NEWSLETTER # 2 / June 2017

Welcome to the second 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

The ECO-COMPASS project has been thriving for over a year. During this time, a good team spirit and collaboration practices let us achieve first encouraging results.

In the second issue of the newsletter, you will find a word from the Project Officer and information on the ECO-COMPASS special session that will be organised in the framework of the ICCS20 in September 2017. You will further get to know how the work 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.

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

NEWS & EVENTS

The ECO-COMPASS partners organise a special session in the framework of the 20th International Conference on Composite Structures (ICCS20). The session will be held on Tuesday 5th September 2017 at the Conservatoire National des Arts et Métiers in Paris, France.

>> Read more

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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

Word from the Project Officer

The ECO-COMPASS project contributes to reach the environmental goals of Europe's Vision of Aviation Flightpath 2050 by developing safe and ecologically improved composite materials for aircraft interior and secondary structures. Conducted in cooperation with Chinese aviation partners, the project has the potential to assess bio-based and recycled materials for aviation applications, thus paving the road towards a new generation of aircraft with a greener footprint along its entire life-cycle.

I wish the entire ECO-COMPASS consortium good luck and success for its ambitious and relevant work!

Dr Daniele Violato, European Commission, INEA, H2020 Aviation Research

ECO-COMPASS special session at ICCS20

The ECO-COMPASS partners organize a special session at the ICCS20. The main objective of the session is to provide a forum for the presentation and discussion of the research activities carried out within the project and the recent developments. The session will bring together international delegates from industrial, research and academic institutions. The following presentations are planned during the ECO-COMPASS special session:

Time	Duration	Title of the presentation	Speaker, Entity
9:00	20’	The ECO-COMPASS project: EU/China cooperation: Introduction and status after 18 months	Jens BACHMANN, German Aerospace Center (DLR)
9:20	40’	Keynote speech No 1: Development of function-integrated structural carbon composites for aerospace	Xiaosu YI, AVIC Beijing Institute of Aeronautical Materials, China
10:00	40’	Keynote speech No 2: Biobased materials for space application	Brigitte DEFOORT, Airbus Safran Launchers
10:40	20’	Lightning Damage Prediction of Carbon Fiber Composite Materials	Xiao ZHANG, Hefeihangtai Electrophysics Technology Co., Ltd, China
11:00	30’	Coffee break	
11:30	20’	Multi-physical analysis on latent heat effect during lightning ablation damage process of carbon fiber composites	Yvxi JIA, ShanDong Univeristy, China
11:50	20’	Development and characterization of nanofilled rosin-based epoxy bio-resins	Konstantinos Tserpes, Laboratory of Technology & Strength of Materials of the University of Patras
12:10	20’	Numerical and analytical evaluation of mechanical, thermal and electrical properties of CNT/polymer multifunctional nanocomposites using representative unit cells	Vasilis Tzatzadakis, Laboratory of Technology & Strength of Materials of the University of Patras
12:30	20’	Performance Enhancement of Natural Fiber Reinforced Polymer Composites through Nanoparticle Grafting on the Fiber Surfaces	Guijun XIAN, Harbin Institute of Technology, China
12:50	20’	Accounting for material non-linear behavior in multiscale analyses	Xavier, MARTINEZ, International Center for Numerical Methods in Engineering (CIMNE)
13:10	20’	Improving interfacial properties of plant fiber reinforced composites by a multi-scaled design methodology	Yan LI, Tongji University, China
13:30	-	End of session and lunch break	

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Summary:

Title of the special session: Ecological and Multifunctional Composites for Application in Aircraft Interior and Secondary Structures

Date: Tuesday 5th September 2017

Venue: Conservatoire National des Arts et Métiers

Address: 292 Rue Saint-Martin, 75003 Paris, France

ECO-REINFORCEMENTS FROM BIO-BASED AND RECYCLED FIBRES

As pointed out in the first eco-compass newsletter, natural fibres for the use in composites are gaining attention. They offer promising specific mechanical properties combined with the potential to reduce the environmental impact. For the application in aviation of composite structures, natural fibres need to be able to substitute glass or even carbon fibres. This is a very ambitious aim and not all questions to prepare the successful application of flax or ramie fibres as reinforcement in aviation are solved.

Figure 1: Hybrid gradient non-woven made of recycled carbon fibres and flax fibres.

In the ECO-COMPASS project, several ways to improve the properties of natural fibre reinforced polymers (NFRP) are under investigation. Partner LEITAT started first trials to increase the number of surface functional groups of recycled carbon fibres with plasma treatment. The aim is to improve the weak fibre matrix adhesion of these fibres to most resin systems (e.g. epoxy). DLR produced the first lab-scale hybrid gradient non-woven (see photo). Gradient means a controlled distribution of two different fibres through the thickness of the non-woven. Recycled carbon fibres have been combined with flax to enhance the mechanical properties. Next step will be to increase the quality of the gradient non-woven and to assess potential advantages. In parallel, the University of Manchester started the production of non-woven with flax and thermoplastic fibres. The Chinese partner Tongji University fabricated and characterized cellulose nanocrystals from flax fibres with a length between 300 and 500 nanometre. The aim is to deposit these nanocrystals on natural fibres to enhance the properties of the composite. Furthermore, phosphorous-based flame retardants have been synthesized. Tests according the the UL-94 standard resulted in ramie fiber reinforced epoxy composites classification.

BIO-RESINS

Parallel to the main objective of the project to develop new bio-based composites for aeronautical applications, the ECO-COMPASS consortium has focused their efforts to develop a new bio-based epoxy resin and curing agent able to be used as matrix in fiber reinforced composites. The resin produced by Chinese partners is based in Rosin derivatives obtained from plants, mostly conifers. Its rigid structure allows obtaining promising mechanical properties to the final cured resins, really interesting for aeronautical applications.

On the other hand, European partners have started with the improvement of the manufacturing process concerning the mixture and curing processes as well as the improvement of the multifunctional properties by means of nanofillers incorporation into the resin matrix. For this reason, different nanofillers with really good expectations have been selected for this purpose: Carbon nanotubes, Graphene oxide, ceramic nanoparticles, and fire retardants based on phosphorous fire retardancy properties which will be covalently linked to the resin matrix.

Finally, and in order to enhance the work performed in WP3, an exhaustive thermal, rheological and surface characterization of the neat resins has been performed using Differential Scanning Calorimetry (DSC), Thermo Gravimetric Analysis (TGA), Scanning Electron Microscopy (SEM) and Rheology tests.

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Figure 2: Rosin based resins manufacturing and application cycle.

MANUFACTURING OF MULTIFUNCTIONAL GREEN COMPOSITES AND ELECTRICAL CONDUCTIVE COMPOSITES

Bio-based materials have been supplied by the Chinese partners, especially AVIC GM - ACC, to the European partners for the processing of characterization samples.

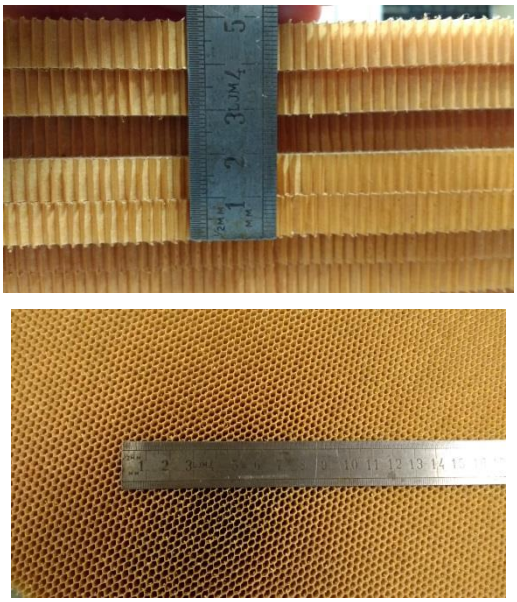

Figure 3: AGMH green honeycomb.

For the manufacturing of laminate samples related to secondary structure applications, two prepregs are now available for the ECO-COMPASS project. The first one is constituted of the AGMP 3600 rosin based epoxy resin (curing temperature 120°C) reinforced with a carbon fiber fabric whereas the other one is composed of the same AGMP 3600 resin reinforced with a natural fiber plain fabric (ramie).

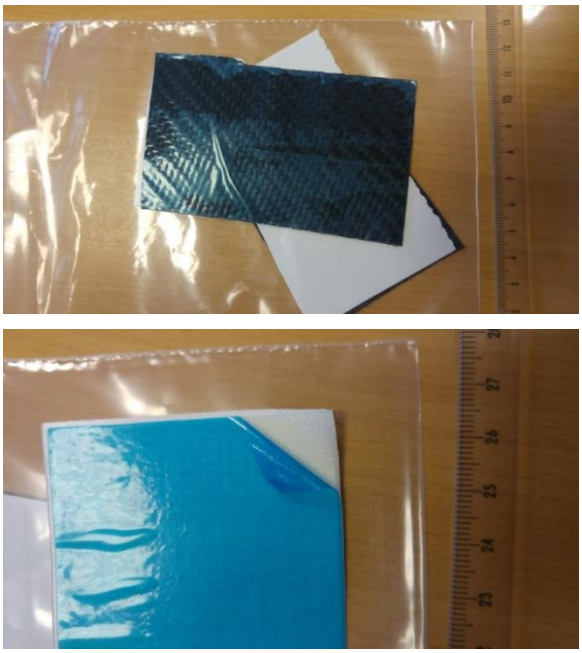

Figure 4: AGMP 3600/ carbon fibers prepreg and AGMP 3600/ ramie fibers prepreg.

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The first manufacturing trials have been carried out to confirm the parameters of the process window of these materials, in order to ensure high final part properties. The coupons will be prepared by mid 2017 according to sample dimensions required in the selected standards for the first mechanical, ageing and fire testing activities planned in the work package 5 “Characterisation”.

Manufacturing composites with enhanced electrical conductivity and adding surface coating for protection purposes against fire and moisture are also important challenges of the manufacturing activities.

CHARACTERISATION

The characterisation and testing programme for fibre, resins and eco-composites was established. The selection of testing procedures and standards was made in a way to facilitate the assessment of whether the eco-composites are suitable replacement of standard materials in some aerospace applications. Therefore, whenever applicable, testing procedures and standards used by Airbus are considered.

The individual components (fibres, matrix and fillers) are characterised within specific work packages (eco-reinforcments and bio-resins development) to determine their physico-chemical and mechanical properties. For instance, DSC, rheological, flexural, tensile, etc. will be performed to select the best candidates and best manufacturing parameters to be considered in further steps.

The eco-composites for secondary structures applications materials, the focus is on mechanical properties, while for the interior applications ones it is on the FST and aging properties. The mechanical properties of materials for secondary structures applications will be determined by tensile, compression, interlinear shear strength (ILSS) and peel tests. For the eco-composites for interior applications, apart from the mechanical characterisation (tensile and flexural), the FST and aging tests will be carried out.

Specific eco-composite materials will be selected to undergo further experimental tests, which are more specific to the type of application. Vibrational, acoustic damping and noise characteristics, and their effects on the passenger comfort/experience will be analysed for eco-composite materials for interior applications. For secondary application materials, the lightning strike protection capability will be tested. Additionally, the multi-functionality of eco-composites will be enhanced through coating and filler applications. The properties found during the experimental phase will be used to validate the FEM models developed in the WP6 “Modeling and simulation”.

Part of the raw materials, namely flax prepreg and green honeycomb, are now available. Also, further developments are expected in the non-woven fibres in the coming weeks. For these reasons, it is expected that specimens will be available for testing before the end of June 2017.

MODELING AND SIMULATION

The capacity of numerical models to reproduce successfully and accurately the response of composite structures has a strong dependence on the material parameters used to describe the model. The experimental WPs of ECO-COMPASS project will provide an excelent database for composite modelling and simulation. Researchers working in WP6 have developed a list of the required material parameters to ensure that they are obtained from the experimental test.

The numerical models already developed are being tested to evaluate their capacity to reproduce the performance of bio-composites. A micro-model of a flax textile embedded in an epoxy matrix was used to evaluate the structural response of a three bending point test. In the Figure 5 it is shown the flax textile (a), the RVE developed (b), a comparision of the experimental and numerical force-displacement graph (c) and the damage parameters in the beam structure and the micro-model (d).

Analyisis have been also performed to evaluate the effect of carbon nanotubes properties in the electrical and thermal conductivity of an epoxy matrix. Representative Volume Elements where developed with Digimat software in which it was studied the efect of interphase, curvature, size, volume fraction and aspect ratio in this properties. Results showed that the first two did not affect the properties while the last three did. had no effect while the last three did affect the properties. Figure 6 shows some of the RVE developed.

Chinese partners have been validating the numerical models developed to characterize damage in nano-filled CFRPs due to a lighting strike. Numerical

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models of a plate subjected to 40kA current applied during 0.2µs have been compared with the results obtained from an experimental analysis. This comparison is shown in figure 7.

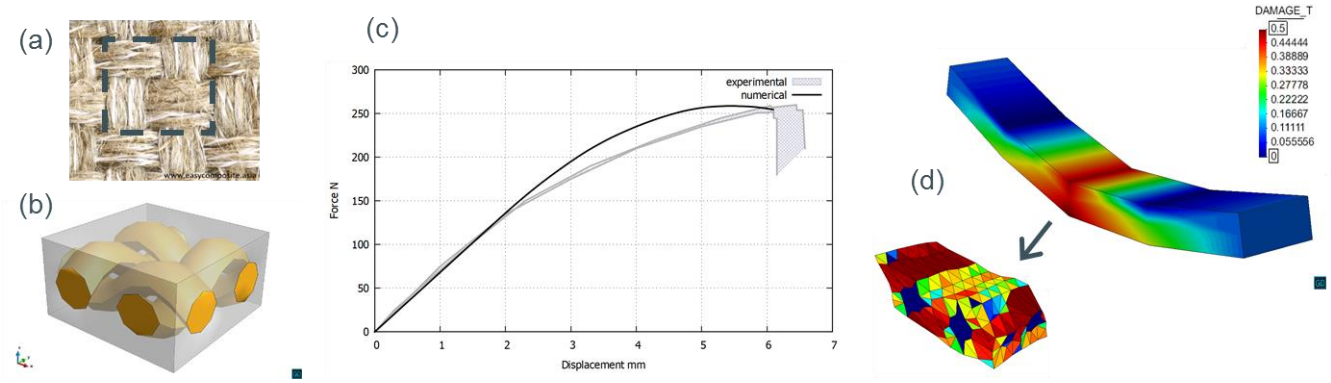

Figure 5: Simulation of flax fabric in an epoxy resin (a, b). Numerical and experimental force-displacement results (c) and damage parameter in the numerical model (d).

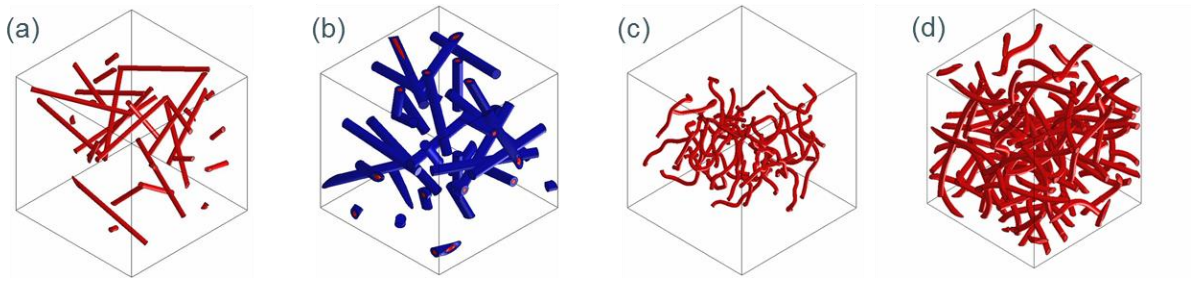

Figure 6: Representative volume elements with straight CNT (a) and modifications of this initial model with larger interface (b), larger curvature (c) and larger volumetric participation and aspect ratio (d).

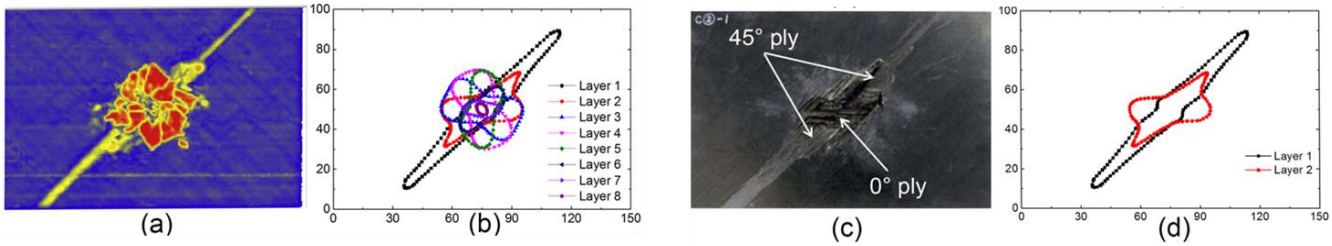

Figure 7: Comparison between experimental[1] and simulated isotherms of IM600/133 under 0.2µs, 40kA. Ultrasonic C-scan (a), overlap of 300 ºC isotherms (b), surface image (c) and 300 ºC isoth. of the top layers (d).

REQUIREMENTS, APPLICATIONS AND DEMONSTRATORS

The material requirements and the standards related to the characterization activities have been summarized in an internal deliverable, gathering inputs from the European and Chinese ECO-COMPASS partners. Such information is used as targets for the development of the bio based materials as well as regarding the testing activities to be carried out within the WP5 “Characterisation”. The manufacturing of demonstrators for interior and secondary structure application has also been planned considering the most promising materials solutions that will be identified in the previous work packages.

[1] Ogasawara T, Hirano Y, Yoshimura A. Coupled thermal-electrical analysis for carbon fiber/epoxy composites exposed to simulated lightning current[J]. Composites Part A: Applied Science and Manufacturing, 2010, 41(8): 973-981

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LIFE CYCLE ASSESSMENT

During the first months of the ECO-COMPASS project, the European partners Airbus, LEITAT and DLR reviewed the available information from publications about LCA in aviation. Focus has been laid on materials under investigation in ECO-COMPASS: the bio-based fibres flax and ramie, recycled carbon fibres and bio-based thermoset resin systems. During the “China-EU Conference on Green Aviation Research“ in Shanghai in November last year, the most important results of this review have been presented to the audience. Furthermore, a publication in a peer reviewed journal is planned in the upcoming months. The LCA review has been carried out to identify possible advantages and also disadvantages on environmental properties by hypothetically using such “green” materials to substitute synthetic constituents of composites used in aviation. Generally, a lack of environmental results for the substitution of synthetic materials by bio-based/recycled composite materials in aviation applications has been found. Further investigations in LCA data for composite materials are needed to better understand potential environmental effects. It is the aim of WP8 “Life Cycle Assessment” in ECO-COMPASS to improve the availability of data and results for eco-materials in aviation. To achieve this aim, the support of suppliers and all project partners to gather the needed data is of high importance.

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.

ICCM21 20-25 AUGUST 2017, XI’AN, CHINA

The 21st International Conference on Composite Materials aims at encouraging exchanges between researchers and promoting the use of composite materials and structures. The conference theme in 2017 is "Advanced Composites: Innovation and Development", which tries to explore the role of innovation in the development of composite materials, and examine if the composite materials are making a difference in boosting the global economy. Source: http://www.iccm21.org/

ICCS20 04-07 SEPTEMBER 2017, PARIS, FRANCE

The 20th International Conference on Composite Structures will provide a forum for the presentation and discussion of the latest research and innovations in all aspects of composite structures and materials.
Source: https://events.unibo.it/iccs20

EASN CONFERENCE 26-29 SEPTEMBER 2017, WARSAW, POLAND

The 7th EASN International Conference on “Innovation in European Aeronautics Research will include talks and presentations by key-figures from the academia, industry, research community and policy makers. It will also include thematic sessions on a series of domains and disciplines of A&AT along with technical workshops where evolving ideas, technologies, products, services and processes will be discussed. Research projects can exploit the opportunity and disseminate their results and achievements in dedicated sessions.
Source: https://easnconference.eu/

CEAS 2017 16-20 OCTOBER 2017, BUCHAREST, ROMANIA

The Aerospace Europe CEAS 2017 Conference brings together academic, research, industry and operator representatives for a fruitful date exchange of the latest ideas and developments in European aeronautics and aerospace.Source: http://ceas2017.org/

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 # 2, we propose you several tags which will lead the interview with the PhD candidate in structural analysis: staff mobility – transfer of knowledge – synergies – outcomes – benefits.

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STEFANO ZAGHI
PH.D. CANDIDATE IN STRUCTURAL ANALYSIS
INTERNATIONAL CENTER FOR NUMERICAL METHODS IN ENGINEERING (CIMNE)

Q1: As a PhD candidate, you participated in a **staff mobility** scheme between CIMNE and DLR from February to May 2017. What were the objectives of your visit at DLR? What were the planned tasks and your daily activities?

Stefano Zaghi (SZ): The purpose of mobility, organized between CIMNE and DLR, falls in the WP6 of the ECO-COMPASS project. In this sense, the goals for this visit are to be experimental tests of composite materials with natural and recycled carbon fibers in the DLR laboratory to validate an optimized multiscale methodology developed in CIMNE able to simulate complex structures. In order to achieve these objectives a daily meeting was crucial, where were defined the activity to perform during the day such as the composite productions, the preparation of the benchmarks or the analysis of the results.

Figure 8: (left) Jens Bachmann and Stefano Zaghi (right) in the DLR laboratory.

Q2: Personnel mobility is one of the channels for **transfer of knowledge**. What specific know-how and good practices have you acquired during this staff mobility scheme? How can these be relevant for your future job and professional development?

SZ: As PhD candidate in Structural Analysis I think that, in addition to the numerical skills acquired during my studies, to complete my professional profile like engineer it was mandatory to know the experimental counterpart of the research. In DLR I had the opportunity to observe how to work in an aerospace research institute, excellence in Germany and in the world. Learning the complete analysis process of composite materials and the usage of laboratory instrumentation to test that materials.

Q3: How will your home and host organizations exploit complementary competences and other **synergies**?

SZ: The ECO-COMPASS project represents an incredible chance to join the skills of the involved partners, improving communications, knowledge, experiences and competences. Exchanging information and know-how is essential to work for the same goals and crucial to obtain a better result. Thanks to this mobility the collaboration with DLR and CIMNE will increase and consolidate. Indeed, the experience of DLR in carbon fibers and the experimental studies of novel materials like natural fibers and bio-resins are of significant importance for the numerical modelling and the subsequent computational analysis.

Q4: What are the expected **outcomes** of your visit at DLR?

SZ: From this mobility I am expecting to validate the method developed in CIMNE comparing the results to the experimental one. Then, to simulate structures able to demonstrate the capability of the new materials studied in the project in terms of mechanical and environmental impact.

Q5: How will these results feed into the ECO-COMPASS activities? What are the concrete **benefits**/perspectives for the project?

SZ: The results obtained through the multiscale models developed in CIMNE will benefit in the simulation of aeronautical secondary structures or components that would be difficult/impossible to studied with experimental tests. Therefore, the numerical validation of natural and recycled carbon fibers composites through laboratory benchmarks obtained in DLR will contribute to analyze possible industrial application of these type of composites materials.

Figure 9: European cooperation during leisure activities.

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