NEWSLETTER # 4 / JUNE 2018

Welcome to the fourth newsletter from the ECO-COMPASS project!

ECO-COMPASS gathers eight European partners from six countries and eleven Chinese partners for a period of three years, until March 2019. Our fundamental goal is to develop and assess ecological improved and multifunctional composites for application in the aviation sector.

Our public newsletters will regularly keep you up-to-date on the progress made within ECO-COMPASS. What's more, you will be given a possibility to discover how the consortium partners cooperate to achieve the project objectives. You will also find out how and when we disseminate the ECO-COMPASS results. This is in case you feel like meeting with us!

Word from the Coordinators

In the fourth issue of our newsletter, you will find some preliminary information about the ECO-COMPASS special session organised in the framework of the ICGC-10 in November 2018. You will further get to know how the activities progressed within the project work packages. The "Get Together" section will inform you about the upcoming major events related to the ECO-COMPASS research fields. Last but not least, the interview will let you discover the day-to-day life of people involved in achieveing the project goals.

We also invite you to visit the ECO-COMPASS website (www.eco-compass.eu) which is regularly updated with pieces of news about the project. Feel free to inform us of any relevant publication, project or event which should be brought to the attention of the ECO-COMPASS community.

European Coordinator Jens Bachmann, German Aerospace Center (DLR)
Chinese Coordinator Xiaosu Yi, AVIC Beijing Institute of Aeronautical Materials

NEWS & EVENTS

ECO-COMPASS is a guest star of the weekly TV series on EU-funded research projects broadcasted on Euronews.

>> Read more

The ECO-COMPASS partners are organising a special session in the framework of the 10th International Conference on Green Composites on 7-9 November in Quanzhou, P.R. China.

>> Read more

CONTACT US

Mail: contact@eco-compass.eu

Website: www.eco-compass.eu

EU Coordinator:
Jens Bachmann, German Aerospace Center (DLR)

Chinese Coordinator:
Xiaosu Yi, AVIC Beijing Institute of Aeronautical Materials

Dissemination Manager:
Dominika Behrendt, L-UP

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ECO-COMPASS on Euronews!

ECO-COMPASS is a guest star of the weekly TV series on EU-funded research projects broadcasted on Euronews in cooperation with the European Commission DG Research & Innovation and DG CNECT.

The video entitled "Airplanes and material gains" shows some of the ECO-COMPASS partners explain their work within the project to popularize science and make it accessible and understandable for the general public.

The report on ECO-COMPAS will be featured in the programme Futuris, covering European science, research and innovation for more than 10 years. The video will be broadcasted to 158 countries in Euronews 12 broadcasting languages (English, German, French, Italian, Russian, Spanish, Portuguese, Arabic, Turkish, Persian, Greek and Hungarian). It is also available on the Euronews Youtube channel.

ECO-COMPASS special session at ICGC-10

The ECO-COMPASS partners are organising a special session in collaboration with ICGC-10 to take place November in Quanzhou, P. R. China.The primary aim of this event is to offer the presenters a forum to engage with large international audience, present the latest results of the project and encourage open exchange of information.

The details on the special session will be shortly released on our website.

ECO-REINFORCEMENTS FROM BIO-BASED AND RECYCLED FIBRES

Two types of nonwoven mats from ELG Carbon Fibre Ltd. have been supplied to LEITAT: one made from dry recycled carbon fibre (rCF), and the other from pyrolized rCF, which has lost its sizing. Plasma activation treatments, with air and oxygen, have been performed in order to increase the number of surface functional groups of the rCF and, therefore, improve the fibre – matrix adhesion. The wettability of these samples has been assessed, and the results show a great improvement on the water absorption capacity of the plasma treated pyrolized rCF nonwoven, whereas no visible difference is seen for the dry rCF. Moreover, after one-month storage of the plasma treated samples under vacuum, no reduction of plasma effects on the rCF nonwovens has been detected.

Furthermore, tests according to existent standards for nonwovens have been defined in order to characterize the treated fabrics. Both mechanical and chemical data will be obtained. Mechanical data obtained from the reinforcement, in combination with mechanical data from the matrix, is used for mechanical simulation of the composite in order to assess the performance of the final product.

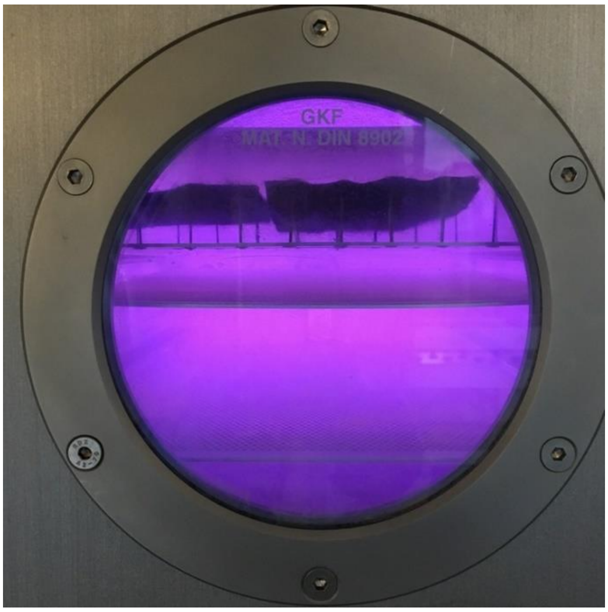

Figure 1 : Low pressure plasma treatment of the rCF nonwovens with air as activation gas.

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BIO-RESINS

During the last months INEGI has continued the work with rosin based epoxy resin characterization and optimization of the curing process. Various thermo-mechanical parameters such as pre-heating chamber and mixing heating temperature, shear mixing speed and time, sonication time have been tested. Preliminary analyses by means of electronic magnifier and metallurgical microscope and more accurated Scanning Electron Microscopy have been performed to characterize the foam generated during the curing process and to determine the hardener and accelerator dispersion. Moreover, mechanical tensile tests (ASTM-D638) and strain-field detection by means of non-contact Digital Image Correlation system have been performed to the rosin based specimens showing that due to the voids generated during the curing process the tensile stress is lower than expected. In order to improve the dispersion of the hardener, different solvent dispersion formulations have been used.

On the other hand, another bio-based epoxy resin from European market has been tried as a potential substitute of the rosin based resin. Curing trials and introduction of silicon carbide (SiC) nanoparticles as matrix nanofillers have been performed. Sonication method has been used to improve the dispersion of the nanoparticles into the matrix. Thermal characterization has been performed obtaining good properties.

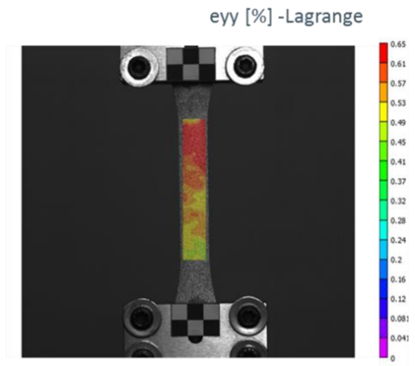

Figure 2 : Strain-field detection by means of non-contact Digital Image Correlation system of rosin based epoxy specimens.

Figure 3 : Cured bio-based epoxy resin from European market nanofilled with silicon carbide nanoparticles.

MANUFACTURING OF MULTIFUNCTIONAL GREEN COMPOSITES AND ELECTRICAL CONDUCTIVE COMPOSITES

During the last months of the project, sandwich panels have been manufactured with green honeycomb and prepreg (rosin) in order to be mechanically characterized.

Monolithic composite panels have also been manufactured with a new technology: Easy RTM^{TM} process.

This technology provides an innovative solution by sophisticatedly separating the LCM in a two-step process in a time sequence. The first action is physically the fill-in without any chemical reaction, and the second one is chemically the curing after all the interfaces are well wetted and the preform is entirely impregnated.

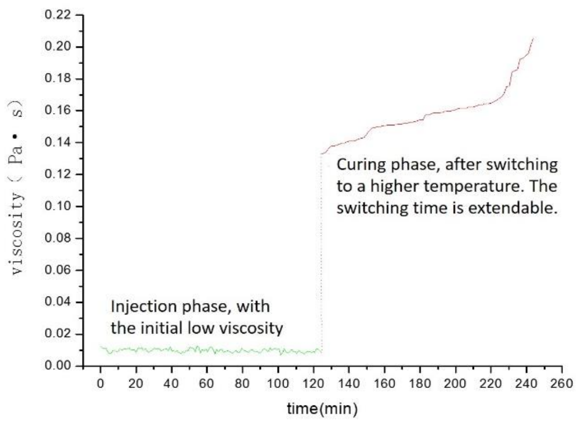

Figure 4 : Viscosity curve during process.

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EASY-RTM^{TM} technology not only makes the LCM process easy, but also expands the material selection and maximizes their use.

Another technology has been developed for Monolithic composite panels manufacturing: using of a natural fiber breather with promising results.

Figure 5 : Manufactured glass fabric panels (middle and high temperature).

Surface conductive film has also been developed for lightning strike protection using micro-scaled toughening interlayers coated with nanoscale silver wires to simultaneously boost interlaminar fracture toughness and electrical conductivity in structural CFRP laminates.

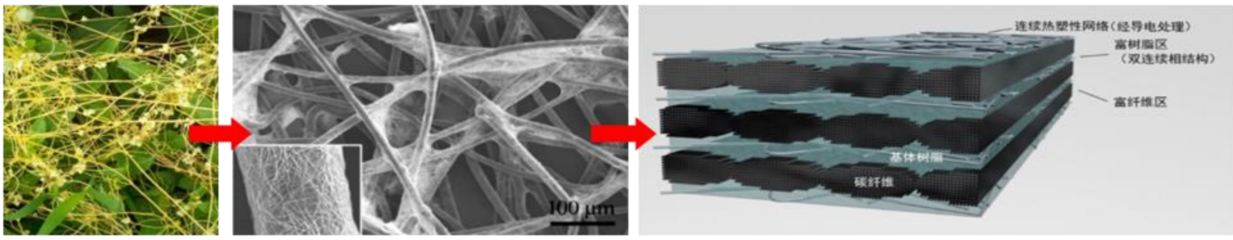

Figure 6 : From nanostructure to coated interlayer film.

Lightning tests have been performed with good results. As well, fire barrier covering composites technology has been developed and vertical burning tests have been performed:

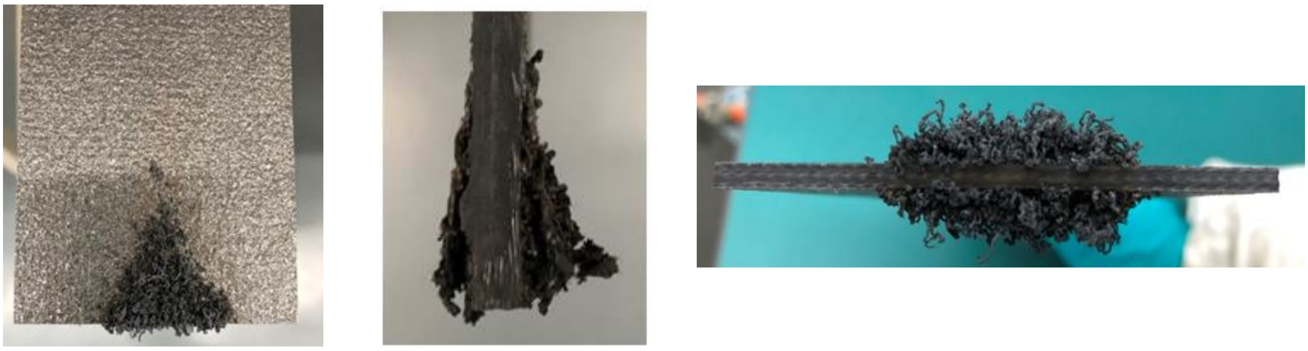

Figure 7 : Vertical burning test.

CHARACTERISATION

In the last months, the density of the carbon fibre rosin (CR) and the ramie fabric rosin (RR) panels were measured. The measured densities were around 9% lower than the calculated values which could be an indication of voids inside the composite. This was further confirmed for the CR composite when the analysis of its fibre volume fraction and micrographs of the panel's cross-section revealed a void content 9.2% which was not captured in the C-Scan of the panels (pictured in the previous newsletter issue).

Analysis of the fibre volume content for the RR composite is ongoing.

Compression Tests

The results from the compressions tests at DLR showed that the CR composite can withstand higher compressive stress whereas the RR composite breaks at higher compressive strain.

From a first inspection of the damage photos (Figure 8) it is visible that the RR and CR composites exhibit

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different failure modes. These can be further investigated with scanning electron microscopy.

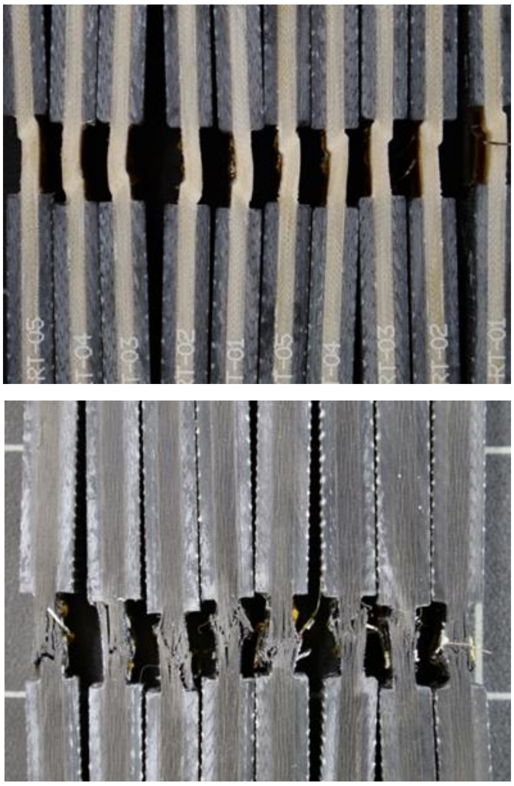

Figure 8 : Lateral view of failed specimens from the compression test of RR (left) and CR (right) composites.

Climbing Drum Peel Test

Peel tests were performed on the green honeycomb sandwich panels which were manufactured by Airbus with materials from the Chinese partners. This test measures the peel strength of the adhesive between the facesheet and the honeycomb. The results are currently being analysed.

Hygrothermal Ageing

Hygrothermal ageing of the CR and RR composites were carried out at 70°C at 85% relative humidity for 1000 hours.

Tensile tests of the aged and unaged specimens at the University of Manchester showed that the CR composite is nearly unaffected by the ageing. The aged RR composite, however, failed at lower tensile strength and higher strain than the unaged specimens (Figure 9).

Interlaminar Sheer Strength (ILSS) of the CR composite was tested at the University of Patras which showed a strength reduction of 4.8% compared to the non-aged specimen.

In parallel, ILSS tests for the RR composite were performed at Airbus and the results will be shared soon.

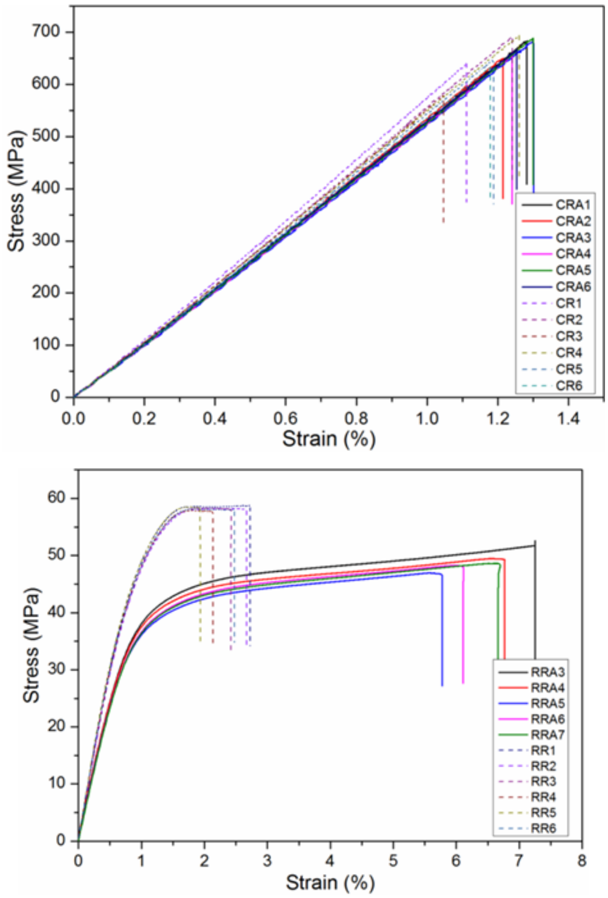

Figure 9 : Left: Stress-strain curves of the CR composite: non-aged (CR); aged (CRA). Right: Stress-strain curves of the RR composite: non-aged (RR); aged (RRA)

MODELING AND SIMULATION

The development of numerical models to characterize eco-composites is advancing at good pace. At current stage, models are being validated and first correlations have been already made with the experimental results obtained from other project partners.

CIMNE and LEITAT have several numerical analysis under development to characterize the mechanical performance of non-woven composites made with flax fibres and a combination of flax and carbon fibres; as well as to characterize rosin reinforced sandwich composites. These analyses are reproducing some of the experimental tests.

University of Patras and Chinese partners continue their work on the numerical prediction of the damage produced in the composite by a lighting strike. These

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analysis are conducted with thermo-mechanical coupled models that use different formulations to predict the laminar and the intra-laminar damage in the composite.

Some of the modelling effort is also placed in the characterization of the vibration and damping composites, which plays an important role in the noise transmission of the plane. Shandong University is working on the correct characterization of the damping parameters of honeycomb cores by theoretical calculation and experimental analyses. The comparison of the numerical and experimental results provides a good agreement in the modal prediction of sandwich structures, as it is shown in the following figure.

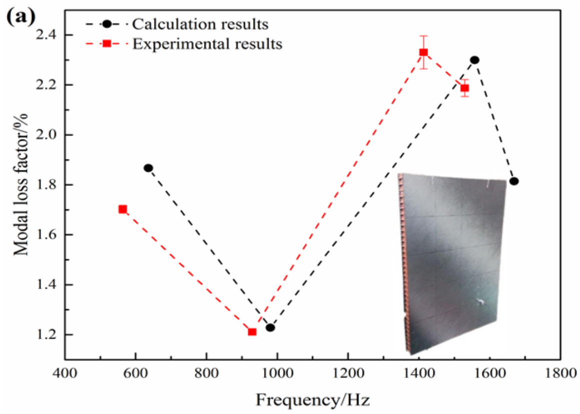

Figure 10 : Damping parameters of CFRP (TR50S15L/YPH-308)/NH-1-1.83-64 sandwich panels.

REQUIREMENTS, APPLICATIONS AND DEMONSTRATORS

Several demonstrators for interior and secondary structures have been defined whereas manufacturing is in progress.

For secondary structures, the European partners have chosen a curved sandwich panel made of green honeycomb and rosin based epoxy/carbon fiber.

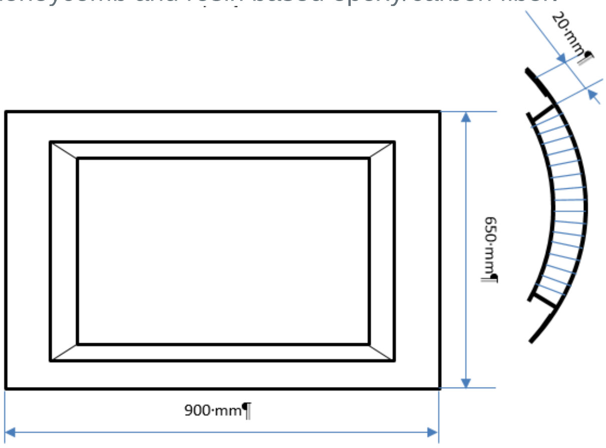

Figure 11 : Curved sandwich panel.

The Chinese partners have chosen a structural composite empennage leading edge device with improved electrical conductivity properties:

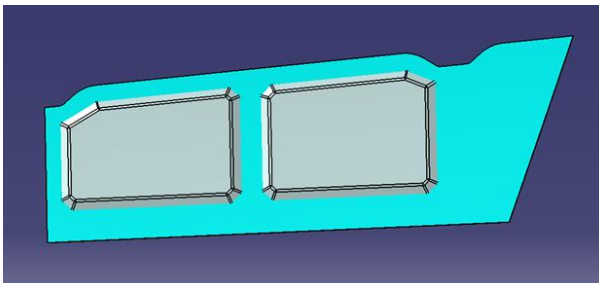

Figure 12 : Empennage leading edge.

For interior structures, the European partners have chosen a plane sandwich panel made of green honeycomb and Rosin based epoxy /ramie fiber.

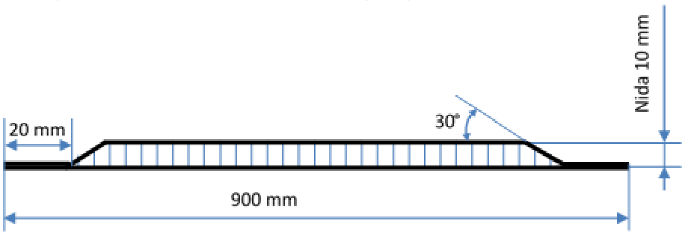

Figure 13 :Flat sandwich panel.

The Chinese partners have chosen a sandwich side panel using green honeycomb as the core material. In a second step, a bio-sourced epoxy prepreg reinforced by glass fiber will be used, once the resin is fire-retardant modified to pass the testing.

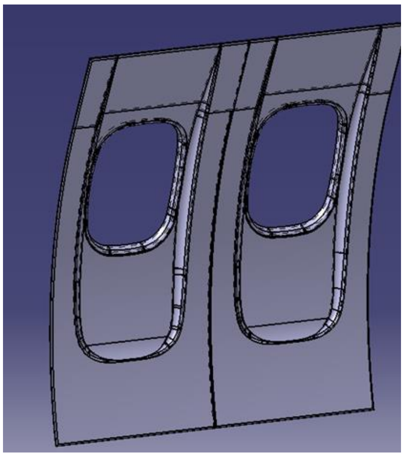

Figure 14 : Interior sandwich panel.

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LIFE CYCLE ASSESSMENT

The Life Cycle Assessment (LCA) is used as a methodology for the comparison between both reference and eco sandwich panel under an environmental perspective. The study considers all life cycle stages from raw materials extraction, processing, manufacturing, use-phase to end of life. The functional unit has been defined as 1 m^2 of panel for aircraft use. The LCA study for interior panel takes into consideration a reference sandwich which is made from glass fibre, phenolic resin and honeycomb. The eco-panel is based on flax fibre fabric, rosin based epoxy resin and greenhoneycomb.

All the stages involved in the manufacturing processes have been considered in line with the SoA. The comparative study has considered the same thickness in both sandwich so far. However, a further comparative environmental analysis for both sandwich with the same mechanical properties is expected to be developed as well.

Inventory data have been gathered from the consortium partners and preliminary impact results have been modelled.

GET TOGETHER

The list of scientific and technological events related to the ECO-COMPASS research fields can be found on our website. The file is regularly updated. Feel free to inform us of any other event likely to interest the ECO-COMPASS community. Hereunder you will find a short selection of major events to take place in the upcoming months.

ECCM 6 & ECFD 7 11-15 JUNE 2018, GLASGOW, UK

The 6th European Conference on Computational Mechanics (Solids, Structures and Coupled Problems) (ECCM 6) and the 7th European Conference on Computational Fluid Dynamics (ECFD 7) will be jointly organized to celebrate the 25th Anniversary of the European Community on Computational Methods in Applied Sciences (ECCOMAS). **The ECO-COMPASS partner CIMNE will represent the project at the event.**
Source: http://www.eccm-ecfd2018.org/frontal/default.asp

ICEAF V 20-22 JUNE 2018, CHIOS ISLANDS, GREECE

The European coordinator of ECO-COMPASS Jens Bachmann (DLR) will give a keynote lecture entitled "Potential for the application of bio-composites containing natural fibres and bio-based thermoset resin systems". The lecture will provide an overview on the recent works on ecological improved composite materials with a special focus on the aviation sector and potential application in interior and secondary structures. **The keynote speech is scheduled for Friday 22 June at 9am.** You can find the full programme of the conference here.
Source: http://ltsm.mead.upatras.gr/lab/lang_en/conference/view/7

8TH EASN-CEAS INTERNATIONAL WORKSHOP ON MANUFACTURING FOR GROWTH & INNOVATION 04-07 SEPTEMBER 2018, GLASGOW, UK

Responding to the increasing interest from the European Aeronautics Community for a scientific event which offers a forum for discussion and exchange of information about state-of-the-art research and development activities in aeronautics and air transport, EASN has announced its 8th EASN-CEAS International Workshop on Manufacturing for Growth & Innovation that will be co-organised with the CEAS and the University of Glasgow.
The ECO-COMPASS partners DLR and CIMNE will represent the project at the event.
Source: https://easnconference.eu/

CAMX 2018 15-18 OCTOBER 2018, DALLAS, USA

Produced by industry leaders, ACMA and SAMPE, CAMX has established itself as North America's event that connects and advances the world's composites and advanced materials communities – the go-to marketplace for products, solutions, networking and advanced industry thinking.
The ECO-COMPASS Chinese coordinator Xiaosu Yi (AVIC Beijing Institute of Aeronautical Materials) will give a keynote speech during the event and provide a general introduction to the project.
Source: https://www.thecamx.org/

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ICGC-10 07-09 NOVEMBER 2018, QUANZHOU, P.R. CHINA

Sustainable development, industrial ecology, eco-efficiency and green chemistry are leading the next generation of materials, products and process development and progress. Green composite materials play an important role applying in the field of high strengh, light weight, recycling and regeneration. In this context, the 10th International Conference on Green Composites aims to addrees the following topics: basic research and application of green composites, i.e. raw materials, function, design, analysis, mechanics, properties and characterization, testing and evaluation, process and fabrication, surface and interface, intelligence, recycling, biodegradable polymers and plastics, nano-celluloses and nano-biomaterials, cellulose based materials, wood polymer composites.

The ECO-COMPASS consortium is organising a special session during the event.

Source: http://www.sampechina.org.cn/

INTERVIEW

ECO-COMPASS newsletters offer you the possibility of getting to know some of the project partners a little better… Thus, the interview section will let you discover the day-to-day life of the people involved in achieving the ECO-COMPASS goals.

In this edition of the ECO-COMPASS newsletter # 4, we propose you several tags which will lead the interview with researchers involved in the investigations: objectives – specific goals – challenges – demonstrators – industry.

JACQUES CINQUIN, SENIOR EXPERT COMPOSITE MATERIALS, AIRBUS GROUP INNOVATIONS

DIDIER FILLEUL, COMPOSITE SENIOR SCIENTIST, AIRBUS SAS

Q1: You are the leader of the work package 4 (WP4) "Manufacturing of multifunctional green composites and electrical conductive composites" and work package 7 (WP7) "Requirements, applications and demonstrators" within ECO-COMPASS. Can you please remind us the objectives of these work packages within the project?

A1: For WP4, manufacturing of multifunctional green composite and electrical conductive composites, the objectives are to:

- validate the manufacturability of the material solutions selected in WP3 "Bio resins" and WP2 "Eco reinforcement from bio based and recycled fibres" for secondary structure applications and interior parts applications,
- manufacture coupons for mechanical and physico-chemical characterization for secondary structures and interior parts applications for the tests defined within the project.

For WP7, requirements, applications and demonstrators, the objectives are to:

- elaborate a list of technical requirements for the materials properties for aircraft secondary structure and interior parts applications,
- define the standards to be used to run characterization tests to produce materials data sheet,
- define demonstrator representative of interior parts and secondary structure parts,
- manufacture the demonstrator with the materials selected in work packages 2 and 3.

Q2: What are the specific goals for the European and Chinese partners? How do you share the tasks?

A2: For the European and Chinese partners, the final goals are quite similar.

For aircraft manufacturers, the main goal is to introduce step by step new materials on the aircraft structure in general. For the Chinese partners there is an additional goal to introduce bio based materials (resin and natural fibres) produced by the Chinese partners in the supply chain of aerospace industry.

The tested Chinese materials are manufactured by Chinese partners. The tested European materials are bought from European materials suppliers. The activity in the tasks are complementary (some samples are manufactured and tested by the Chinese partners and some other are manufactured and tested by the European partners). For validation of testing and manufacturing facilities, some samples are manufactured and characterized by both the Chinese and European partners.

Q3: Airbus and Aviation Industry of China (AVIC) are collaborating to produce composites for interior and secondary structures applications. What are the challenges of these activities? What requirements and constraints do you have to take into account?

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A3: The main challenge for the interior parts are the fire properties of the final parts with fumes, toxicity and energy released during burning. What's more, the materials selected need to be processed very easily to produce this category of part at the lowest price (including material cost reduction in comparison to the reference material used). And, as always, the final weight of the part is a pre requisite for aerospace industry.

For secondary structure parts, a minimum of mechanical properties are requested for this category of part, with again the lowest possible final cost for the parts to be produced (material and process). The final weight of the part is also an important point to consider.

Q4: Representative demonstrators are planned to be manufactured during the project to validate the eco-composites. What innovative technologies developed within ECO-COMPASS do you use to manufacture the demonstrators?

A4: For the interior part demonstrator, the main innovation will come from the material with the use of bio-based resin and bio-based fibre for the sandwich core and for the skins. A specific fire protection deposed at the surface of the parts to avoid complex development to make bio based materials compatible with fire and toxicity requirements is also one of the innovations of the project.

Q5: From the Airbus point of view as a potential user, can you tell how the ECO-COMPASS results are relevant for the industry? How can they be exploited in the next decade and in the longer term?

A5: The ECO-COMPASS results are the first step to evaluate bio-based materials and to determine the possibility to introduce them in the next decade on civil aircraft structures from the technical and properties point of view. However, for the long term, the final decision to use large amounts of these materials for interior parts will be a global environmental decision taking into account the carbon foot print of these new materials compared to the traditional ones.

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