TPAC Newsletter

Edition December 2020

TPAC in your Mailbox!

Dear Reader,

The year comes to an end, and it's undoubtedly not just a year like any other! Corona had and is still having its way and I can but hope that the impact on all of you has been manageable, both in your professional as well as your private life.

As I wrote in our previous letter, at TPAC we have been able to continue work on our projects with you, albeit in a slightly different way forced by the circumstances.

However, altogether I believe significant progress has been made of which this newsletter gives you an overview: from project progress and novelties to other relevant TPAC-related news items.

As usual, in addition, you can always follow the latest of TPAC on:

- thermoplasticcomposites.nl
- linkedin.com/company/thermoplasticcomposites
- twitter.com/TPACNL

I hope you enjoy reading this newsletter. And …. I wish you all a happy holiday season and, this year even more than ever, all the best for the coming New Year of 2021!!

Kind regards,

Ferrie van Hattum

NEWSFLASHES

End project B-wood

The project B-Hout Behoud, looking into recycling building waste wood in composite products in collaboration with companies Rouwmaat and Innodeen, has come to a successful end! More info in this newsletter and at https://thermoplasticcomposites.nl/research-areas/recycling/hout-behoud/

Lecturers prepare composite samples for their students at TPAC facilities

Corona rules forced mechanics-lecturer Cees Besteman and his colleagues to prepare themselves laminates out of glass-fibre composite for their minor-students.

For more information, please see: https://thermoplasticcomposites.nl/lecturers-make-test-samples-for-their-minor-students/

Our latest news items, always on:
thermoplasticcomposites.nl/**news**

Textile weaving company seeks future in new composites

In the city of Enschede – once world's second-largest textile city – almost all textile weaving companies have gone, except ACTK. But also the future of this long-standing weaving company is at stake. Director Coert Meihuizen now invests in development and co-operates with TPAC of Saxion. "We cannot keep on going with our traditional customer base. We seek our future in the weaving of new materials."

ACTK (A.C. ter Kuile) is a traditional manufacturer of interlinings, fabrics for use in formal clothing. However, for a number of reasons the production decreases and the company seeks new markets to survive. Meihuizen. "We see a future in the weaving of new materials, new composites: weaving future materials." He works closely with the Dutch company CompTape, a producer of thermoplastic composite tapes, under the name CompWeave. This activity combines the technology of the tape producer with the weaving skills of ACTK.

Saxion's ThermoPlastic composites Application Centre TPAC is actively involved in supporting these developments. Professor Ferrie van Hattum: "We work frequently with composite tapes in process development, for example to 3D-print tapes for use in heavily loaded parts or as an integrated part in plastic injection "over"-moulding. But tapes are not fabrics. And many times fabrics are required in applications: this is what Ter Kuile does."

Weaving tapes is a special skill, says Van Hattum. "Traditional textile yarns are typically smooth and flexible and weaving machines have worked with these materials for a very long time on an industrial scale. So weaving those is in itself not a problem. However: weaving the new materials often is not quite that easy. Composite tapes differ significantly from textile yarns. As most weaving machines are not suited or not easily adapted to work with composite tapes, only a very limited number of composite fabrics are available. This is a significant hurdle towards a wider application of thermoplastic composites. Here, we see the potential of ACTK and the CompWeave material. We are currently running a project called Circular Thermoplastic Composite Production (CTCP) where we look into the use of recycled plastics, bioplastics and biofibres in the composite tapes. After merging them you have the tape but not a fabric and this is where Meihuizen steps in. He weaves the fabric that can be moulded into plates or products for many sectors, for example the car industry or office furniture."

Henk Heuvelman

CTCP – Circular Thermoplastic Composite Production

In the project "Circular Thermoplastic Composite Production" new types of circular composites are being developed. Circularity can be obtained through the fact that the composite is fully bio-based or the fact that the composite is easy to recycle, like e.g. single-polymer composites.

On the experimental tape line of project partner CompTape various material combinations were investigated. Biobased tapes were successfully produced from Biomid fibres (cellulose) and a matrix of PLA or bio-PE. The single-polymer composite from PLA fibres and PLA matrix however were difficult to produce. In order to improve impregnation, the melt property of PLA was modified. The increasing of melt flow index of PLA was achieved by using different amounts of ethylene glycol (EG). This result is interesting for a potential coupling with fibres that need to be processed at lower temperatures.

Biomid fibre + Bio-PE   *Glass fibre + Bio-PE*

Compression moulded samples were made, and studied for flexural behaviour and interlaminar shear strength. The bending stiffness of composites made of Bio-PE and Biomid or glass fibres are comparable.

Rik Brouwer

This research is co-financed by Regieorgaan SIA, part of the Dutch organization of scientific research (NWO).

FIXAR – Future Improvements For Composite Sustainable Automated Repair

Experimental research is being conducted on thermoplastic repair joints using induction welding technique with FIXAR project partner KVE. The research is aiming to look into possibility of welding UD thermoplastic tape material. Along with material, the joint geometry is a key parameter that is also being investigated. In particular stepped and scarfed joints are under investigation as these geometries qualify the aerodynamic performance specifically for wind turbine and aerospace structures.

Simultaneously, a parallel finite element study on joint performance of thermoplastic repair is being conducted at TPAC. The study investigates the scarf joint performance of an elliptical repair patch.

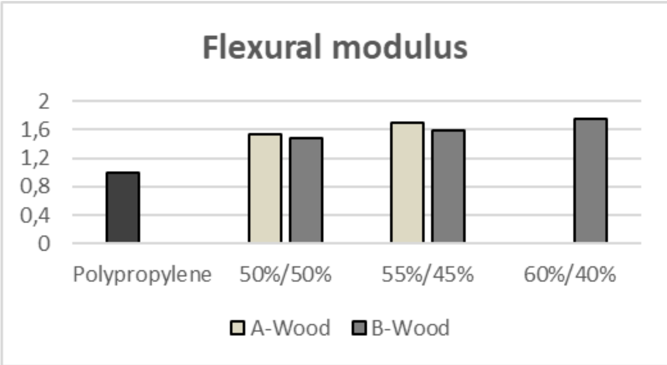
Esha Mohindru

This research is co-financed by Regieorgaan SIA, part of the Dutch organization of scientific research (NWO).

B-hout Behoud (Wood Preservation)

The project *B-Hout Behoud*, that started in October 2019 in collaboration with companies Rouwmaat and Innodeen, has come to an end. The research, carried out during the year, led to the following results:

- the processing of recycled (A-, B-) wood composites at lab scale is possible and successful;
- by analysing the material composition, no harmful components were detected in B-wood fibres;
- a suitable mixing method has been developed: the good mixing and the fibre content have a significant effect on the mechanical properties of wood fibre and polypropylene composites.



As a consequence of the project, partners Rouwmaat and Innodeen have started running test production trials for wood fibre composite siding in combination with post-consumer recycled polypropylene. The production of a composite that contains recycled B-wood fibres, is a goal for the future.

Marco Del Vechio

This research is co-financed by Regieorgaan SIA, part of the Dutch organization of scientific research (NWO).

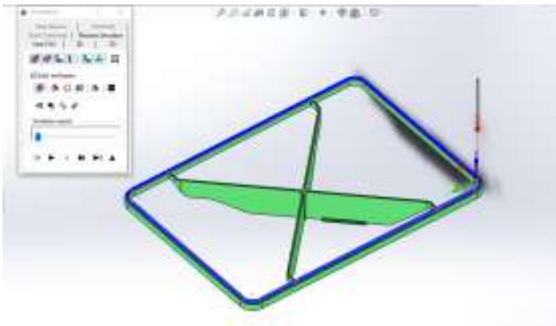
FibreRec

Within FibreRec we are looking at different types of waste streams (PP, PE, PET) as a feedstock for composite production. For all these waste streams glass fibre tapes have been produced. These tapes were then compression moulded into bars for 3-point bending and Interlaminar Shear (ILSS)-testing. This, combined with the earlier executed tests on the matrix materials, will give us a good overview of the potential of different kind of materials. This road map could be used to compare the recycled materials with the virgin materials or to visualise which material matches a desired product based on mechanical properties.

Apart from making the tape, within the project we are also looking into the different methods of making inserts with the tape for use in subsequent moulding processes. Different approaches are taken on this:

- ***Dual 3D printing;***
  For the dual printing we are looking into combining the regular 3D-printing of plastic and our in-house developed process of 3D-printing of composite tapes into one machine. An insert design for dogbone tensile specimens has been made to be printed. Different material inserts will be printed and overmoulded (by injection moulding) with virgin or recycled plastic.

- ***Robotic printing;***
  We have been further developing the printing head for continuous fibre composite printing installed on our robotic arm. For validating the process and the materials, we are planning to print an insert to be used in one of our demonstrator products: a generic automotive part using composite inserts. The 3Dprinted insert will be used as in integrated stiffening element in the outer edge, as indicated in the figure.



- ***Filament winding;***

A final approach is using filament wound inserts for subsequent use in rotational moulded parts. For the winding of the inserts, our student Caroline Yilmaz, worked on the 2- and 4-axis winders and experimented with the winding of different inserts. We are planning to combine this insert winding with our rotation moulding.

Recently we purchased a lab-scale rotational moulding device, a Rotorocket. With this set-up we are going to test rotational moulding with different glass tape inserts that are produced on the 2-axis winder. As an alternative we are also looking into the rotation moulding of a cylinder and applying the tape reinforcement afterwards.

In one of our demonstrator cases we are looking into integrating woven composite fabrics into a demonstrator part. From all the produced rTapes, woven fabrics are made, and will be compression moulded on our recently refurbished press, now equipped with a 300 x 400 [mm] mould and a controlled full heating and cooling cycle. Student Brian te Nahuis, is now doing the final touches before the weaves are compression moulded and the next stage, overmoulding on the demonstrator part described before, can begin.

For the coming period we are finishing the final mechanical testing and further looking into the insert production and processing of these inserts.

Ilse ten Bruggencate

This research is co-financed by Regieorgaan SIA, part of the Dutch organization of scientific research (NWO).

MERGEurope - 3DFaim

TPAC is involved in a European network on Lightweight Structures "MERGEurope", coordinated by the Technical University of Chemnitz (Germany). As part of this network, the project 3DFaim runs where a small consortium consisting research organisations and SMEs is looking into the 3Dprinting of lightweight structures. TPAC and Dutch company CompTape, as supplier of the composites tapes used, are involved in the 3Dprinting of composite inserts to be used in subsequent production and testing of an automotive demonstrator. The final production trials are foreseen for the end of 2020.

Ferrie van Hattum

The participation in this research is co-financed by the Province of Overijssel.

TPAC anticipates Green Deal legislation

Almost one year ago, the European Commission has adopted a new *Circular Economy Action Plan* - one of the main blocks of the European *Green Deal*, Europe's new agenda for sustainable growth. The Action Plan announced initiatives along the entire life cycle of products, targeting for example their design, promoting circular economy processes, fostering sustainable consumption, and aiming to ensure that the resources used are kept in the EU economy for as long as possible. Beside circularity, a carbon free future is another focal point of the program.

Following from the Green Deal, new legislative measures are being developed by the EU, reserving a budget of 100 billion euro for the first period of this program, being 2021-2027. A first concrete measure will be to raise a tax of 0,80 euro/kg for packaging plastics that are not recycled.

TPAC has been anticipating these developments and initiated research for TPC recycling in 2014. Since then our recycling portfolio expanded significantly. Early this year we signed the European plastics Pact, which brings together frontrunner companies and governments to accelerate the transition towards a European circular plastics economy.

Initially, we developed a recycling process for TPC at labscale and produced both high-end and low-cost demonstrators with this new process. Currently, we work closely together with several large companies in order to further industrialize this technology.

Beside TPC recycling, we are running several projects to reinforce recycled (municipal) plastic waste in order to further reduce TPC raw material prices and to reduce product weight. Benefits from weight reduction are a.o. reduction of use of natural resources, CO_2 savings in mobile applications and less energy use during manufacturing.

In order to further foster circularity as aimed for by the Green Deal, we extended our research by improving circularity of new TPC materials, by exploring less conventional materials like single polymer composites from recyclates and biobased fibres and polymers.

Apart from generic circularity, we have been contributing to recycle other particulate problematic waste streams, a.o. fishing gear, polyurethane foams and components, and fibres from B-wood into composite materials.

We are sure that more useful solutions will find their way to a more sustainable world in the years ahead. Our projects would not exist without the enthusiasm and support of our valued project partners, and the funding by Tech For Future and Regieorgaan SIA a.o.

Rik Voerman

ROC-Mechatronics students intern at TPAC

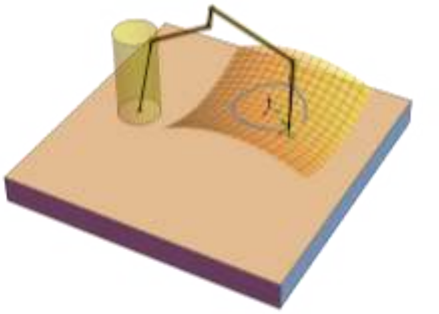
Fourth-year mechatronics students Rene Groeneveld and Rutger Venekatte from the ROC Hengelo are doing an internship at Saxion's TPAC in Enschede.

"Our internship is not actually about plastics or composites. We are more involved as a technical service for the installations", says Venekatte. A range of machines and test setups have been installed and assembled in TPAC's laboratory. In certain cases technical improvements are possible in terms of safety, automation and efficiency. After an introductory internship of ten weeks, the two interns will carry out their 20-weeks graduation assignment at TPAC. They will make their own designs and write their theses about it. After graduation, Ruther Venekatte first wants to work in practice for a year and then pursue further studies in Electrical Engineering at the Hogeschool Utrecht. Rene Groeneveld is considering studying mechanical engineering at Saxion University of Applied Sciences.

Rutger Venekatte

Robotic development

For the purpose of speed-controlled robotic processes (like welding and 3D printing), Saxion has developed an elegant algorithm comprising closed form analytical solutions for the generic 6-axes, spherical industrial robot. The incorporated parametric Denavit-Hartenberg table allows for the evaluation of nearly every industrial robot regardless its manufacturer, joint conventions and input file format. Additional inputs are the position and orientation of the workpiece (which can be functions of time or the covered path distance) in conjunction with a (time dependent) clearance and orientation of the Tool Centre Point with respect to a chosen reference frame. The intended path is directly translated into joint rotations after a thorough assessment regarding workspace containment, numerical stability, singularities, joint rotation ranges and velocities / accelerations.



One of the major contributions here is the formulation of closed-form analytical solutions for the joint velocities. This approach implies very smooth operation of the robot and minimises sudden accelerations. Another important property of the obtained solutions is that potential singularities are entirely avoided. After all these assessments, the remaining feasible solutions are subjected to a Dynamic Programming based optimization routine to either minimize total power consumption for a particular job, or, when a particular tool point speed is not required, to minimize the total job time within the workspace, velocities and acceleration constraints for the involved moving parts. The method will thoroughly be tested on thermoplastic 3D printing with continuous fibre composites where perfect control over speed and temperature is essential.

Sotiris Kousious

Colofon

If you might have any questions after reading this newsletter, please contact TPAC directly:

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