



How to reduce warpage of melamine laminates

Bert Stijnen, BSc.
Technical Service Manager, Melamine Skill Center
DSM Melamine
e-mail: bert.stijnen@dsm.com

Dr. Jan Jaap Nusselder
DSM Melamine
e-mail: jan-jaap.nusselder@dsm.com

Summary

Melamine and phenol formaldehyde (MF and PF) cellulose based laminates (HPL, CPL, LPL) are being used extensively in the panel industry. Despite their many advantages, flat panels produced from such materials have a tendency to warp immediately after processing as well as in subsequent service time.

In this paper some aspects affecting the warp of panels have been studied by using different analytical techniques.

The results from the investigation showed that:

- Low volatile content of the impregnated paper results in a better dimension stability of the final laminate.
- The effect of the MF resin chemistry (molar ratio, starting pH) on dimension stability is minor, but not negligible.
- Porosity and morphology of the laminate is related to volatiles of the impregnated paper.

Background

In the steadily growing market of laminates and flooring, the dimensional instability of the final product in varied climates causes warpage and is still considered as a serious problem. The dimensional instability limits the choice of design and put restrictions on the dimensions of the produced laminated panels.

Warp in this publication is defined as the center deflection to the edge or to the diagonal of a panel.

The warpage can be explained as the imbalance of stresses over the cross section of the panel. Among many variables, asymmetric moisture distribution across the panel thickness probably plays an important role in causing such a stress imbalance and can appear during production, storage and use.

Besides the moisture distribution across panel thickness, other important factors that contribute to warping are possibly the modules of elasticity and the linear expansion of the individual laminates and their thickness ratios.

Dimensional instability in laminates might be a problem that arises from the cure kinetics of the resins involved as well as from in-service moisture absorption. The thermo visco elastic properties induce internal stresses of MF and PF cellulose composites.



A clear visco elastic response allowing time-temperature superposition in a bi-phase material could be foreseen, as well as high levels of internal stress build-up on cure due to the high cross-link density and therefore shrinkage of the cured resin and low compressive modulus of the fibers.

The influence of hygro-thermal properties on the dimensional stability of composite materials, such as laminates, aiming towards the fundamental understanding of the process-structure-property relations of Melamine- and Phenol-based composites is studied by:

- 1) Process build up on cure, shrinkage, defects and the influence of resin stresses and defects on moisture diffusion and relaxation behavior.
- 2) Service (relaxation), moisture diffusion, moisture induced profiles and the influence of visco elastic relaxation as a function of sorption kinetics on dimensional stability, as well as influence of process on fiber/matrix/interface stresses, ply deformations and laminate dimensional stability.
- 3) Structure and dimensional stability and mechanical behavior.

All this is based on the mechanical property concepts including: stress concentration, brittle-toughness transition, visco elasticity and tertiary structure (polymer morphology). However, we most probably cannot explain physical property variations such as dimensional instability based on primary and secondary structures alone.

Besides these investigations a more pragmatic approach to solve the problem of dimensional instability (then the one given above) is needed.

Project

Therefore the aim of our project was to improve the MF-cellulose part of the laminate in both, longitudinal and cross fiber direction, and to meet the demands on dimensional stability within the existing laminate concept.

In order to realize this, the following steps were performed:

- Collecting data of currently used overlay and substrate material
- Studying the influence of resin chemistry and process parameters at impregnation (Variation of molar ratio, pH at resin synthesis, volatiles of impregnated paper)
- Correlating input data with the results of the warping experiments
- Developing practical guidelines for the laminate production to improve quality

The investigations were done on lab scale trials, pilot scale trials as well as production trials.

The dimension stability and surface properties in different climates were analyzed by using: deflection measurement of center versus edge, permeability test for water vapor and He-gas, proton relaxation measurements, SEM and DMA.



Results

The investigation resulted in:

1. Volatiles of impregnated paper have high impact on warpage

Lowering the volatile content in the MF-impregnated overlay and MF-impregnated decorative paper increases the dimension stability of laminates in longitudinal and crosswise direction.

In other words, the B-stage moisture, measured as weight loss of the paper at cure, is strongly related to the C-stage property "dimensional stability".

The understanding of the correct moisture level, together with its corresponding process parameters, results also in a material with closer surfaces.

These results highlight the importance of the MF-cellulose part to the final product property.

2. MF resin chemistry has lower impact on warpage

The effect of the resin chemistry on the dimension stability is minor compared to that of the volatile content in the impregnated paper, but should not be underestimated.

The F/M ratio = 1.5 resulted in better dimension stability and clearly showed a number of other benefits, compared with the MF resin with higher F/M ratio.

Benefits are:

Larger processing window, good impregnation properties, no sticking, simple resin formulation, environmentally friendly, reduced brittleness in the B-stage at low levels of moisture content.

For more information:

Bert Stijnen, BSc.

DSM Melamine

P.O. Box 18, 6160 MD Geleen, The Netherlands

+ 31 (0) 46 476 64 21

www.melaminebydsm.com