

EcoBuild – a competence centre for eco-efficient and innovative wood-based materials

Message from the Management

An important strategy for the development of EcoBuild during its first year has been to link up external experts (visiting professors and other researchers) with the centre. They are contributing to specific technical areas and sub-projects by offering advice and guidance, and the centre also gains from this through widened international perspectives and networks. To date the visiting professors are: Prof. em. Roger Rowell from University of Wisconsin, Prof. Phil Evans of the University of British Columbia (UBC), and Prof. Thomas Nilsson at SLU in Uppsala. They are all world-leading researchers in their specialist areas: Roger mainly in chemical modification of wood and wood composites, Phil in coatings for wood, and Thomas in microbial degradation and durability of wood.

Roger has taken a temporary office for 4 months this year in the EcoBuild corridor at SP Trätekt. He has given a course in wood chemistry and five other lectures, and he has been active in several sub-projects within EcoBuild. Roger will also spend March-May 2008 in Stockholm. For that sojourn we plan a new, industry-oriented course in wood chemistry, and opportunities will be provided for him to visit those industrial partners of EcoBuild who so wish.

Phil paid us a first visit now in October. The plans for him include more of participation from a distance, mainly in the sub-project on clear coatings. We may develop some sort of exchange programme for undergraduate and PhD students between UBC and EcoBuild.

Thomas works full time, based at SP Trätekt in Stockholm, and he has above all supported us in the evaluations of field trials of the durability of wood and wood-based materials and regarding degradation mechanisms of fungi.

Within the SP concern, about 10 graduated researchers and about 5 engineers and technicians are active in the centre. Another 10 external researchers and 6 PhD students, largely at KTH, are now also linked to the centre. This network for EcoBuild will continuously be subject to changes and further extensions.

This issue of the newsletter emphasizes the area of Biobased Coatings, and particularly one of the sub-projects. We will continue to take closer looks at other areas and projects in future issues.

Magnus Wälinder



Examples of extruded wood-plastic composites (WPCs), see note on the licentiate seminar of Kristoffer Segerholm, page 3.

Modified wood fibres in high-volume uses



Mark Lawther, sub-project 15 leader

Intensive activities have been pursued in the area of modified wood fibres. Softwood fibres have been acetylated in the small pilot scale at DanAcell in Denmark, producing a stock of acetylated fibres. Also other variants of the process have been employed, by cyclic anhydride addition, resulting in different hydrophilic properties and complex binding ability towards heavy metal ions.

Acetylated fibres are now being evaluated in MDF type composite boards. In addition, non-woven

filters containing modified fibres will be produced, for testing in water-cleaning applications (oils and heavy metal ions).

In parallel with the further investigations and evaluations of small scale batches of fibres and experimental products, the next major step is taken through the installation of a larger pilot plant in Denmark. Its design and planning is now completed, and we foresee it to be fully operational during the second half of 2008. The plant will have a capacity of up to 60 kg/hour of acetylated fibre. Other kinds of chemical modification will also be possible in this plant, which is optimally designed for wood fibre transport and drying as well as modification. ■

Centre Management



*Magnus Wälinder
Centre Manager*



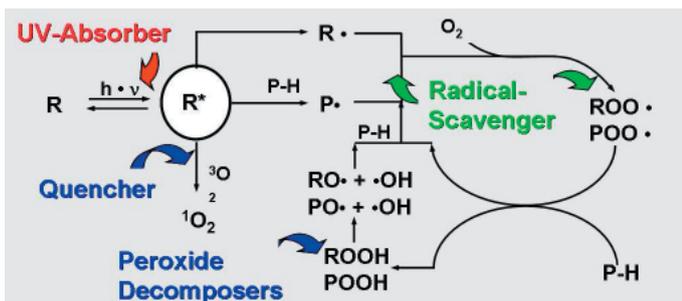
*Mats Westin
Deputy Centre Manager*

The challenge on durable clear coatings is taken



Anna Bäckman (left), now responsible for sub-project 4 Clear Coatings, moves to another position at the end of the year and is replaced by Ylva Kärrfelt (right).

It is common knowledge that wood is affected by light, both by colour changes and by degradation of the surface. Particularly during outdoor exposure, the effects are rapidly noticeable on untreated wood, which becomes grey and more loosely bound raised fibers become visible in the surface. This is mainly because the surface lignin is degraded into smaller molecular fragments that can be washed out by rain. Also clear-coated wood undergoes these changes, since conventional coatings are more or less transparent to both visible light and UV light. The result is a loss of adhesion, and when the coating film lets go the process is accelerated.



The complex breakdown mechanisms can be targeted in several ways.

Extensive research is being performed in many places around the world, says Jan Ekstedt, now responsible for the Coatings area in EcoBuild, but turning over the leadership by the end of the year to Ylva Kärrfelt, a new employee at SP Trätek. Our efforts in this area have the ambition to advance a large step in this development. Three main development lines for UV protection are:

- Nanoparticles. When the size of particles in a lacquer formulation is decreased to a range that is comparable to the wavelength of UV light they obtain in some respects completely new properties. Such a lacquer is transparent to the eye but blocks out the most energy-rich radiation from the wood substrate.
- UV absorbers and anti-oxidants. Selected molecules have the ability to absorb the radiation energy or rapidly neutralize the free radicals formed. A number of complicated mechanisms are involved, and an example of that is seen below. Also the binder itself in the lacquer may need protection, and it is therefore to an advantage if this function can be built into the polymers.
- Chemical stabilization. By chemical modification the wood material can be rendered much more resistant to the effects of light radiation. Acetylation — one of the methods studied within EcoBuild — is one such example, and another well-tried method is treatment with chromium salts.

No lacquer or varnish can shut out the light completely, and there are inherent limitations with the other methods. Combinations of these methods are therefore expected to give maximum performance.

In the first phase of this sub-project the work emphasizes screening of ideas and making priorities. The development will subsequently employ a large number of laboratory tests, already being planned, and the results will also be corroborated in field trials.

The industrial partners and the researchers in universities and institutes connected with the programme have a very high competence. We are at the research frontiers and will contribute towards pushing it further ahead.

This part of EcoBuild has a truly great potential in widening the usage of wood in exterior applications, since visibility of the wood structure is a much-sought-for quality sign in e.g. many parts of Europe.

The applications span from outdoor furniture, garden tools and playground equipment to exterior joinery, claddings of buildings and other construction works.

North American knowledge on UV protection

Prof. Phil Evans (U of British Columbia) gave a lecture on the 22th of October, as announced in our previous newsletter, outlining strategies to realize the dream of durable clear coatings for wood in exterior exposure.

It is perfectly clear (!) that we have a case where the product durability depends on both the properties of the coating as such and those of the substrate. The main degradative agent is UV light, and it can affect a coating film as well as any wood-based material. The breakdown of lignin has the most pronounced effects in unprotected wood, where smaller split-off molecular fragments can be washed out by rain, leaving a pelt of loose fibres. Also coated wood is affected, however, which leads to loss of adhesion and peeling of coating films. These effects are most pronounced under variable moisture conditions.

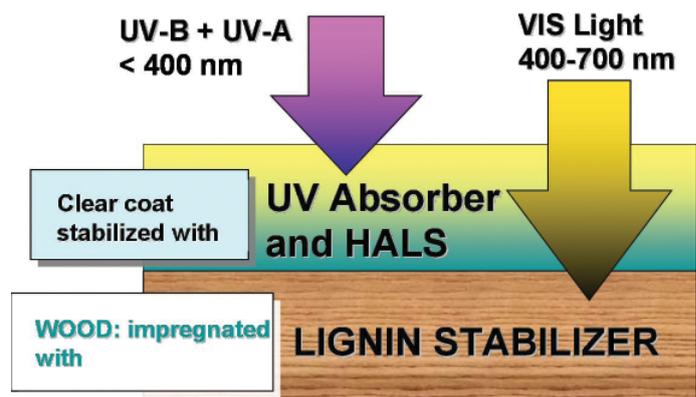
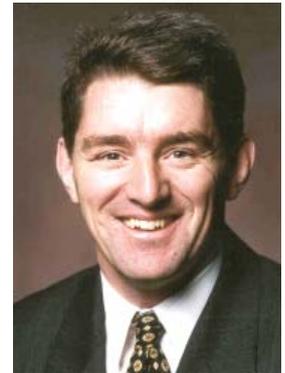
Basic mechanisms employed in the protection against light degradation are:

- Reflection of UV light
- Absorption of UV light
- Scavenging of free radicals formed by UV light

These three modes of action can all be incorporated in coating films, but due to the limited film thicknesses they can never be fully sufficient. Adhesion problems are preferably prevented also by modifications or treatments of the substrate, where at least the two latter mechanisms can be utilised. Pre-treatment of the wood by UV-absorbers and/or anti-oxidants can impart dramatic increases in the service lives of coated products, but the governing mechanisms are still not fully understood.

Visible light is most commonly associated with colour changes, which is evident indoors on e.g. wooden floorings and furniture. The violet region of the visible light also contributes to lignin breakdown, and that was perhaps new information to many in the audience. Still, UV is the radiation with the highest energy and has the more drastic effects. Protective systems must primarily be tailored to take care of this part of the spectrum.

Sterically hindered amines or phenols are well-known agents for UV protection with different modes of action that are already used in many



Protection against UV and visible light.



Clear-coated cladding with severe UV degradation and flaking lacquer.

coatings, but there are also other novel systems that are very promising. Pre-treatment with various chromium compounds can be very efficient, and Phil showed examples of such systems that easily afford 20 years of service life. The lecture gave an excellent overview of possible strategies, richly illustrated with results from field exposed test samples, and frequently delving deeply into the molecular mechanisms involved.

Acetylation and other methods for chemical modification of wood are studied within EcoBuild. Although they are primarily intended to increase the durability from other points of view, they can also give a much better resistance to photodegradation.

To conclude, it may suffice to say that the involvement of Phil Evans and the experience of his group has meant a substantial strengthening of the endeavours within EcoBuild to reach a higher level of development of durable clear coatings for wood. ■



Visible wood is desired on special objects.

New tools for quality control of furfurylated wood

The quality control system is an important integral part of the production of furfurylated wood. It is highly desirable to be able to analyse, with high accuracy, the content of furan polymer in the wood as a measure of the modification level. The modification level, usually expressed as WPG (Weight Percent Gain), is directly correlated to the level of property change – regarding durability, dimensional stability and mechanical properties. Stig Lande, PhD student at the Norwegian Forest and Landscape Institute, with co-workers has developed well functioning calibration models for



Stig Lande, PhD student at the Norwegian Forest & Landscape Institute.

both NIR (Near Infrared) spectroscopy and TGA (Thermo-gravimetric analysis) of furfurylated wood, partly within Subproject 17 – “Quality control systems for furfurylated wood”. This work was recently presented at the European Conference on Wood Modification in Cardiff, Wales, and a manuscript has been submitted for publication in a scientific journal.

Brief news and current events

Annual General Meeting 2008

The annual General Meeting will be held in Stockholm at the end of January. The exact time and place for the venue will be announced shortly.

Steadily increasing competence

Kristoffer Segerholm, KTH, will present his licentiate thesis on the 18 december at 10-12. The title is: “Wood plastic composites made from modified wood. Aspects on moisture sorption, micromorphology and durability.” The moderator is prof. Per Johan Gustafsson, Construction Sciences, LTH. All interested are welcome to KTH Bygghälsan, Brinellvägen 34.



ecobuild.se

One of the most important tasks of EcoBuild is to communicate our results to the surrounding world through various media channels. The home page of EcoBuild is one of several channels. It displays in brief the activities in the centre, it presents the industrial partners and financiers, and it is used for posting news concerning the centre and the work performed. The home page has been in operation since before the summer, and it is continuously developed and improved. In addition, an internal web forum has recently been launched for internal communication purposes. After logging in, partners of the centre can share working documents and other information regarding their projects and the centre in full.

YKI joins the Centre

YKI, the Institute for Surface Chemistry (nowadays belonging to the SP group) now enters the subproject “Highly UV-resistant clear coatings for wood in exterior application”. YKI will strengthen the project with its competence concerning nano-particles with well-defined particle size reflecting light radiation in the UV and violet part of the visible region. Furthermore, the project will benefit from YKI’s expertise on dispersion of these and other coating components.

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- Larsson-Brelid, P., Westin, M. "Acetylated Wood — Results from Long Term Field Tests", pp. 71-78.
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- Lande, S. "Development of modified wood products based on furan chemistry".

- Larsson Brelid P., Wålinder, M., Westin, M., Rowell, R.M. "EcoBuild – a center for development of fully biobased material systems for building and furniture applications".

In: Proceedings of the 3rd meeting of the Nordic Baltic Network in Wood Material Science and Engineering, Helsinki, Finland, 2007, October 29-30. ISBN 951-45-9098-8:

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