NEWSLETTER # 5 / JANUARY 2019

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 fifth issue of our newsletter, you will find some feedback on 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

Feedback from the ECO-COMPASS special session at the ICGC-10.

Read more

The special issue on the ECO-COMPASS project ha been published in open access mode in the Aerospace Journal. It will also be available in a printed book format.

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

Follow us :

This project has received funding from:
- The European Union's Horizon 2020 research and innovation programme under grant agreement No 690638
- The Ministry for Industry and Information Technology (MIIT) of China Special Research Plan on Civil Aircraft under grant No MJ-2015-H-G-103

Feedback from ECO-COMPASS special session at ICGC-10

The project special session was held on Thursday 8th November 2018. It was organised in collaboration with ICGC-10 at the premises of the Quanzhou Normal University in China. It was chaired by Prof. Yan Li from the Tongji University.

The primary aim of this event was to offer the presenters a forum to engage with large audience, encourage open exchange of information with fellow delegates and present the latest achievements of the project.

The event proved to be a unique opportunity for the participants to obtain an overview of the recent advancements on the research scene, with 5 presentations from the participating European organisations. The conference attendees had the opportunity to engage into fruitful discussions and networking with the representatives of academia, research community and industry involved in ECO-COMPASS.

More than 100 delegates participated in the event.

The ECO-COMPASS presentations can be downloaded from our website:

- Contributive talk No 1: X-ray tomography imaging of sandwich panels made of ramie fibre and carbon fibre by Zehong SONG, University of Manchester
- Contributive talk No 2: Interlaminar shear strength of unaged and aged carbon fibre reinforced rosin-based epoxy composites by Vasileios TZATZADAKIS, Laboratory of Technology and Strength of Materials Department of Mechanical Engineering and Aeronautics, University of Patras
- Contributive talk No 3: Outlook on the potential of hybrid nonwoven from flax fibres and recycled carbon fibres by Jens BACHMANN, German Aerospace Center (DLR)
- Contributive talk No 4: Homogenisation procedures for the analysis of eco-composite for aeronautical structures by Xavier MARTINEZ, International Center for Numerical Methods in Engineering (CIMNE)
- Contributive talk No 5: Preparation and characterisation of bio-based thermoset nano composites by Carmen Sguazzo, Institute of Mechanical Engineering and Industrial Management (INEGI)

Figure 1: The ECO-COMPASS partners participating in the ICGC-10.

This project has received funding from:
- The European Union's Horizon 2020 research and innovation programme under grant agreement No 690638
- The Ministry for Industry and Information Technology (MIIT) of China Special Research Plan on Civil Aircraft under grant No MJ-2015-H-G-103

ECO-REINFORCEMENTS FROM BIO-BASED AND RECYCLED FIBRES

At the University of Manchester, the wet-laying method was chosen to produce nonwoven hybrid composites from short recycled carbon fibres (rCF) and flax fibres. Similar to the paper-making process, the fibres are first dispersed in water and then deposited onto a porous net to drain the liquid. This method is especially suitable for short fibres as most reclaimed carbon fibres come in short lengths, and the water can help to prevent carbon fibres becoming airborne.

Recycled carbon fibre and flax fibres were mixed in different ratios along with thermoplastic fibres which act as the matrix. Several mats of the same ratio were layered and compressed under heat to produce the composite. Three-point bending tests show that flexural properties are not significantly reduced when 25% of the rCF are replaced by flax in the composites with the rCF:flax ratio of 3:1 and 1:1. Vibration tests are also being carried out to measure the influence of the mixing on damping properties.

Figure 2: Recycled carbon fibre and flax fibre composite specimens after flexural tests show the effect of a higher flax content on the crack propagation.

BIO-RESINS

Various nanofiller dispersion trials have been performed to the bio-based epoxy resin from the European market. The nanofillers selected for this activity have been SiC nanoparticles, multiwall carbon nanotubes (MWCNT), and different types of nanoclays.

SiC nanoparticles and MWCNT have been dispersed into the epoxy matrix using different methods and the cured samples have been analyzed by Scanning Electron Microscopy (SEM). Prior to the dispersion of these nanofillers, functionalization of carbon nanotubes and addition of dispersion agents have been used as strategies to improve the dispersion of the nanofillers into the epoxy matrix.

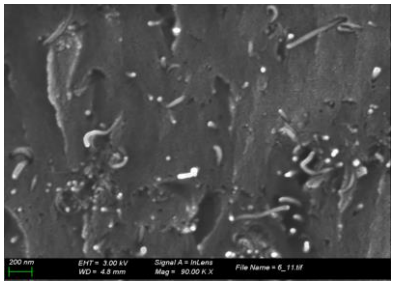


Figure 3: SEM picture of a cured bio-based epoxy resin with MWCNTs dispersed into the matrix.

Parallel to the dispersion studies, tensile and compression probes have been developed for mechanical properties testing. These tests were performed for the neat specimens and they and they will be prefroemd in the near future to nanofilled specimens. Moreover, covalently linked fire retardants have been used to formulate the neat epoxy resin. Specimens formulated with the flame retardant have been developed and will be tested according to ISO 5660 and UL-94 standards.

Figure 4: Tensile specimens based on SiC nanofilled bio-based epoxy resin from the European market.

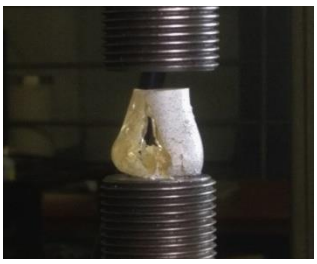


Figure 5: Compression test according to ASTM D695.

This project has received funding from:
- The European Union's Horizon 2020 research and innovation programme under grant agreement No 690638
- The Ministry for Industry and Information Technology (MIIT) of China Special Research Plan on Civil Aircraft under grant No MJ-2015-H-G-103

MANUFACTURING OF MULTIFUNCTIONAL GREEN COMPOSITES AND ELECTRICAL CONDUCTIVE COMPOSITES

Bio-based composite materials with different fire protection systems were successfully manufactured by INEGI. No problems were encountered in the application of both paint or mat.

Three commercial coating treatments – thermal curing are on the way to be evaluated by LEITAT for external aggression of bio-source composite.

Antimicrobial and dimensional tests (possible delaminating between layers studies at low temperature to confirm compatibilities between composite – coating protector) will be performed soon. The Chinese partners have developped a breather with natural fibers that gives good results for curing at high and medium temperature under vacuum or autoclave manufacturing:

Figure 6: Plates manufactured with NF breather.

They have also developped a specfific material protection technology for fire which, compared to state of the art, leads to an improvement on total smoke emission and drastic reduction of energy produced during burning.

CHARACTERISATION

During the few last months, the mechanical characterisation of the monolithic and sandwich composites has been completed. New results are presented in the following figures.

In addition, INEGI started with fire safety tests on flax prepregs with different treatments for reduced flammability. The University of Patras has been investigating the electrical conductivity and electromagnetic shielding effectiveness of carbon and flax fibre composites.

Climbing Drum Peel test

Peel tests were performed on the green honeycomb sandwich panels. The peel strength of the sandwich composite with the carbon face sheet (SCR) is 18.2% higher than the ramie sandwich panel (SRR). Observations through x-ray tomography confirm that resin fillets from the adhesive on the surface between the face sheet and the honeycomb core may enhance the peel strength of the sandwich panel.

Four-Point Bending

Four-Point Bending test showed similar load-to-failure for both sandwich panels. However, the SRR had a larger deflection-to-failure value, indicating higher energy dissipation capacity.

Hygro-Thermal Ageing

The specimens were conditioned at 70°C and 85% relative humidity for 1000 hours. In terms of peel strength, an approximately 20% reduction in the peeling strength for both sandwich panels was measured. Meanwhile, the load-to-failure was reduced by around 14% in the aged SCR specimen in comparison to its non-aged counterpart. The reduction for the aged SRR was 9.2%.

Interlaminar shear strength (ILSS) tests for the ramie monolith composite were carried out at Airbus. After ageing, ILSS is reduced by 49%.

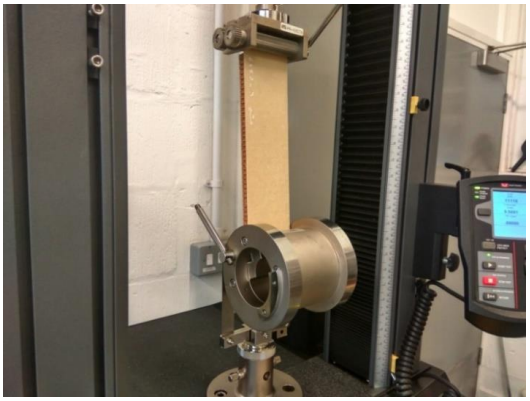


Figure 7: Set-up for peel test.

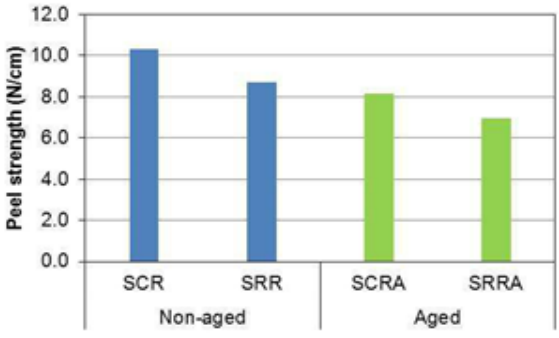


Figure 8: Effect of ageing on the peel strength of sandwich composites.

This project has received funding from:
- The European Union's Horizon 2020 research and innovation programme under grant agreement No 690638
- The Ministry for Industry and Information Technology (MIIT) of China Special Research Plan on Civil Aircraft under grant No MJ-2015-H-G-103

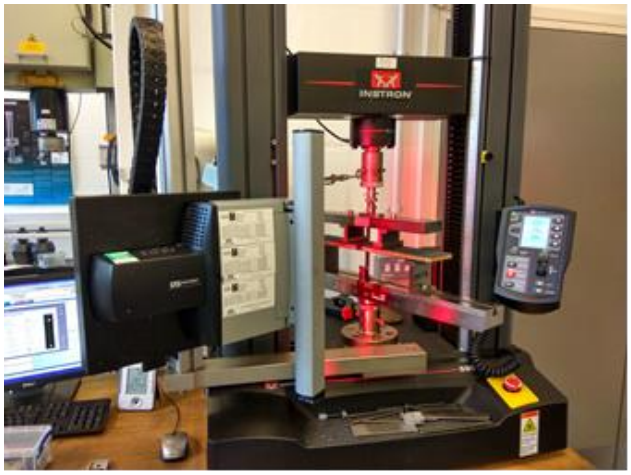


Figure 9: Four-point bending set-up.

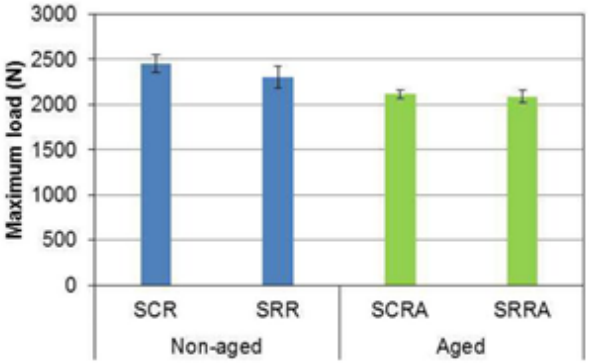


Figure 10: Flexural load-to-failure for aged and non-aged sandwich composites.

MODELING AND SIMULATION

The numerical models developed by CIMNE to characterize eco-composites have been applied to the simulation of non-woven flax composites, which have been manufactured and tested by DLR in the framework of the project. These models are based on homogenization procedures. In particular, fibre random orientation is accounted using the serial/parallel mixing theory, that obtains the composite performance from the constitutive equations of its components. And fibre misalignments are included in the analysis by modifying both, fibre and matrix parameters, using the results obtained from a multiscale simulation of a Representative Volume Element (RVE). The top part of Figure 11 shows the RVE failure when a tensile load is applied to it. Whereas the bottom part of the figure shows the comparison between numerical and experimental results for the force-displacement graph of the 4PB test conducted at DLR.

The same RVEs analysed by CIMNE with its in-house FEM code have been analysed by LEITAT with a commercial FEM package. The results obtained with the different software are being studied in order to develop an analysis procedure that should be as independent as possible of the software used.

The University of Patras has developed a numerical model of a single-fibre RVE to evaluate the effective axial electrical conductivity of a CF/CNTs epoxy composite, assessing the influence of the CNTs number, the aspect ratio and the volume fraction. These analyses have shown that all the scenarios with a CNT aspect ratio of 50 at volume fraction above 1% and the scenario with a CNT aspect ratio of 20 at a volume fraction of 5% provide an improvement of the composite's effective axial electrical conductivity. The numerical results have been compared with the results obtained from an analytical model, obtaining an excellent agreement with a maximum deviation of less than 0.1%.

Researchers from Shandong University have continued their work on analysing the improvements provided in the electrical conductivity of the composite when electrically modified interlayers for Lighting Strike Protection (LSP) are added to the composite. The lightning strike damage resistance of CFRP laminates with these interlayers has been evaluated experimentally and by means of coupled electrical-thermal-pyrolytic FEM model.

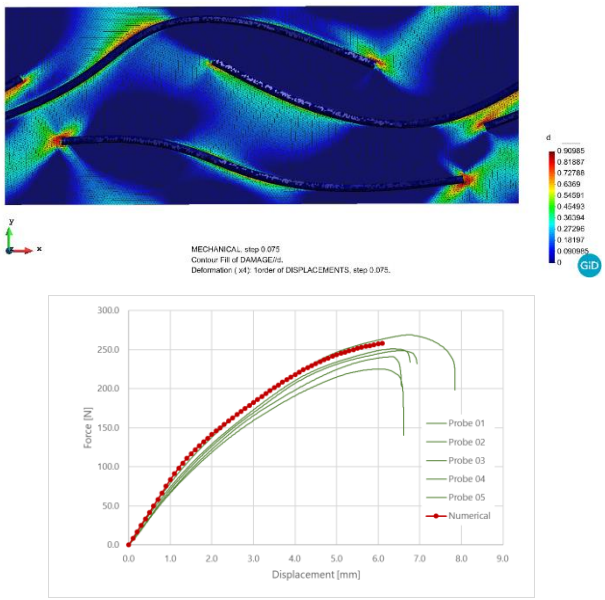


Figure 11: Damage in the RVE when subjected to a tensile test. Comparison between numerical and experimental results for a 4PB test made on the material.

This project has received funding from:
- The European Union's Horizon 2020 research and innovation programme under grant agreement No 690638
- The Ministry for Industry and Information Technology (MIIT) of China Special Research Plan on Civil Aircraft under grant No MJ-2015-H-G-103

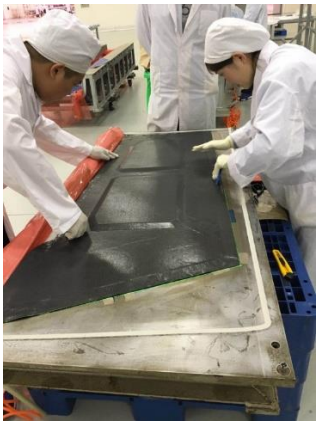
REQUIREMENTS, APPLICATIONS AND DEMONSTRATORS

Several demonstrators for interior and secondary structure have been manufactured.

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

Figure 12: Curved sandwich panel.

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



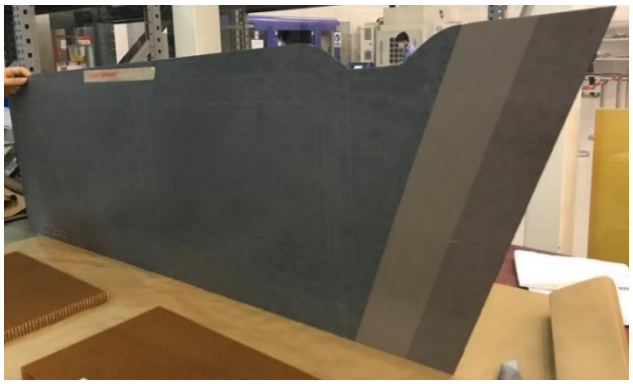


Figure 13: Empennage leading edgel

Lightning strike coupons tests have been manufactured and tested (analysis is in progress):

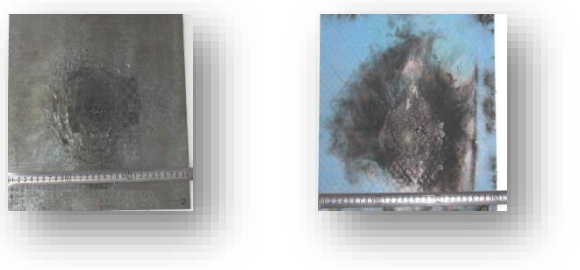


Figure 14: Coupon test.

For interior structure, the European partners have chosen a planned sandwich panel made of green honeycomb and rosin based epoxy /ramie fiber.

Figure 15: Interior 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, after the resin will be fire-retardant modified to pass the testing:

Figure 16: Sandwich side panel.

This project has received funding from:
- The European Union's Horizon 2020 research and innovation programme under grant agreement No 690638
- The Ministry for Industry and Information Technology (MIIT) of China Special Research Plan on Civil Aircraft under grant No MJ-2015-H-G-103

GET TOGETHER

The information on the scientific and technological events in which the ECO-COMPASS partners plan to participate can be found on our website. Feel free to inform us of any other event likely to interest the ECO-COMPASS community. Hereunder you will find our short selection of major events to take place in the upcoming months.

AIAA SCITECH 7-11 JANUARY 2019, SAN DIEGO, CALIFORNIA, USA

The 2019 AIAA SciTech Forum will explore how our industry is being transformed by on-demand delivery of customized products and services. Learn how advances in additive manufacturing, high-speed networked computers, autonomous systems, and big data analytics, are reshaping aerospace supply chains, improving productivity, and opening the market to new entrants. Source: AIAA SciTech 2019.

EMUS 2019 11-12 JUNE 2019, BARCELONA, SPAIN

The European Multifunctional Structures conference will look into a wide range of structural systems, serving different purposes: structures with embedded sensors that give them the capacity to react to an external stimulus, structures with embedded antennas, self-healing and self-monitoring structures, structures with improved fire performance, acoustic performance, or electromagnetic performance, and so on. The large amount of possibilities offered by multifunctional structures make them very valuable in all engineering fields, being of special relevance to the transport sector, in all its forms: automobiles, ships and yachts, aero-structures. Source: EMuS 2019.

PARIS AIR SHOW 17-23 JUNE 2019, PARIS, FRANCE

The 53rd Paris Air Show will take place at the Le Bourget Parc des Expositions from 17 to 23 June 2019, and once again will bring together all the players in this global industry around the latest technological innovations. The first four days of the Show will be reserved for trade visitors, followed by three days open to the general public. Source: Paris Air Show 2019.

AIAA AVIATION FORUM 17-21 JUNE 2019, DALLAS, USA

The AIAA Aviation and Aeronautics Forum and Exposition will combine the best aspects of technical conferences with insights from respected aviation leaders. Source: AIAA Aviation Forum 2019.

EUROMAT 1-5 SEPTEMBER 2019, STOCKHOLM, SWEDEN

EUROMAT 2019, the European Congress and Exhibition on advanced materials and processes, is the premier international congress in the field of materials in Europe addressing the following technical subject areas: functional materials, structural materials, processing, characterization and modelling, energy and environment, raw materials and bio-based materials. Source: EUROMAT 2019.

ICSI2019 2-5 SEPTEMBER 2019, MADEIRA, PORTUGAL

The International Conference on Structural Integrity focuses on all aspects and scales of structural integrity thematic. This ranges from basics to future trends, with special emphasis on multi-scale and multi-physics approaches, and applications to new materials and challenging environments. Source: ICSI 2019.

EASN INTERNATIONAL CONFERENCE 2019 3-6 SEPTEMBER 2019, ATHENS, GREECE

The 9th EASN International Conference on Innovation in Aviation and Space will include a number of plenary talks from academia, industry, research community and policy makers. It will also include thematic sessions. Research projects are invited to exploit the opportunity and disseminate their results and achievements in dedicated sessions. The conference is co-organised by the EASN Association, the University of Patras and the National Technical University of Athens Source: EASN International Conference 2019.

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.

This project has received funding from:
- The European Union's Horizon 2020 research and innovation programme under grant agreement No 690638
- The Ministry for Industry and Information Technology (MIIT) of China Special Research Plan on Civil Aircraft under grant No MJ-2015-H-G-103

In this edition of the ECO-COMPASS newsletter # 5, we propose you several tags which will lead the interview with researchers involved in the investigations: materials – fire protection - Fire, Smoke and Toxicity (FST)- technology readiness level (TRL) - gender aspects.

CARMEN SGUAZZO
RESEARCHER
LABORATORY OF OPTICS AND EXPERIMENTAL MECHANICS
INSTITUTE OF MECHANICAL ENGINEERING AND INDUSTRIAL MANAGEMENT (INEGI)

Q1: Can you briefly describe your involvement in ECO-COMPASS?

A1: The research institute where I work, INEGI in Portugal, is one of the scientific partners of the ECO-COMPASS project. Particularly, I work on the functionalization and the characterization of bio-resins and, internally to the institute, I coordinate the activities of the units involved in the project, whose research fields are related to composite manufacturing, protection technologies and characterization of fire performances.

Q2: What kind of **materials** are you producing in the project and for what purpose?

A2: We are producing bio-based resins, which will constitute the matrix component of fiber composites. We are improving their electrical conductivity and fire resistance properties by means of nanotechnologies. Finally, we assess their mechanical, electrical and fire resistance properties. Furthermore, in the other unit of INEGI, we are manufacturing plant-based fiber composites and investigating suitable fire protection technologies.

Q3: Improving **fire protection** is one of the activities of the project. What are the current limits and benefits of bio-based materials in terms of flammability?

A3: Lowering the flammability of biomaterials is an important topic in different fields of application and technology developments. As mentioned, in this project we focus on epoxy and fiber-composites fire protection.

Currently, the approaches for the improvement of flame retardancy of bio-based resin systems comprise the enhancement of properties by means of flame retardant additives, such as silicon-based additives, or by means of nanomeric particles, like nanoclays and carbon-nanotubes. Another possible approach is the development of new formulations of bio-based resin systems with improved properties, including flammability aspects.

On the one hand, the introduction and the use of bio-based materials with improved flame-retardancy offers an innovative approach towards solutions with reduced environmental and health impact. On the other hand, the complexity lays on the diversification of bio-based matrix systems and types of flame retardant additives, which can be investigated.

Q4: Can you explain us why it is important to make a **Fire, Smoke and Toxicity** (FST) assessment in ECO-COMPASS?

A4: The FST assessment in ECO-COMPASS is important in view of the final applications considered in the project. Indeed, the bio-based composites and resin systems are developed for both aircraft interiors and secondary structures, thus requiring to identify the material FST specifications.

Q5: Generally, what is the **technology readiness level (TRL)** of the fire protection solutions developed in the project? What are the next steps towards the application in industry?

A5: The scientific partners involved in the fire protection topic, started from the formulation of concepts and the experimental proofs of the investigated solutions. Currently, such solutions are validated at laboratory scale. The next steps will be to prove them at industrial scale: this will enable their possible uptake and application.

Q6: Research and development are generally perceived as a mainly male domain. As a female researcher participating in ECO-COMPASS, can you tell us how **gender aspects** are considered in European research & innovation collaborative projects? What would be your recommendations to make science and technology more women-friendly and to increase women's visibility in this field?

A6: In the framework of the European research & innovation projects, the institutions are already encouraged to promote the gender balance at all levels and roles. Unfortunately, if one looks at the data and statistics, women are still under-represented. Anyway, I see that female presence has been rapidly growing among the young generations, and this is very positive. It is essential to continue promoting initiatives for encouraging and for guarantying the gender equality in all the phases of the career, as well as being involved in raising awareness activities.

This project has received funding from:
- The European Union's Horizon 2020 research and innovation programme under grant agreement No 690638
- The Ministry for Industry and Information Technology (MIIT) of China Special Research Plan on Civil Aircraft under grant No MJ-2015-H-G-103