BioStruct

NEWSletter

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Second BioStruct training event took place on June 7th 2011 in Jyväskylä, Finland

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Project overview

BioStruct is a large-scale collaborative project funded by the European Commission. The project involves 21 partners from 10 European countries, and has a total budget of around 10 million €. The project is planned for a total duration of 48 months, and started in September 2008.

BioStruct aims to develop the next generation of wood and cellulose-reinforced composites - so-called „enhanced wood-plastic composites" or eWPCs - for complex structural and multifunctional components.

The project was set up to overcome the most important problems in the application of reinforced bio-composites by combining material development and process development in an integrated approach. In close collaboration with polymer, fibre and additive producers, compounders within the consortium have developed new material formulations to fit end-user requirements from four different industrial sectors: automotive, construction, electronics and packaging. In parallel, process developers are optimising and adapting injection moulding as well as extrusion technology to process these new materials under optimum conditions with the highest possible production rate.

In the past 8 months of the BioStruct project, work on material development has entered into a new phase. Whereas in the first 24 months work was focussed on the development of new polymeric materials and bio-based fibres, more emphasis is now being placed on tailoring the new fibres and polymers to the individual needs of the specific applications and processes. Henkel has started to synthesise the 4th version of Macromelt resins, again improving mechanical as well as processing properties to further facilitate compounding and injection moulding.

Lenzing and VTT have continuously improved the flow properties and dispersability of the fibres in various matrix resins. This progress was mainly achieved by improved milling conditions and new surface coatings applied to regenerated cellulose fibres, and by a detailed study of the influence of different refining and fractionisations of natural cellulose fibres. The compounds developed in WP4 using these newly improved materials have shown interesting potential. Material analysis demonstrated the higher impact strength and strength of certain material formulations.

To extend the possible applications of BioStruct materials, additional matrix materials were studied. Promising results were obtained, especially with some biobased Polyamide 10.10 type resins.
In process development, one focus point was the study of the plastification behaviour of PLA and Macromelt resins carried out by the injection moulding machine manufacturer ENGEL. The RTD partner AIMPLAS, on the other hand, studied

different material and processing approaches to improve the crystallinity of injection moulded PLA products. The effects of different nucleating agents as well as different PDLA types were studied, showing drastic improvements in crystallisation speeds. In profile extrusion, initial samples with foamed cores were produced by TCKT.
Work towards demonstration parts resulted in detailed plans for the individual case studies:

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automotive, construction, packaging and electronics. Further initial product samples have been produced. Results obtained during their product testing will be fed back into the material development work to tailor the material properties more closely to the needs of the individual case studies.

The role of the IRG is to provide additional advice to the project partners in terms of defining requirements within their sectoral scope, material and product validation, and the dissemination and exploitation of the project results. Partners in the IRG therefore cooperate on a voluntary basis with the BioStruct consortium for the benefit of both the project and the partner. In the course of the project, BioStruct has attracted a number of industrial partners interested in working with the consortium. From the beginning Leistritz (compounding equipment), Novem (automotive Industry) and Vimar (electronic equipment) were members of the IRG. Further industrial partners have subsequently complemented the group with their individual competences and interests:

1. Baerlocher – additive manufacturer
2. Philips – small household equipment
3. Votteler – lacquer producer

Wood fibres as reinforcing materials in enhanced WPC's

Wood Plastic Composites (WPCs) are typically compounds of thermoplastic polymers and wood-based reinforcement or fillers. Reinforcing or filler material usually consists of sawdust or sawdust powder. For reinforced plastic applications, there is increasing interest towards the use of wood fibres instead of wood powders because wood-based fibres can offer many advantages for WPCs.

Nowadays there are some limitations in conventional wood plastic composites. Properties do not meet the requirements for technical applications and polymer compatibility with wood based fibres is limited. Sawdust reinforced applications are often used only in low value applications. To enable the full reinforcement capacity of wood-based fibres, problems such as insufficient fibre dispersion and adhesion to the matrix, inconsistent fibre uniformity and durability during processing have to be solved. To overcome these obstacles, options such as physical, chemical or enzymatic fibre treatments can be used.

Wood fibres offer high reinforcement capability and good mechanical properties for wood plastic composites. Low price and easy availability of wood fibres are the things that make them interesting. Uniformity of wood fibres is a clear advantage compared to sawdust or annual fibres. Even then, more research work is needed in the field of WPCs to enable the full reinforcement capacity of wood fibres.

One question is how to feed the wood fibres into the compounder? A lot of work has been done by VTT Technical Research Centre of Finland to find a suitable delivery form to wood fibres so that they are dosable and dispersable in the wood plastic composite compounding process. Several different granulation methods for wood fibres have been evaluated. Pelletising of wood fibres was found to have many advantages: pellets are simple to feed to the compounder and it is an advantageous fibre form for fibre modifications. The optimised pelletisation process for the fibres is feasible also at pilot and in full industrial scale.

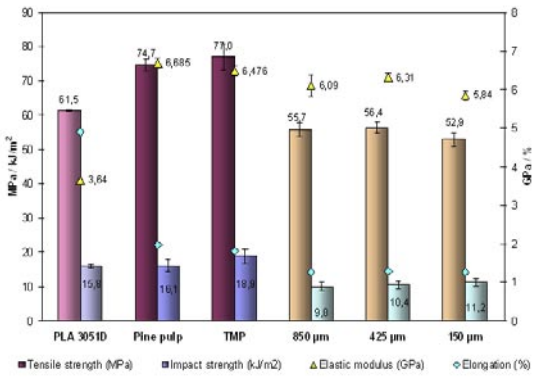

Figure 1. Mechanical properties of PLA 3051D composites with 30 wt% of two wood pulp types: pine and TMP and three wood flours with different particle sizes.

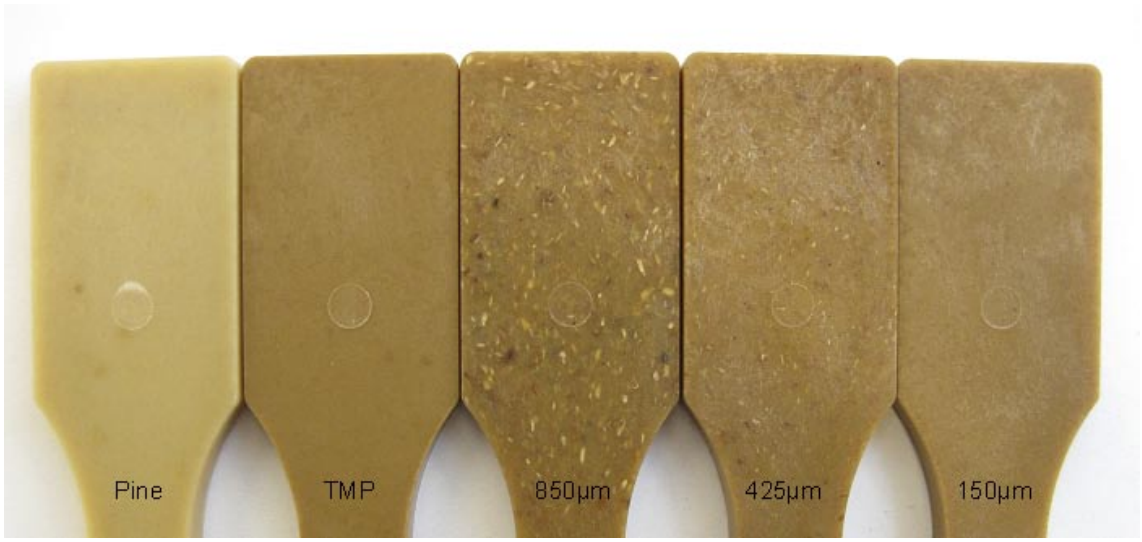

Figure 2. Macroscale fibre dispersion of pine pulp, TMP and three wood flours with different particle sizes in PLA matrix with fibre content of 30 wt-%

It has not been obvious which kind of wood fibres are the most suitable for wood plastic composites. Different kinds of fibres have been tested during BioStruct project. Figures 1 and 2 show comparison of pulp fibres vs. wood flours in WPC applications. PLA composites were produced with 30 wt% pulp fibres (pine pulp and thermomechanical pulp (TMP) and wood flours (three particle sizes).

Summary:
Natural wood-based fibres are some of the most important renewable fibre materials available easily in large amounts. They have high potential as a raw material for new kinds of bio-based composites and plastics. Wood fibres provide improved mechanical properties for wood plastic composite applications compared to wood flours, which are generally used in WPC applications.

Second BioStruct training event on "Bio-Fibres and their Processing" Jyväskylä, Finland (June 7th, 2011)

Following the success of the first BioStruct training event in Pfinztal, Germany (February 16th, 2011) the BioStruct consortium held its second such training event in Jyväskylä, Finland at the VTT premises. The event was on "Bio-fibres and their Processing" and we saw close to 30 participants on the day.

The training event was opened by coordinator Dr. Jan Diemert (Fraunhofer ICT) and recognition was given to Finland's input in the creation of the BioStruct project. Here a brief introduction to the BioStruct project and its 21 partners was given. The four areas of case studies were introduced as the automotive, electronic, construction and packaging industry and the strong participation of end users was highlighted with emphasis on the importance of continuing to stimulate end-user input.

Wood fibres

The first presentation was given by Elina Laatikainen (VTT) on "Wood Fibres". Wood fibres were seen in the past as 'cheap fillers'. BioStruct began with the aim of changing this perception. However woods' properties (thermal etc.) are not alone suitable for certain applications and it was for this reason the concept of eWPC's (enhanced wood-plastics composites) was created. VTT's presentation emphasized the processes to create better adhesion between wood fibres and polymers. Three main treatments of wood fibres were listed as physical, chemical and enzymetic. The conclusions of this presentation highlighted the great potential for wood fibres in bio-composites and whilst additional research is still being

conducted; wood fibres may already be seen as price efficient, having high reinforcing capabilities and a sustainable availability. Wood fibres are also eco-friendly and open to modifications.

Cellulose fibres

Martin Marsche (Lenzing) then gave a presentation on "cellulose fibres" and explained their potential to replace glass fibres for reinforcement. During this explanation the importance of fibre length was highlighted and Martin stated that cellulose fibres should be the same length as glass fibres for strength reasons, however increased fibre length can also lead to complications so it is best to maintain a reasonable fibre length for processing. One of the major advantages of celluslose fibres over glass fibres (not including environmental friendliness) is its ability to flow easily into small areas that glass fibres are unable to reach. This results in a better surface with better impact strength, increased thermal properties and uniformity of colour.

Properties of BioStruct materials

Following this presentation, Lars Ziegler (Tecnaro) presented the properties of BioStruct materials together with Denis Chantergraille (Addiplast). In this presentation an introduction was given to PLA and bio-based Polyamide matrices as well as compounds based on these materials.

Among the various results shown in this presentation it was demonstrated that when BioStruct materials were blended with other polyamides this could lead to increased impact properties. Furthermore increased thermal properties of compounds using BioStruct-fibres were also pointed out. On the other hand it is important to note that temperatures during processing need to be kept below 200 degrees due to the limited stability of the bio-based fibres.

BioStructs overall aim is to propose to end users different compounds that fulfill all required specifications. In some technical applications additional functionality of the compounds is needed. Flame retardant compounds and electrical conductive materials were therefore also developed within BioStruct.

Manufacture and use of BioStruct materials & outlook

Jan Diemert (Fraunhofer ICT) gave an overall view on the "Manufacture & use of BioStruct materials" together with and overall outlook on the BioStruct project. The coordinator explained that the feeding of fibres is of paramount importance and these fibres can begin as milled fibres, chips or strands (VTT pellitisation process). Overall, good compounding requires a balancing in input, mixing and degradation and it must be remembered that compounding is only the beginning of the process and injection moulding or later stages become even more harsh on fibres.

The limitations of injection moulding were addressed concerning humidity/moisture and the importance of measuring moisture levels continuously during processing as well as drying materials before processing was raised.

The main advice concerning processing would be to balance mixing and screw design in order to get better dispersion through better processing. And finally one of the main ways to ensure good processing is to stay below 200 degrees and continuously monitor temperature/don't rely on machine thermometers.

Furthermore, the developments of the bio-composite injection moulding have been complimented by the introduction of targeted reinforcement in the form of sheets and thin ribs. These plywood or flax/PLA (UPM and NetComposites) inserts aim to give extra mechanical performance locally in order to broaden the possible applications.
Many material and processing problems have been solved, but end user requirements are still being developed. The BioStruct project has so far demonstrated the new interesting applications where currently no bio-composites are being used.

BioStruct has also demonstrated alternative compounding processes and these have been demonstrated in a very successful way (+ some still under development).

BioStruct materials may be used in such applications as decking, construction, furniture, automotive, packaging and the electronics. The BioStruct case studies in the automotive, construction, electronic and packaging industries shall show test results and the topic of the next training event shall concentrate more on these case studies and results.

Training events may be seen as a great opportunity for end-users to come along and become aware of BioStruct materials and processes. The next training event is scheduled to take place in Austria during the final quarter of 2011. The BioStruct consortium hopes to raise even more interest from end-users. These events are seen as the perfect time for potential end-users to express their interests in eWPC's and join the BioStruct industrial reference group (see below for more information). For information on the next training event, please keep an eye on the BioStruct project website at: www.biostructproject.eu.

Information will also be sent to all parties registered to receive the BioStruct newsletter. If you would like to register to receive the BioStruct newsletter please register at: http://www.biostructproject.eu/index.php?id=newsletter_sg.

Partners

SEVENTH FRAMEWORK PROGRAMME

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