METAL DECORATION BY DECORAL® TECHNOLOGY - SUPERDURABLE WOODGRAIN

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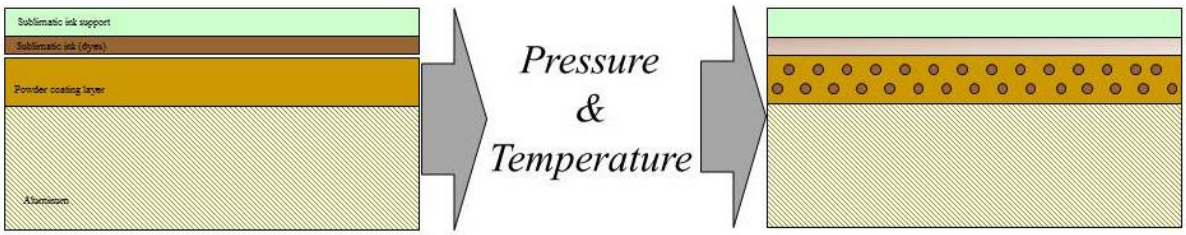
Abstract
The finishing of metals, obtained by sublimation on polyurethane powder coated substrates has achieved excellent results in terms of outdoor resistance. Nonetheless recent developments in coating technology have dramatically pushed the old achieved performance levels up. The polyurethane powder coatings of superdurable series by Decoral System® have opened new fronteers of higher performance for this popular decoration technology.

Market and Technological Developments
The increasing demand of woodgrain finishings, or, generally speaking, decoration finishings on metals by heat-transfer process has imposed significant efforts to companies involved in this business: from decoration process management to raw materials' manufacturing. Decoral System®, market leading company as far as supply of turn-key plants, raw materials and know-how for this technology is concerned, has recently developed and marketed a new series of powder coatings specifically designed for heat-transfer technology. Superdurable Series (DS 04XXS and DS 07XXS) achieves a significant improval in outdoor durability performance, unattainable to standard powder coatings.

Sublimation as physical transfer process
The process of sublimation, also known as thermal transfer, which was adopted by Decoral System® since Nineties requires the use of special polyurethane powder coatings showing a high compatibility with sublimation inks; on the other hand sublimatic inks are characterized by the presence, when formulating, of a special class of dispersed dyes, capable, at a given temperature (about 200°C), of moving directly from solid to gaseous state. Only later, after cooling and returning to the solid state, they will remain in solution, in the coating strate. (Picture 1).



Picture 1: process of sublimation, ink transfer in the pre-coated layer of coating.

Heat-transfer, fields of application

The main advantages of Decoral System® heat-transfer technology consists of the high definition of the output, its versatility on processable shapes (it can be applied to various types of extruded products, i.e. profiles, laminates and solid objects), materials and fields (provided that shapes can be powder coated and then decorated). Tailor-made pictures and patterns can be obtained. The maintenance of decorated surfaces is absolutely simple and quick. The most basic condition to apply heat-transfer process is resistance without deformation to the process of sublimation temperature (about 200°C for 10 minutes).

The superdurable polyurethane powder coatings

Decoral System® has developed a powder coating which gives the finished product improved outdoor performances. The special formulation of these coatings, requiring special polyurethane resins with high resistance properties to degradation and an innovative combination of UV absorbers, holds for a high resistance to light (especially as far as short wavelengths are concerned) and weather conditions (heat and humidity), which are the most significant agents of degradation.

How to measure outdoor performance

To evaluate the resistance of the finishes two types of tests are used:

- Accelerated Weathering Test
- Natural Exposure Test.

In the first case, tests are conducted in lab, it means they are controlled and repeatable. They are meant to accurately simulate and recreate some of the factors of a natural exposure.

In the second case, tests are conducted in a real environment: it means they are not predictable (i.e. affected by the real climate) and their purpose is to control and confirm the results of Accelerated Weathering Tests. In Decoral® R&D laboratories are routinely

conducted hundreds of tests of this type to assess/monitor reliability of current and under development finishings.

Accelerated Weathering Test

All samples are exposed to radiation of Xenon lamps and to wet/dry cycles by special equipment (Q-Sun, SOLARBOX), see Picture 2. Such equipment is used in accordance with international standards imposed by norm ISO 11341, i.e. complying with the following settings:

- light intensity, 550 ± 20 W / m ^{2} (290-800 nm)
- black panel temperature, 65 ± 5 ° C
- wet cycle 18 minutes
- dry cycle 102 minutes.

At the end of the test, whose minimum duration is 1000 hours, Residual Gloss (EN ISO 2813, with an angle of incidence 60°) and Color Variation ΔE (CIELAB method - ISO 7724 / 3) are measured comparing pre-test values. In this way it is possible to evaluate the aging of surfaces using standard indexes. The accuracy of the test is verified through the use of samples in white, whose aging behaviour is known.

Picture 2: equipment for the Accelerated Weathering Test.

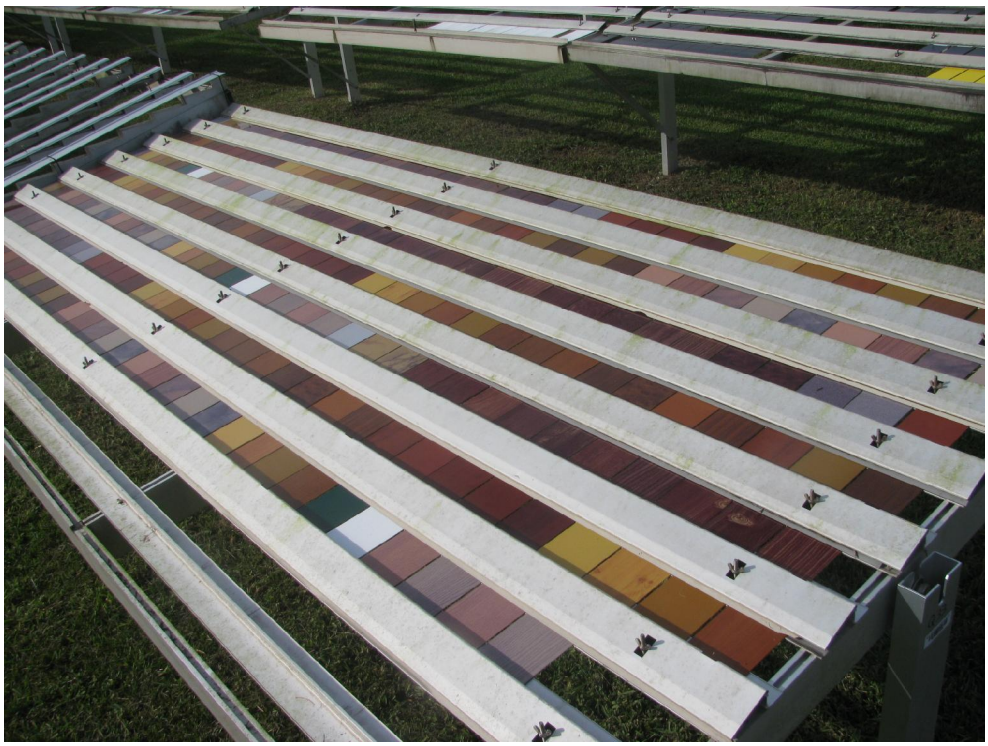
Natural Exposure Test

Natural Exposure Tests are conducted in Atlas Weathering Service Sites – Florida (Picture 3). South Florida climate indeed is hot, wet and higly exposed to UV-rays. All

samples are subjected to natural irradiation in Florida according to the international standard ISO 2810, i.e. complying with the following specifications:

- facing south
- tilt angle 5° from the horizontal
- open backing.

After 12 months exposure period, residual gloss (EN ISO 2813, with an angle of incidence 60°) and color variation ΔE (CIELAB method - ISO 7724 / 3) are measured comparing pre-test values. Even the Natural Exposure Test accuracy is verified by through the use of samples in white, whose aging behaviour is known.



Picture 3: Florida Natural Exposure, test samples.

Preparing Sample Surfaces for Testing

All samples subsequently subjected to AWT or NET are prepared as follows:

- application of powder coating, carried out in compliance with the parameters set by TDS both in terms of temperature and time (20'@ 200°C)
- heat-transfer process was conducted in compliance with the parameters described in TDS, in terms of minimum temperature that the metal must reach (200°C).

Sample Preparation for the Comparative Test on Superdurable Products

Two sets of samples were prepared, one using superdurable powder coatings, (Series DS 07XXS, including the samples A1, B1, ..., N1) and one using standard series coating

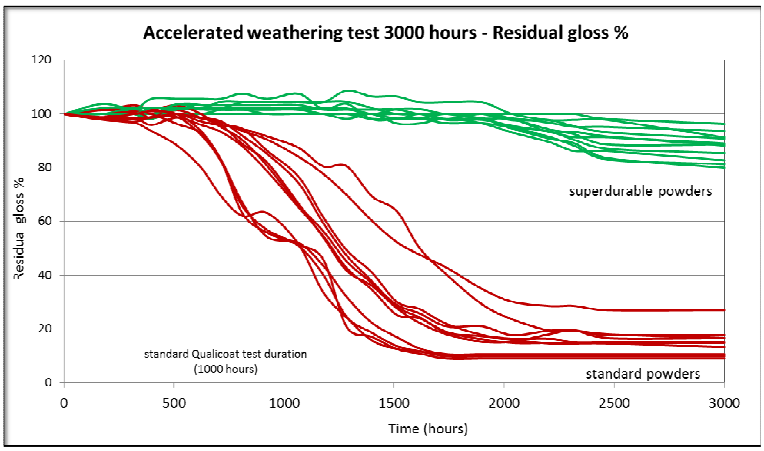
(DS 7XX series, including the samples A2, B2 , ..., N2). Different shades of coating and different codes of heat-transfer film finishes were combined in order to obtain a significant and representative range of woodgrain finishings.

Superdurable vs Standard

As previously described, the two sets of products have been tested through a comparative AWT of 3000 hours (3 times the minimum time value required by the most renowned International Specifications, 1000 hours) and to a comparative NET in Florida for 12 months.

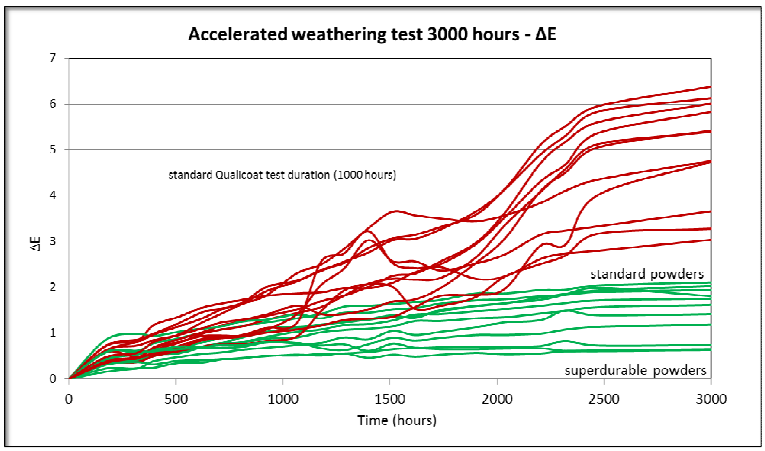
Comparative Performance of samples subjected to AWT

The measurement of residual gloss, carried out on samples subjected to AWT after every 100 hours, shows that the value is significantly more stable in the samples prepared with the coating of Superdurable Series. After 3000 hours, on all superdurable tested samples, the value of residual gloss percentage is even higher than 80%. Standard Coating Samples, although meeting the minimum requirements of the international specifications (>50% residual gloss), after a thousand hours, show a significant loss of surface gloss, due to the initiation and propagation of radical reactions, started by UV irradiated on the samples. Note the sharp behavioud difference of the two sets of products, in Picture 4. Samples marked with green colour show a small degradation (residual gloss close to 100%).



Picture 4: residual gloss behaviour graph.

In terms of color variation, all samples prepared with coatings Series DS 07XXS show a greater stability to irradiation by xenon lamps. None of the samples in green in Picture 5, exceeds 2 ΔE value Standard products show higher values of ΔE, whose variation depends also on the specific type of finishing.

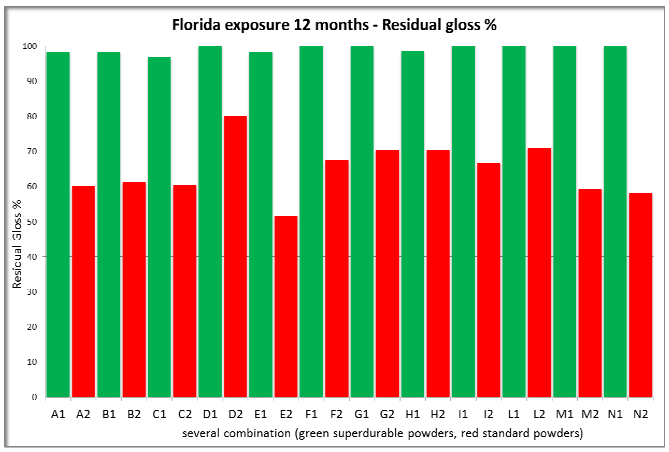


Picture 5: colour variation graph.

Comparative Performance of samples subjected to NET

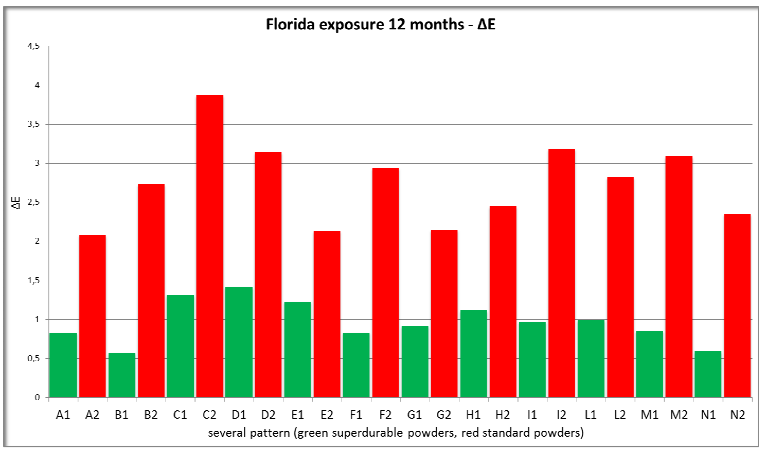
Coming back after 12 months exposure in Florida, samples were washed, subjected to instrumental measurements and showed the following behaviour:

- on finishes made with superdurable powder coatings, gloss values are virtually the same, staying close to 100% (Picture 6, samples in green)
- on finishes prepared with standard coatings gloss retention is reduced, even if complying with >50% tresholds set by International Specifications (Picture 6, samples in red).



Picture 6: 12 months NET in Florida, comparison between the values of percentage of residual gloss, green samples representing superdurable products.

In terms of colour variation, samples prepared with coatings DS 07XXS series are performing definitely better (all sample show ΔE values of less than 1.5).



Picture 7: 12 months NET in Florida: comparison between the values of measured ΔE, green samples representing superdurable products.

Specifically, we can state that the results obtained with the comparative AWT are absolutely confirmed by comparative NET. The performance of samples prepared with standard coatings, exposed for 12 months in Florida, is consistent with the performance of the same samples subjected to Accelerated Weathering Tests after 1000 hours, both for Gloss Retention and Colour Variation.

Conclusions

The results obtained so far are very encouraging and allow to link the new experiences in formulation to improved performing finishings, using Superdurable powder coatings. Moving from Standard Series to DS 07XXS Series, decorated surfaces with high resistance properties to elements can be obtained. Therefore unexplored new fronteer unfold for heat-transfer technology, especially in those markets where need for reliable warrantable finishes are strong.

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