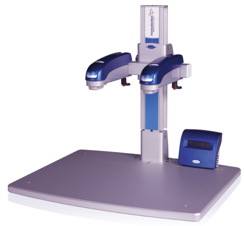
Application note
HORUS

Effect of the substrate on the drying: evaluation of pre-coating suitability for aeronautical coatings



Introduction

In aeronautical coatings, the number of layers spread on the aircraft has been multiplied in recent years. Every layer has its specific function, and most often, they are provided by different manufacturers. Pre-coatings can significantly influence the drying behavior of the subsequent layer. In some cases the pre-coating retards the drying of the next layer, which leads to longer drying times.
In this work, we will show how HORUS can answer to this important issue, as it measures the drying on the specific substrate which is used for the application. The drying behavior of a polyurethane resin is analyzed on aluminum and on a pre-coated aluminum substrate used in aeronautical industry.

Method reminder

Horus® uses an optical method based on the multiple backscattering of laser light. A laser is sent on the film layer, where it is backscattered. An optical detector take pictures of the interferential images, also called speckle images. These images will change in time due to the Brownian motion of the particles. A patented image processing algorithm enables to obtain the Fluidity Index (FI). The lower is this index, the lower is the viscosity of the coating and the more advanced is the drying process.
The Fluidity Index will change in different rates, which will enable to distinguish different characteristic phases during the drying process, such as open time, dust-free time and complete drying.
One of the key assets is that the substrate can be adapted according to the application (glass, metal, ceramics, wood, ...).

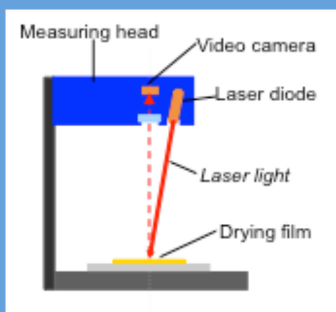


Figure 1. Schematical representation of the Horus configuration.

Results

Figure 2 shows a typical kinetic of a Horus measurement of a polyurethane based paint on non-treated aluminum. This process usually consists in 4 phases:

- Phase I: Decrease of the Fluidity Index. This phase is mainly characterized by solvent evaporation. The end of this phase is given by the characteristic time T1.
- Phase II: Fluidity Index decreases significantly, indicating an increase of viscosity due to cross-linking of polyurethane. T2 characterizes the end of this phase.
- Phase III: Fluidity Index decreases continuously, but less rapidly. This is the longest phase and ends with T3.
- Phase IV: Fluidity Index does not evolve anymore. The coating is entirely dried.

The times T1, T2 and T3 may be attributed to different characteristic stages of the drying such as “tack free time”, “dust free time”, etc. depending on the paint type.

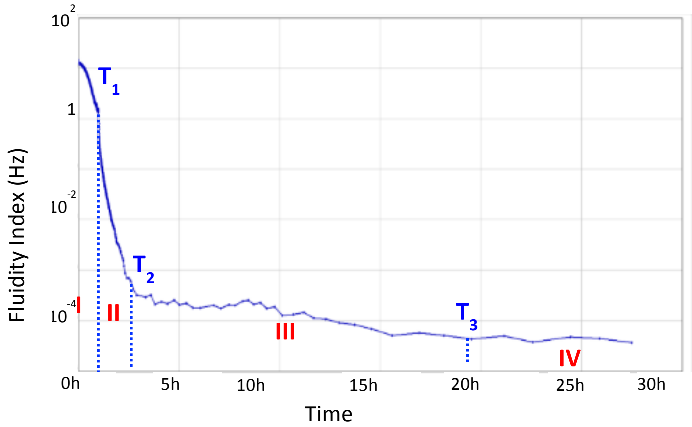


Figure 2. Typical evolution of Fluidity Index (FI) during drying for a polyurethane resin paint.

Figure 3 shows the evolution of the Fluidity Index of the same polyurethane paint on aluminum (blue) and on pretreated aluminum (green).

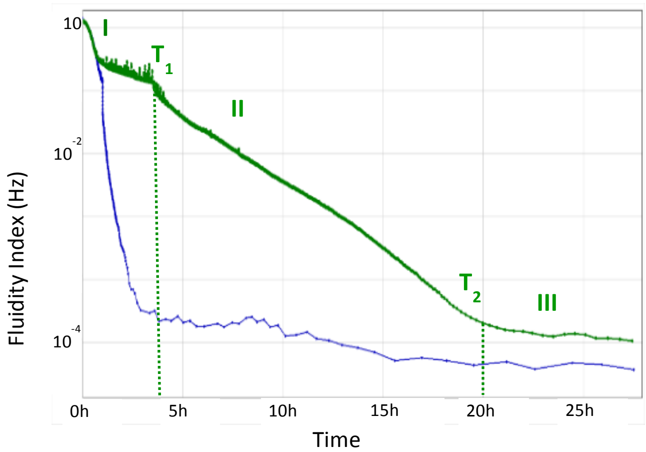


Figure 3. Comparison of the drying for a polyurethane paint on aluminum (blue) and on the pre-coated substrate (green).

The drying steps are the same for the two substrates, which indicates the same mechanism of drying.
Nevertheless, polyurethane paint drying on pre-coated aluminum was significantly delayed. On the pre-coated substrate, the time to reach T1 is three times longer than on the untreated substrate. The time to reach state T2 was even six times longer on the pretreated substrate. The use of this pre-coating would then lead to longer production times, which may not be acceptable.

Substrate	T1	T2	T3
Aluminum	1h	2h 50	19h 30
Pre-coated Aluminum	3h 25	20h	N/A

Summary

Measurements with HORUS evidence the impact of pre-coatings on the drying behavior of paints used in aeronautical industry. In this particular case, it was shown that the pre-coating is not suitable for the subsequent application of urethane paints.

Benefits

FAST - Possibility of 4 simultaneous measurements
ACCURATE - No dependence on the operator, precise and automated results, free choice of the substrate
EASY - 1-click experiment and data-treatment