EcoBuild

Institute Excellence Centre for eco-efficient and durable woodbased materials and products

Activity Report 2014

We build a sustainable future with biobased material

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EcoBuild Activity Report 2014
Photos: www.istockphoto.com, EcoBuild

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Preface

During 2014 it became very clear that the co-hosting of EcoBuild by SP and Swerea IVF was up and running very smooth in all aspects. The centre is now standing solid on its own feet without external financial support to the centre management. It is very pleasing to conclude that we have 5 new members along with an increase in turnover from 30 MSEK to 34 MSEK. An effort has also been put into the updated website and the new activity report.

In December Sara Olsson defended her Ph D thesis "Enhancing UV protection of clear coated exterior wood by reactive UV absorber and epoxy functional vegetable oil". The work has been performed within EccBuild and has focused on a UV protecting primer for clear-coated wood, consisting of epoxy functional vegetable oils and a reactive UV absorber.

Prof. Roger Rowell visited us again last year giving a course in wood chemistry, biocomposites and building materials, but also an encouraging and eye-opening presentation to the board. The essence was that the wood industry is looked in old thinking regarding their products, developing what they always have developed. This described as the row boat syndrome: Moving forward but looking back. Wood and wood based products needs to be reinvented through innovative technical solutions and this is where EcoBuild can play an important role.

I look very much forward to the EcoBuild seminar "Biobased materials for the future", which will be held on April 14th in Borås. This is a new approach to attract new partners and inform existing partners.

Hans Thulin, CEO AntiCorr
Chairman EcoBuild Centre board

About EcoBuild

A sustainable future with biobased materials

EcoBuild is a competence centre for cooperation between universities, institutes, and industry. Its theme and basic idea is to refine forest raw materials or other renewable biomass to new, innovative components and product systems, mainly for applications related to the building sector, and for furniture, textiles and vehicles. The ultimate goal is fully biobased material systems and products.

We work in the whole value chain – from raw materials to end products – with both small and large companies. The centre pursues applied research and product development within five interconnected focus areas (FA):

FA1 - Biobased Binders & Coating Systems

The work in this area involves biorefinery concepts and biobased binders (both thermoset and thermoplastic). The resins are intended for use as biobased alternatives to the current, petrochemical based binders for panels & boards, coatings, biocomposites and engineered wood products.

FA2 - Biocomposites

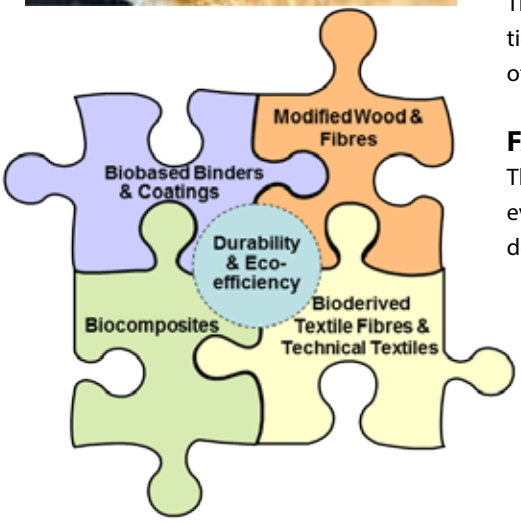
This area covers wood polymer composites, both thermoplastic and thermoset, for the use in furniture, automotive, building and joinery applications.

FA3 - Bioderived Textile Fibres and Technical Textiles

Manufacture of textile fibres from cellulose is the main activity in this area. The aim is to develop environmentally and economically better textile fibre using new technology for dissolution of wood cellulose and subsequent fibre-spinning.

FA4 - Modified Wood and Fibres

This area focuses on techniques for modification of wood and fibres, such as acetylation, furfurylation, and thermal modification, in order to improve decay resistance and other properties.



FA5 - Durability and Eco-efficiency

The durability of the materials and products developed within the other focus areas are evaluated from different aspects. Sustainability assessments are also performed for the developed materials and products.

About EcoBuild

Key facts about EcoBuild

Member companies: Since its start in 2007, 50 companies have participated in Eco-Build. The sizes of these companies cover the whole span from very small enterprises to worldwide concerns. As of the beginning of 2015, 23 companies are currently members.

Staff: During 2014, 129 persons were connected to activities within EcoBuild. Of these, 108 are researchers that are active within our projects, with 71 pursuing their research mainly at institutes or universities and 37 at the partner industries.

Turnover: During 2014 the turnover for the centre was 34 MSEK. Industry funding amounted to 11 MSEK, comprising 1.9 MSEK cash contributions and 9.1 MSEK of their own work efforts. The budget is further balanced with research grants from national and international programmes and with the research institutes own internal funding, the latter providing 7.6 MSEK for co-financing projects.

Dissemination: During 2014, results from EcoBuild projects were dessiminated th-rough 12 peer reviewed papers and 16 conference contributions.

EcoBuild is organised and hosted in a joint partnership by two institutes; SP Technical Research Institute of Sweden and Swerea IVF. It has at its disposal a hub of professors, senior scientists, PhD students, laboratories and pilot plants, mainly in Stockholm, Borås and Mölndal.

Vision:

EcoBuild is an internationally leading competence centre for development towards the biobased society.

Mission:

With a significant connection to the local raw materials base and internationally recog-nized excellence, to actively contribute to biobased and economically efficient value chains.

Centre management

Management team

Centre management

Marielle Henriksson, SP
Centre Manager

Jonas Aspling, Swerea IVF
Deputy Centre Manager

Support functions to the centre management

Mats Westin, SP
Research Coordinator

Martin Stråat, Swerea IVF
Research Coordinator

Magnus Wålinder, KTH
University Coordinator

Centre board

Chairman: Hans Thulin, CEO, AntiCorr
Charlotte Bengtsson, Head of Department, SP Wood Technology
Eva Hörwing, Byggelit Holding
Helena Tuvendal, Senior Project manager, Södra Innovation and Sustainability
Lars Stigsson, CEO, KIRAM
Lars Wiklund, Senior Manager External RDI Group NBD,Holmen
Pernilla Walkenström, Manager Materials, Swerea IVF
Ulf Odda, Purchase Manager, AkzoNobel

From left: Lars Wiklund (Holmen), Hans Thulin (AntiCorr), Helena Tuvendal (Södra Innovation and Sustainability), Pernilla Walkenström (Swerea IVF), Lars Stigsson (Kiram), Eva Hörving (Byggelit Holding), Charlotte Bengtsson (SP). Missing: Ulf Odda (AkzoNobel).

Partners

Member companies

- AkzoNobel Industrial Finishes AB
- Alfa Laval Nakskov A/S
- Burnblock ApS
- Casco Adhesives AB
- Eastman Chemical Company
- Hennes & Mauritz AB
- Holmen AB
- IKEA of Sweden AB
- Kebony ASA
- KIRAM AB
- Lantmännen Ekonomisk Förening
- MoRe Research Önsköldsvik AB
- NorDan AB/TanumsFönster AB
- Ofk Innovation AB
- Perstorp AB
- SCA R&D Centre AB
- SEKAB E-Technology AB
- SSAB Tunnplåt AB
- Sveaskog Förvaltnings AB
- Södra Skogsägarna Ekonomisk Förening
- Volvo Car Corporation AB
- Volvo Group Trucks Technology AB
- Woodisol AB

Member research institutes

- Danish Technological Institute
- Innventia
- Norwegian Institute for Forest and Landscape
- SP Technical Research Institute of Sweden
- Swerea IVF

Universities

- Algarve University
- Chalmers University of Technology
- Grenoble INP-Pagora
- Royal Institute of Technology
- Technische Universität München
- University of British Columbia
- University of Coimbra
- University of Copenhagen
- University of Nice
- University of Portsmouth

Research activities – two examples

PolyWood - Wood-polymer composites for use in marine environments

Furfurylated wood (wood modified by furfuryl alcohol) is prepared from sustainable natural sources and without the use of toxic compounds by in situ polymerisation. Furfurylated wood has in some earlier tests demonstrated an excellent resistance towards marine borers. However, the resistance exhibits an unexplained variability that cannot be accounted for at the current level of understanding of the process. Important aspects of the polymerisation mechanism and the polymer formation in conjunction with natural fibres are still not well understood. More detailed data, particularly of the interactions occurring at the molecular scale, will enhance the understanding of the formation of polymer in wood and the resulting structure.

The project has now run for 26 months and promising results and new insight in the chemistry of wood modification has been achieved. Both laboratory and field testing has been conducted to evaluate the biological responses on different chemical formulations. The laboratory test for Limnoria attack is well established and has resulted in a good method for evaluating early response on the different chemical formulations used for furfurylated wood samples. In addition a laboratory test for Teredo (shipworm) attack is under development.

Several analytical methods have been evaluated for their suitability to reveal differences in the formed polymer. There have been three criteria to evaluate, regarding the polymer formation; a) where is the polymer formed in the wood structure? b) How is the polymer structure influenced by catalysts, solvents and wood substrate present? c) Does the polymer form any chemical bonding to the wood substrate? Fluorescence microscopy has revealed different polymer structures and placement of polymer in the wood structure. Differential scanning calorimetry (DSC) has revealed differences in reactivity and possibly interaction by wood substances during polymer formation. Infrared spectroscopy (IR) has showed possibly chemical bonding to wood substances by a refined technique using theoretical IR spectra and comparing them to real spectra obtained from the modified wood samples. This latest result is a break-through in order to confirm chemical bonding and interactions between added chemistry and wood substrate.

The project continues for one more year and the knowledge and insights obtained so far will be guidelines for further work to optimize existing technology and will be a basis for developing a potential marine resistant wood product, which is the main objective of the PolyWood project.

The project is financed by The Research Council of Norway and Kebony AS.
Project leader: Stig Lande, Kebony AS
Participants: Kebony, Skog og Landskap, SP Technical Research Institute of Sweden, Technishe Universität München, Univ. of Nice, Univ. of Copenhagen, Univ. of Portsmouth.

Research activities – two examples

UV-protecting primer for wood clear coatings

The interest in clear coated exterior wood is increasing, and to meet the demand there is a thrust after improvements in the performance of these systems. One weak point of clear coated wood in exterior applications is there susceptibility towards UV-light which degrades the wood and hence affects its properties and appearance. The scope of the project has been to develop a "green" primer for exterior wood that improves the UV-resistance of wood products, such as doors or window frames. This is achieved by using a combination of an epoxy functional vegetable oil and a reactive UV-absorber which both have the ability to react covalently with a wood substrate, and can in turn protect it from UV radiation from the sun for a longer period of time. This since the covalent bond between the UV absorber and the wood hinders leaching of the UV-absorber, which otherwise is a common issue. Studies have also shown that the presence of a hydrophobising compound, such as a vegetable oil, also helps in decreasing leaching and degradation.

The results from the study were positive, showing that the treatment has an effect when it comes to UV-protection of clear coated exterior surfaces. Weathering trials of pretreated samples with and without a clear coat have been performed in accelerated ageing facilities as well as outdoor and both show improved performance of the pretreated samples compared to untreated controls. Two smaller studies have also been performed within the project. The first one focused on showing that the proposed reactions actually occur and also where in the wood cell structure the UV absorber/epoxy oil is actually attached. This study was performed using model substances of lignin and thin wood veneers which were analysed using NMR and FTIR microscopy, respectively. The results were unfortunately inconclusive in terms of where in the cell structure the reaction occurs, but the NMR analysis showed that the proposed reactions do occur. The second study focused more on showing the improvement of pretreated wood, compared to untreated controls, in terms of less degradation after UV exposure. The results clearly showed less degradation for samples pretreated with the reactive UV-absorber in combination with an epoxy functional vegetable oil, and improvement could also be seen for samples treated with only epoxy functional vegetable oil. This study was performed in Japan in cooperation with Forestry and Forest Products Research Institute (FFPRI) in Tsukuba and Kyushu University in Fukuoka.

The project was run within the competence centre EcoBuild and was financed by Lantmännens forskningsstiftelse and Formas.

A short spin-off project is now being performed within EcoBuild where not only the UV protective effect of different vegetable oils is studied but also other properties, such as dimensional stability and the hydrophobising effects of the oils. This small study is financed by Lantmännens Forskningsstiftelse.

Project leader: Sara Olsson, SP Technical research institute of Sweden
Participants: SP Technical Research Institute of Sweden, Royal Institute of Technology, Lantmännen, AkzoNobel, NorDan, AntiCorr.

Dissemination of results

Peer review papers

1. Olsson SK, Johansson M, Westin M, Östmark E. Reactive UV-absorber and epoxy functionalized soybean oil for enhanced UV-protection of clear coated wood. Polymer Degradation and Stability, 2014, 110, 405-414.
2. Olsson SK, Matsunaga H, Kataoka Y, Johansson M, Matsumura J, Westin M, Östmark E. A SEM study on the use of epoxy functional vegetable oil and reactive UV-absorber as UV-protecting pretreatment for wood. Submitted to Polymer Degradation and Stability 2014.
3. Olsson SK, Johansson M, Westin M, Östmark E, Trey S. Effect of lignin structures on the reactions with epoxidized vegetable oils. Submitted to Holzforschung 2014.
4. Ringman R, Pilgård A, Brischke C, Richter K. Mode of action of brown rot decay resistance in modified wood: A review. Holzforschung, 2014, 68, 239–246.
5. Ringman R, Pilgård A, Richter K. Effect of wood modification on gene expression during incipient *Postia placenta* decay. International Biodeterioration & Biodegradation, Part B, 2014, 86: 86-91.
6. Ringman R, Pilgård A, Richter K. In vitro oxidative and enzymatic degradation of modified wood. International Wood Products Journal. In press.
7. Alfredsen G, Pilgård A. *Postia placenta* decay of acetic anhydride modified wood – effect of leaching. Wood Material Science & Engineering, 2014, 9, 162-169.
8. Alfredsen G, Ringman, Pilgård A, Fossdal CG. New insight regarding mode of action of brown rot decay of modified wood based on DNA and gene expression studies: a review. International Wood Products Journal. In press.
9. Zimmer K, Høibø OA, Vestøl GI, Larnøy E. Variation in treatability of Scots pine sapwood: a survey of 25 different northern European locations. Wood Science and Technology, 2014, 48, 1049-1068.
10. Zimmer K, Treu A, McCulloh KA. Anatomical differences in the structural elements of fluid passage of Scots pine sapwood with contrasting treatability. Wood Science and Technology, 2014, 48, 435-447.
11. Sandin Albertsson G, Clancy G, Peters G, Svanström M, ten Hoeve M. Making the most of LCA in technical inter-organisational R&D projects. Journal of Cleaner Production, 2014, 70, 97-104.
12. Sandin G, Peters G, Svanström M. Life cycle assessment of construction materials: the influence of assumptions in end-of-life modelling. The International Journal of Life Cycle Assessment, 2014, 19, 723-731.

Conference papers and posters

1. Ehmcke G, Ringman R, Pilgård A, Richter K. 2014. Improvement of a cytochemical method for localization of hydrogen peroxide and adaptation to furfurylated wood. Proceedings of the 10th Meeting of the Nordic Baltic Network in Wood Material Science & Engineering (WSE). October 13-14, Edinburgh, Scotland.
2. Pilgård A, Ringman R, Kölle M, Brischke C, Richter K. 2014. Expression of *Postia placenta* wood degradation genes in thermally modified wood. Proceedings of the 10th Meeting of the Nordic Baltic Network in Wood Material Science & Engineering (WSE). October 13-14, Edinburgh, Scotland.
3. Pilgård A, Arnold P, Richter K. 2014. Protein extraction from wood decay fungus *Postia placenta*. Proceedings IRG Annual Meeting, IRG/WP 14-10827.
4. Ringman R, Pilgård A, Richter K. 2014. In vitro oxidative and enzymatic degradation of modified wood. European Conference on Wood Modification. March10-12, Lisbon, Portugal.
5. Alfredsen G, Ringman R, Pilgård A, Fossdal CG. 2014. New insight regarding mode of action of brown rot decay of modified wood based on DNA and gene expression studies. The 7th European Conference on Wood Modification.
6. Ringman R, Pilgård A, Alfredsen G, Goodell B, Richter K. 2014. Possible targets of wood modification in brown rot degradation. The International Research Group on Wood Protection, IRG/WP/14-40676.
7. Treu A, Gobakken LR, Larnøy E, Alfredsen G. 2014. Tremodifisering – Acetylering. In: Trebehandling – innovasjon, metoder og trender. Norsk institutt for skog og landskap. pp 27-29.
8. Treu A, Zimmer K. 2014. Furfurylated wood for the use in marine environment - the influence of wood species on the poly-condensation of furfuryl alcohol. Northern European Network for Wood Science and Engineering (WSE); October 13-14.

Dissemination of results

9. Zimmer K, Larnøy E, Treu A. 2014. A guideline for sorting easy to impregnate Scots pine sapwood based on three treatability studies from Northern Europe. Annual Meeting of the International Research Group on Wood Protection. May 11-15.
10. Zimmer K, Treu A, Høibø OA, Vestøl GI, Larnøy E. 2014. Anatomical causes for refractory behaviour of Scots pine sapwood. European Conference on Wood Modification. March 10-12.
11. Zimmer K, Treu A. 2014. Differences in ray anatomy between high and low permeability Scots pine sapwood. Northern European Network for Wood Science and Engineering (WSE). September 11-12.
12. Lübke ML, Hill CAS, Pfriem A. 2014. Bound water in small wood samples investigated by low-field nuclear magnetic resonance. Northern European Network for Wood Science and Engineering (WSE). October 13.
13. Sandin G, Peters GM, Svanström M. 2014. How can we develop forest products for the future? Poster contribution to the Marcus Wallenberg Prize (MWP) Symposium, Stockholm, Sweden.
14. Røyne F, Peñaloza D, Sandin G, Svanström M, Berlin J. 2014. Climate impact assessment in forest product LCAs – implications of method choice for results and decision making. Oral presentation (by Røyne F) at the SETAC 20th LCA Case Study Symposium, Novi Sad, Serbia.
15. Jones D, Sundqvist B, Wännström S, Mackintosh W, Malmberg J, Stenemyr. 2014. "Furu2Furan" – An overview of a Swedish project developing furanic chemical routes from lignocellulosic residue streams. Cost Action FP1105 fifth workshop, November 11-12, Thessaloniki, Greece.
16. Pilgård A, Ringman R, Richter K, 2014. The role of Fenton derived hydroxyl radicals in oxidative and enzymatic degradation of furfurylated wood. XXIV IUFRO World Congress October 5-10, 2014, Salt Lake City, UT, United States.

Additional presentations at conferences and seminars

1. Henriksson M. Nya produkter av skogsråvara. Temadag om familjeskogsbrukets roll i ett alltmer biobaserat samhälle för riksdagsledamöter arrangerad av LRF Mälardalen och Mellanskog. August 8, 2014, Härjarö, Sweden.
2. Sundqvist B. BioCoilCoat – ökat innehåll av biobaserade kemikalier i grön bandlack. Slutkonferens Branschforskningsprogrammet för skogs- och träindustrin, VINNOVA, January 16, 2014, Stockholm, Sweden.
3. Sundqvist B. Furan based binders and applications through smart and integrated use of biomass. SPIRE Brokerage event. October 21, 2014, Brussels, Belgium.
4. Sundqvist B. BioCoilCoat - Förnyelsebara kemiska komponenter i bandlacker. Workshop - Nya samarbeten och idéer inom läkemedel livsmedel, kemi och skogskemi, SP Sveriges Tekniska Forskningsinstitut, December 2, 2014, Stockholm, Sweden.

Theses

1. S Olsson. Enhancing UV protection of Clear Coated Exterior Wood by Reactive UV absorber and Epoxy Functional Vegetable Oil. Doctoral thesis 2014, KTH Royal institute of technology, Stockholm, Sweden.

Patents

1. 2014-06-27: W121930001 Alkali recycle in cellulose spinning.

Popular scientific contributions

1. SVT/UR, the ForTex consortium contributed with lab illustrations on how textiles can be prepared from wood. 201411 http://www.ur.se/Produkter/184047-Kvalitet-Haute-couture-pa-auktion (The program "Kvalitet", minute 23)
2. Henriksson M. Demonstrators for Ekoportal2035 SP Wood Technology Newsletter, March 2014.
3. Henriksson M. Rewarding course in wood chemistry. SP Wood Technology Newsletter, May 2014.
4. Henriksson M. Forest day for parliamentarians. SP Wood Technology Newsletter, September/October 2014.
5. Olsson S. Extended collaboration with Japan. SP Wood Technology Newsletter, April 2014.
6. Östmark E. Our international collaborations. SP Wood Technology Newsletter, May 2014.

Do you want to know more?

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