as economic and technical advantages are realised.

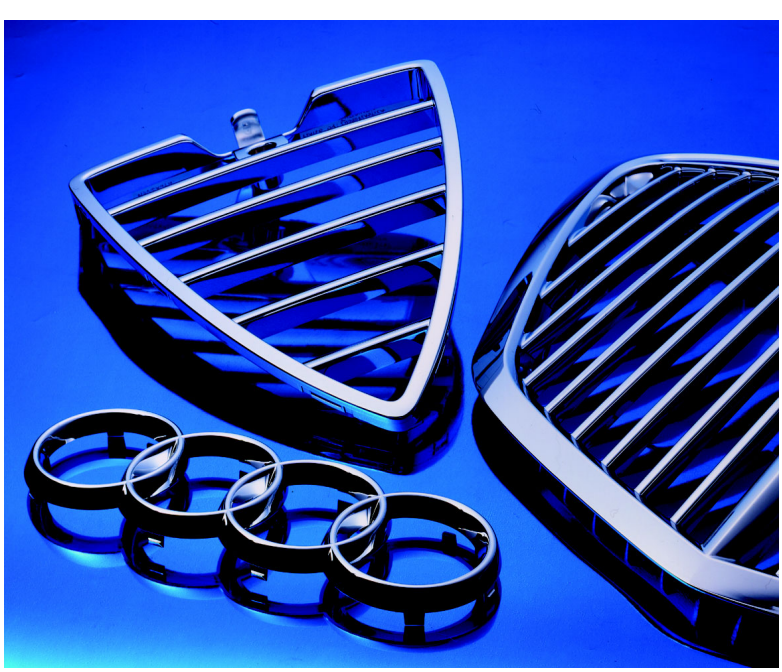

Fig. 4 – Application example automotive industry

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About the author

Mariola Brandes, born in 1966, since 1989 engaged in surface technology. She joined Atotech Deutschland GmbH in 1990, first working in research and development, and later switched to worldwide product management of Plating on Plastics and Copper Processes.

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