Foil surfaces in window construction – Short report

Subject	Study of the application of innovative foils as weather protection for timber building components using timber windows as example
Short title	Foil surfaces in window construction
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Research institute	**ift** gemeinnützige Forschungs- und Entwicklungsgesellschaft mbH Theodor-Gietl-Straße 7-9 83026 Rosenheim
Project manager	Dipl.-Ing. (FH) Ingo Leuschner
Project engineers	Dipl.-Ing. (FH) Ingo Leuschner Dipl.-Ing. (FH) Benno Bliemetsrieder
2nd research institute	Hochschule Rosenheim F&E Kompetenzzentrum (R&D Competence Centre) Hochschulstraße 1 83024 Rosenheim
Project engineers	Prof. Erwin Friedl (project management for 2nd research institute) Dipl.-Ing. (FH) Andreas Hemer

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1 Objective of research

The briefing for this research project was to study the usefulness of foil coatings as weather protection for dimensionally stable timber components, in particular windows and external pedestrian doors. The intention was to ascertain that such coating systems are safe to use, under exposures that are typical of the built environment, for a sustainable period of usage.

External surface coating of timber has to fulfil a variety of technical and conceptual functions. Currently, almost 100% of timber windows and external doors are coated in a wet coating process, which is one of the biggest cost factors in the manufacturing process.

In addition, it is also the biggest uncertainty factor with respect to any potential premature damage as well as the main focus of the expected cost of regular maintenance. As a result, the end customers are highly unsatisfied with the situation regarding the cost of maintenance and upkeep for surface coating.

For many years now, Germany has experienced an overall decline in the market share of external building components consisting of the renewable raw material timber because many building owners opt for less care-intensive alternatives such as plastic windows.

It is therefore necessary to improve the production and function of surface coatings. It is hoped that the findings obtained in the research project will give important impulses for improving the production processes and hence result in improved economic efficiency as well as a reduction of emissions and residues compared to conventional coating processes.

Replacing the wet coating processes with overspray systems or extensive recycling technology would save resources and reduce solvent emissions as well as meet the general climate protection targets.

2 Execution of research

A number of tests have been carried out as part of the project and concepts for the future application of foil coating have been worked out. It is now more possible to carry out an in-depth assessment of foil coating systems on the basis of the findings obtained.

Using test specimens designed to represent the targeted building components, the effects of various factors and parameters were simulated and the results compared with a previously defined requirement profile. Important points investigated in this context were the moisture content of the timber section, adhesion, elasticity and changes in the surface of the foils. The main parameters leading to variations in performance were:

a) foil:
different colours and décors and the resulting surface temperatures, different resistance to water vapour diffusion, different basic materials and foil thicknesses;

b) timber:
influence of the different timber species and substances contained in wood, the effect of moisture in wood during production and service, modified timber species and timber-based panels;

c) manufacture:
influence of different adhesives and application methods, construction systems and production concepts;

d) boundary conditions:
climate (precipitation water, vapour, temperature, radiation),
mechanical impact (usage in accordance to the intended use, extraordinary damage events).

By investigating various design approaches and products and taking into account climatic and other exposures typical of building components, some recommendations have been established for using these coating methods and for improving the respective products and manufacturing methods.

3 Summary of results

Although the foils investigated are somewhat denser than conventional surface coatings, this does, in itself, not present any real disadvantage. They have good elasticity and offer good protection against the destructive effects of UV radiation. The investigated foils are generally suitable for surface-coating external timber components such as windows.

In practice, the performance of surface foils does not only depend on the foil product. Other factors, such as the adhesive, the substrate and not least also the application method, can have a big influence and cause interacting effects which, in turn will have an effect on the visual and technical performance. The interaction is illustrated diagrammatically in Fig. 1.

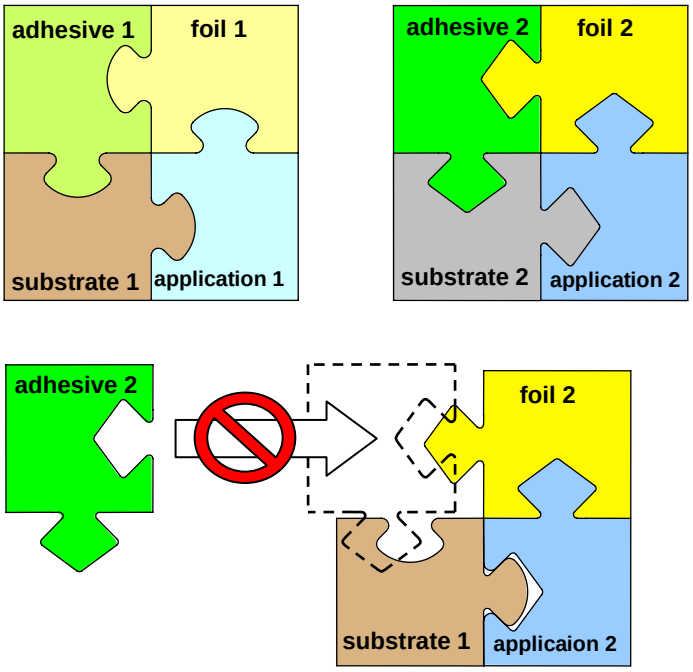

Fig. 1 Combination of parameters

The studies show that the foil coating will considerably slow down the re-drying process of timber parts with high moisture content. This means that with foil-coated building components special care must be taken to avoid any heavy ingress of moisture, e.g. by capillary action. However, practical experience has shown that it is rarely possible to avoid the ingress of water through faulty areas.

The diffusion of moisture through the foil is dependent on the internal and external climate conditions. The simulation of moisture accumulation in foil-coated building components shows that no significant amount of moisture has to be expected to penetrate into the wood via diffusion, provided certain design principles are complied with.

With foil-coated components, as with conventional items, the moisture content in the wood on installation should be within the common-practice range of max. 12% to 15%. Fig. 2 shows potential pathways for moisture to get into components such as a window profile.

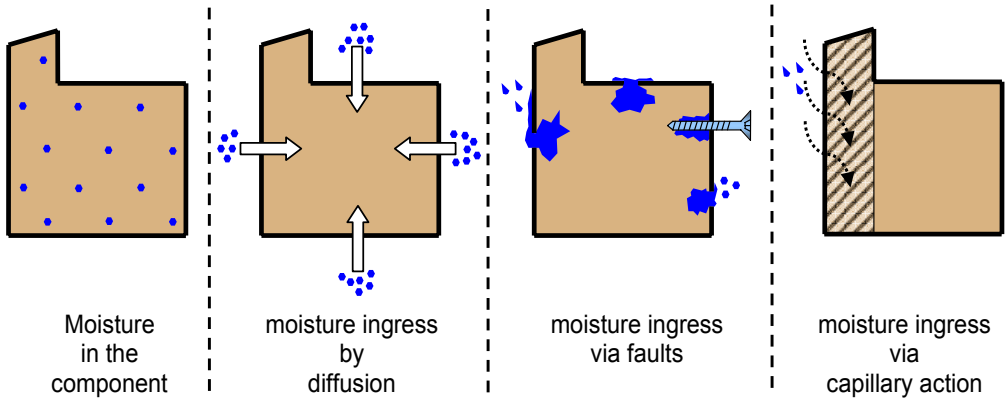

Fig. 2 How does water get into wood?

Compared to conventional surface coatings, some of the coated components showed an improved resistance to weather when exposed to artificial and natural wheathering. Some damage did occur through chemical incompatibility in connection with substances in the wood, which may be aggravated by certain climatic conditions.

With respect to all other tested characteristics that are relevant for surface coatings, the foil-coated test specimens did not show any particular vulnerabilities. On principle, timber and wood-based materials are well suited for foil coating (see Fig. 3 and Fig. 4). However, the timber species should be suitable for dimensionally stable exterior timber components and be of good quality.

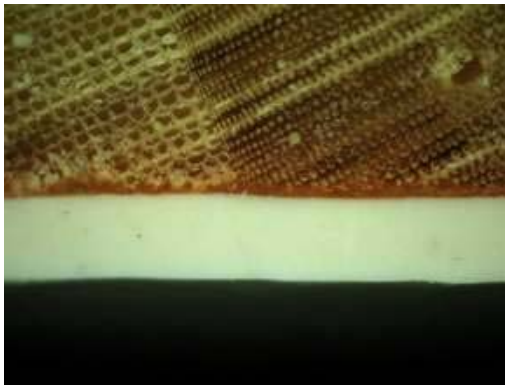

Fig. 3 foil-coated solid timber profile
100x magnification

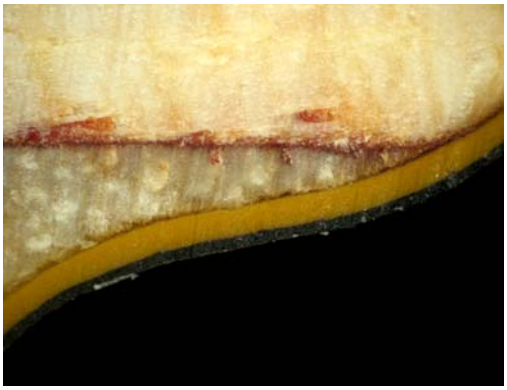

Fig. 4 foil-coated Multiplex
50x magnification

Conventional window profiles are not specifically designed for the requirements of foil coating. Although it must be said that important profile details also present problems for the coating with conventional wet coating methods, a fact that is demonstrated by the many defects encountered in practice. This is another reason for suggesting to deviate from the standardised profiles and develop new window systems with 'foil-friendly' profile geometries.

The sealing of the joint at the frame corners is particularly important for foil-coated windows because of the much reduced rate of re-drying. The test models constructed as part of the project demonstrated that considerable effort is necessary in order to achieve a satisfactorily functioning corner seal. During our testing, all test models were subject to moisture ingress, which in some instances was enormous.

During the service life of foil-coated windows there are no unusual requirements or effects that have to be expected or taken into account. Both maintenance and repair are possible although visual disadvantages may have to be accepted in certain cases. Apart from windows, facades, pedestrian and industrial doors, the use of foil coating on timber components is conceivable in many other external applications (e.g. facade cladding, balconies, decking, playground items and garden furniture etc.).

The production aspect of the subject 'foil surfaces in window joinery' was carried out by the 2nd research institute, Hochschule Rosenheim.

The studies and findings indicate that, on principle, it is possible to use foil-coating on window components. However, for a successful implementation it is necessary for the current mechanical engineering technology to be developed further since the investigated processes do not allow full automation and to a large extent require a manual work input.

The commercial viability of foil-coating depends to a large extent on the spectrum of parts to be produced and/or the different profile geometries. This means that any statements about commercial viability do not necessarily apply on a general level and have to be considered separately for each individual case.

Based on the findings of the research project, foil-coating of dimensionally stable components, such as timber windows and external pedestrian doors, as a means of protection against the weather appears possible provided certain design aspects are taken into account.

In particular, for a successful implementation, the design detail of profile geometries and frame corner joints has to be adapted to the special requirements of foil coating.

In this context, the above studies offer a good basis for working out a suitable verification programme and concepts that are helpful for planning a change to foil-coating in the production of windows and external pedestrian doors.

4 Acknowledgement

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Holz-Schiller GmbH
Pointenstraße 24-28
D-94209 Regen

ift Rosenheim
Theodor-Gietl-Str. 7-9
83026 Rosenheim

Telefon +49 (0) 8031 261-0
Telefax +49 (0) 8031 261-290

E-Mail: info@ift-rosenheim.de
http://www.ift-rosenheim.de