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Session 2 "Adhesives and Glueing"

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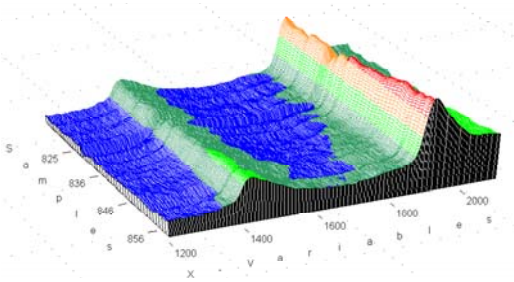
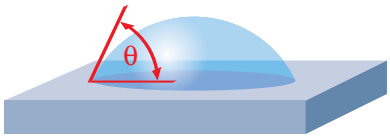


Wood Modification and Processing



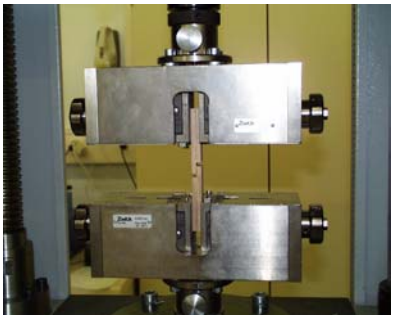
Adhesives and Glueing

Post Conference Edition of the Proceedings of the International Symposium „Wood Based Materials"

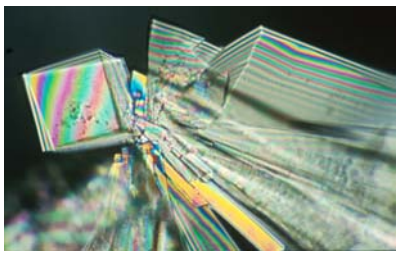
organized by COST Action E13 „Wood Adhesion and Glued Products" and „Wood Kplus"

The issue covers the post conference edition of the proceedings of the symposium „Wood Based Materials – Wood Composites and Chemistry", which was organized by the Competence Centre for Wood Composites and Wood Chemistry „Wood K plus" in cooperation with the COST Action E13 – Wood Adhesion and Glued Products" in Vienna, Sept. 2002. The proceedings comprize 5 key-note lectures and 27 oral presentations, a summary of the Cost Action E13, a presentation of the Austrian Competence Center „Wood Kplus" as well as 30 Posters with following topics:

- Wood modification and processing
- Adhesives and glueing
- Compound materials and glued products
- Wood chemistry and biotechnology



Compound Materials and Glued Products



Wood Chemistry and Biotechnology

Abstracts and Summaries

Combination of different analytical methods for the investigation of UF- and MUF-adhesives

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Summary

More than 80 different industrially produced UF- and MUF-adhesives were analysed by several techniques (GPC, NMR, chemical analysis). All results were evaluated by two different statistic methods (principal components analysis and cluster analysis). The results show correlations only within one analytical technique. It has to be accepted that results determined by different analytical techniques are difficult to compare. To characterise an adhesive it is necessary to use the analytical methods carefully. Nevertheless one new relation was discovered between the number-average of molecular weight (M_n) and the ratio of formaldehyde to amino groups (F/NH_2), which is equal to the molar ratio (U:F or M:U:F).

In the adhesives formaldehyde does not react as a crosslinking but only as an elongation agent. An uncured adhesive is composed of mostly linear molecules with some potential crosslinking centres.

Evaluation of Adhesive Cure during Hot Pressing of Wood-based Composites

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Abstract

Hot pressing is the most energy and cost intensive step during production of wood-based composites. Therefore, it is claimed to minimize curing time by tailoring wood material and thermosetting adhesive on pressing conditions. The wood particle-adhesive interaction within a wood composite mat is highly complex and in terms of the curing process not totally understood. In order to characterize the bond strength development of urea formaldehyde resin (UF) in wood-based composites during hot pressing, two new methods have been developed. Both systems are described and initial results are presented. The first method is based on internal bond measurements. Resinated wood fiber mats are pressed under highly controlled conditions and subsequently tested in tension mode. The second method is based on the 'Automated Bonding Evaluation System' (ABES). Miniature fiber discs are pressed and tested in shear mode within the pressing setup. The effect of pressing parameters like temperature, final mat density and adhesive percentage associated with pressing time on bond strength development are shown. Furthermore, influencing parameters like core temperature level, density profile and stress relaxation due to changing press parameters have been identified and their effect on bond strength is evaluated.

Identification of one-component PU adhesives by analysis of cured glulines

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Summary

A pilot test aiming at identification and characterisation of one component PU adhesives was conducted. The glulines from five sets of wood samples glued with one component and two component PU adhesives were studied. The gluline samples were produced by three different adhesive brands produced by two different manufacturers.

Cold fractured cross sections of the gluline samples were analysed by means of scanning electron microscopy (SEM) and energy dispersive X-ray analysis (EDX). Porosity of adhesive and the penetration of adhesive into the wood were determined. Presence and type of filler was determined.

Gluline samples were treated with various degradating reactants to be able to perform a separation of the different components of the adhesive, i.e. the polyoles and isocyanate complexes. After separation of the different components by TLC, HPLC or GPC, the components were identified by FTIR combined with ATR-technique, GCMS, FTIR, and TOF- SIMS.

The results of the study show that samples of cured glulines can be used to identify the adhesive brand used. The chemical analysis of samples made from different production batches of the same adhesive showed some differences, although it is not presently clear whether these reflect variations in the analysis procedure or real differences between specific production batches.

The results indicate that it is possible to use stored samples of hardened glulines for identification of the adhesives used in glued products, as well as for identification of uncured resins.

The porosity of gluline samples observed in the microscopy analysis showed clear correlations with the mechanical strength of the gluline.

EMDI isocyanate resin for particleboard: The effect of process variables on its bonding efficiency

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Summary

This paper describes research undertaken to examine the effects of mat moisture content (MC), platen temperature and wax content upon the bonding efficiency of EMDI resin, as determined by internal bond strength measurements. It was found that the MC of the mat and the platen temperature did not significantly affect the bonding efficiency of EMDI bonded boards. However, the inclusion of 1% wax did significantly affect the bonding efficiency of EMDI resin.

Surface interactions of wood with adhesives

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Summary

Properties of wood surfaces, and particularly their interactions with adhesives was studied.

The surface inactivation of wood due to the development of chemical weak boundary layers was monitored by wettability studies based on contact angle measurements. The time dependence of the formation of such weak boundary layers was determined for Scots pine and Norway spruce. To evaluate the wettability data, a *constant wetting rate angle* (cwra), representing the situation when a liquid droplet spreads on the surface at a constant rate, was determined. For planed surfaces there was typically a linear reduction in wettability during a week after machining, whereas sawn surfaces exhibited a time-lag of a few days before the wettability started to decrease. A comparison of surface wettability data with quantitative and qualitative analytical determinations of lipophilic wood extractives revealed a rather complex picture, the wetting behaviour being dependent on the storage time after the machining of the surface. The time-dependent surface inactivation data can be used to assess performance requirements for optimum adhesion in industrial gluing and coating processes.

The relation between glue adhesion properties and wood extractives content was evaluated by a standard shear strength test and a non-standard fracture test on pine heartwood material classified according to its content of lipophilic extractives. For specimens assembled with a water-resistant polyvinyl acetate adhesive, glue adhesion properties were to some extent negatively affected by the existence of resinous weak boundary layers. Failure was more likely to occur at high wood extractive contents, roughly above 7%.

Simulation of the effects of a cooling zone in the internal conditions of MDF continuous hot-pressing process

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Abstract

The more recent innovation in the continuous hot-press is the introduction of a cooling zone in the last section of the press, at two thirds of press length. Many economical and technological advantages were reported, namely a decrease of steam pressure (lower risk of blisters and delamination), better dimensional stability and internal bond of the boards, less gas pollution and power savings. The understanding of the combined effects of the physical-chemical-mechanical phenomena involved in the hot-pressing of MDF is very important for better operating practices and process design through the introduction of such technological innovations. A model is presented for this operation and integrates all mechanisms involved in the panel formation (heat and mass transfer, chemical reaction and rheological behavior). This dynamic model permits the simulation of the effects of the cooling zone in the internal conditions, predicting the evolution of temperature and gas pressure along the press length and also the temperature and density vertical profiles at the end of the press. The model performance was analyzed using the typical operating conditions for the hot-pressing of MDF with a cooling section and the results were compared with experimental data from literature obtained in an industrial press. This model could be a good tool for optimization and control of the press cycle and also for the scheduling of this operation in order to improve process efficiency through an increase of energy savings, better quality and reduction of VOCs and formaldehyde emissions.

Comparative behaviour of exterior grade wood adhesives for high MC timber gluing

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Abstract

Gluing of high moisture content timber (MC between 18% and 30%) at ambient temperature has been shown to be perfectly possible by using PRF and MUF fast-setting, separate applications honeymoon-type adhesives, as well as by using single application polyurethane (PUR) adhesives. The polyurethane appeared to be the faster bonding one due to its water-induced hardening reaction, but with the other two adhesives presenting also good performance. However, the need to maintain the bonded but wet wood joint clamped until reasonably dry to avoid wood distortion indicates that anyone of the three adhesives is equally good to bond wet wood and that it is the higher rate of setting/curing which determines the capability of the adhesive to bond wet wood.

However, the existence of the very marked temperature-dependant creep in wood joints bonded with polyurethane adhesives in the 40°C–80°C range has been noted and should lead to the adoption of polyurethanes of higher level of cross-linking for this application or to the adoption of a higher safety factor in the use of the current materials.

Behaviour of 1 K PUR adhesives under increased moisture and temperature conditions

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Abstract

Despite the approval of several 1 K PURs for structural bonding, there still are reservations about their reliability under heat and high moisture stress. The aim of our experiments was to analyse the behaviour of commercial 1K PUR adhesives test under increased thermal and humidity conditions. We selected the heat resistance test methods and the tensile shear test after different climate treatments as short term test methods. The heat resistance of six selected adhesives in gap joints turned out to be inadequate, whereas in close contact joints four brands showed a rather satisfying thermal stability. Compared to dry wood, the wet wood strength decreased under the required target values. After priming with an HMR primer, though, the wet wood performance improved considerably. The study confirms that the impact of moisture and heat reduces the strength performance of 1 K PURs. The degree of reduction under temperature stress seems to be related to the formulation of each single PUR system, and further analysis is needed to understand the mechanism. Wet wood strength of 1 K PURs can be improved efficiently, if required, by applying a HMR primer prior to glueing.

Interaction of 1 K PUR Adhesives and different Wood Surface Parameters

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Abstract

This paper defines in detail two parameters (surface roughness and contact angle) which may provide indications on the interaction of the surface of wood and a 1 K PUR adhesive with respect to the adhesive bond quality. First the roughness Ra of planed spruce boards was measured as a function of the cutting direction (rift, half rift and tangentially sawn). It is found that the mean roughness does not correlate with the cutting direction. As expected, a clear difference in the Ra values is found, depending on the machining technique used in processing: sanded surfaces have about twice the roughness of planed wooden surfaces. Similarly, analysis of the dynamic contact angles of 1 K PUR droplets determined on the planed and sanded surfaces of three softwood species prove that mechanical treatment has a more pronounced impact than the species effect: the contact angles of sanded samples are about 10 ° smaller than those of planed ones. After application of a surface primer in addition, the contact angles of the planed samples increase, but are reduced on the sanded surfaces. However, shear strength analysis of test samples representing the corresponding surfaces indicate that a prediction of the adhesion quality based on the selected surface parameters is difficult.

Blocked Isocyanates in UF-Resins

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Summary

We have prepared blocked isocyanates on basis of TDI and MDI and investigated their thermal properties using DSC and IR analysis. Stable dispersions of blocked isocyanates in UF resin could be prepared, thus allowing a new product perspective of UF resins.

The behavior of unblocked and blocked isocyanates in water and in UF resin without hardener, respectively, was investigated by means of IR-spectroscopy and DSC analysis. Different reaction mechanisms in water and in UF resin were observed. It was disclosed that the reaction between the blocked isocyanate and UF resin occurred via an addition-elimination mechanism at essentially lower temperature than the decomposition of pure blocked isocyanate. The formation of polyurea capsules in aqueous systems with unblocked isocyanates was proved via IR-spectroscopy. In contrast the systems with blocked isocyanates showed no buildup of polyurea capsules.

The formation of a urethane linkage during reaction between freed isocyanate and the methylol group of the UF resin was proven via solid-state NMR-spectroscopy. A much faster consumption of methylol groups in UF resin with isocyanate in comparison to pure UF resin was observed during IR analysis thus confirming the reaction between methylol and isocyanate groups.

The behavior of blocked isocyanates in UF resins is entirely different when compared to pure isocyanate such as TDI or MDI. Thus the reaction with methylols of UF resin leads to a fast reaction at temperatures at 110°C avoiding the loss of free isocyanate via di- or trimerization pathways, which allows a more efficient use of isocyanates within the UF-resin.

Adhesive systems tailor-made for various wood working applications

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Summary

Wood adhesives are used in a wide variety of applications such as Gluelam, Flooring materials, Panels, Furniture and Building components.

The adhesives must perform according to a wide variety of requirements. They must withstand the stresses in the glued product, tolerate the climate exposure, be environmental friendly and easy to use, be cost efficient and fulfil the requirement given by different standards.

The demand for higher production capacity with higher quality glue bond performance and at the same time the focus on more environmentally friendly products, makes the development of new adhesive systems very challenging.

More Information:

www.boku.ac.at/holzforschung

www.kplus-wood.at

www.cost.cordis.lu