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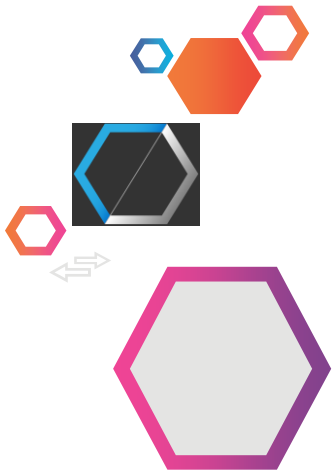
MODCOMP

"MODIFIED COST EFFECTIVE FIBRE BASED STRUCTURES WITH IMPROVED MULTI-FUNCTIONALITY AND PERFORMANCE"



NEXT GENERATION OF CARBON FIBRE BASED MATERIALS

This project has received funding from the European Union's Horizon 2020 research and innovation programme, European Research Council (ERC) under the European Union's Horizon 2020 research and innovation programme, Industrial Technologies, Advanced Materials and Nanotechnologies, H2020-NMP-2014-2015/H2020-NMP-2015, under grant agreement No. 685844.

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Inside you can find:

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Latest Research Achievements

After 4 years of successful research cooperation, the MODCOMP project comes to an end in March 2020. The following Newsletter presents the latest research work on the field of modified cost-effective fibre-based structures with improved multi-functionality and performance.

Electrochemical treatment of CFs: 4 Years of Progress and Development

The surface treatment of CFs is essential to improve the adhesion with various matrices and as a result to enhance the mechanical performance of the final composite. Electrochemical treatment is a method that aims at the modification of the surface chemistry and wettability of CFs, and confer multi-functionality by introducing new functional groups. In this scope, NTUA worked on the functionalisation of CFs by electrochemical treatment and subsequent electropolymerization onto them. The first step has proven capable of increasing the surficial activity and the roughness of the fibers without damaging their structure. For the second step, this method can be used for creating grafted polymer coatings; this translates into increased wettability of the fibers from the matrix and quite possibly enhancement of the interlaminar shear strength.

After 48 months of continuous research, experiments, tests and redesign of the processes, NTUA is capable to support four of the MODCOMP's demonstrators with functionalised materials via upscaling of the process. Large plies of CF fabrics (50cm x 50cm) can be treated with polymethacrylic acid, a polymer coating that has proven to improve the interlaminar shear strength and the fracture toughness of composites up to 50%. The main aim was to design (and possibly construct) a proper pilot scale treatment facility that will permit the introduction of the process in industrial level. After a lot of research and collaboration among MODCOMP partners, NTUA has constructed a fully operational pilot line process that can treat CF continuously via electropolymerization with a production rate up to 200m/day.

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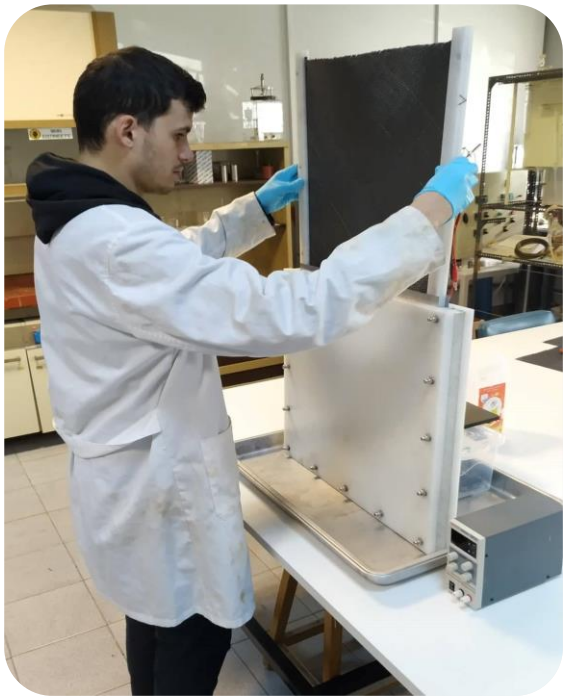
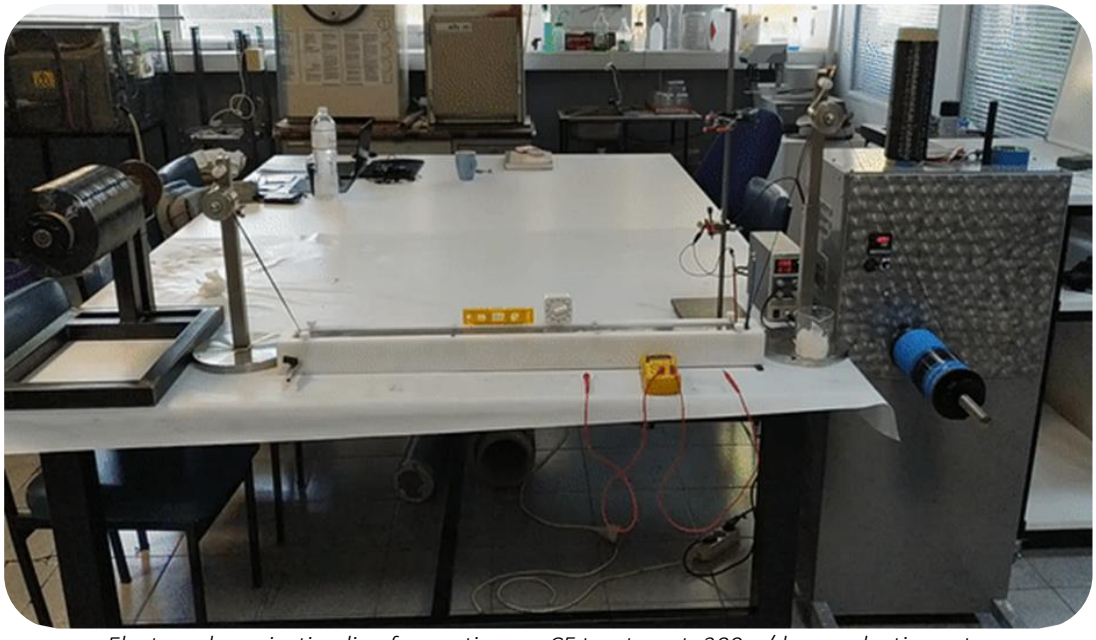


Electropolymerisation of CF fabrics in a 50x50cm^2 electrochemical cell. Electropolymerised fabrics were used in AED's demonstrator (aeronautical components), as well as in GSG and AP&M constructions (AdShel, SecureShel and Sleekfast, respectively).



Electropolymerisation line for continuous CF treatment; 200m/day production rate.

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A propellant tank as a demonstrator

Yuzhnoye SDO within the MODCOMP project is developing a demonstrator - a propellant tank, which is a cocoon type structure with a diameter of ~ 300 mm and a length of ~ 600 mm.

Three demonstrators have been made in the project: the technological one from the material used by Yuzhnoye SDO for units of this type, from the material adopted in the project (HTA40 E13 6K 400 tex carbon fiber) and from HTA40 E13 6K 400 tex carbon fiber treated with ASPN5 active screen plasma at UoB (University of Birmingham, United Kingdom) (picture below).

Yuzhnoye's demonstrators

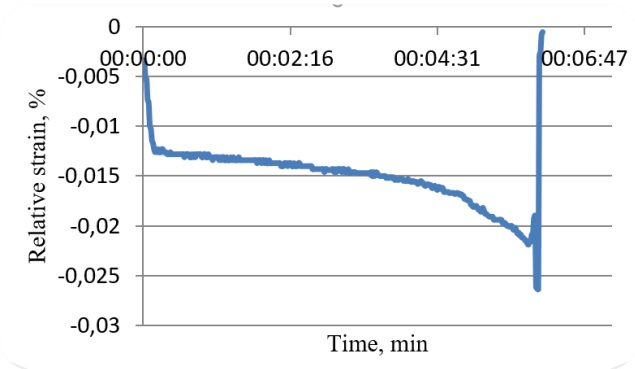
The demonstrators were made on a five-axis winding machine with MAW 20 FB5/1 CNC (picture below).

Winding process of the Yuzhnoye's demonstrator

In order to confirm the project concept, all the demonstrators were tested with internal pressure to destruction.
The tests were carried out on the hydraulic bench of Yuzhnoye SDO with a maximum working pressure of 750 atm and using tooling specially developed in the project (picture below).

Demonstrator before and after testing

The effectiveness of using modified carbon fiber was assessed by measuring strain during loading of the propellant tank with internal pressure to destruction (see below).



Demonstrator (propellant tank) strain curve at the transition from the cylindrical part to the fitting

Strain measurement during internal pressure testing is carried out by a 16-channel strain gauge station. The values of the internal pressure and deformation of the tank during tests are recorded with a sampling of 0.2 seconds.

After testing in accordance with the program, studies of the microstructure of carbon plastics and determination of their strength characteristics are carried out. Conclusions about the effect of ASPN5 active screen plasma developed by UoB (University of Birmingham, United Kingdom) will be drawn in the final report and presented in webinar.

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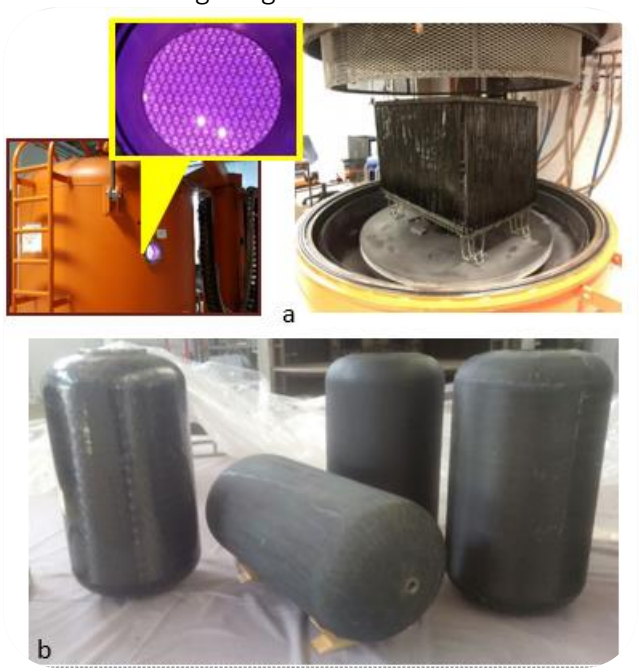
Surface modification of carbon fibres for high performance carbon fibre composites

MODCOMP project aims to develop novel engineered fibre-based materials for technical, high value, high performance products for non-clothing applications at realistic cost, with improved functionality and safety. The main objective of WP1 is to develop and apply advanced surface modification techniques for the activation and functionalization of carbon fibre surfaces to enable the fabrication of fibre-based structures with improved multi-functionality and performance.

The new surface modification techniques have been developed for carbon fibres (HTA40 E13 6K 400tex carbon fibres and G0926, G1157 carbon fibre fabrics (Toho Tenax-E) by three partners [1, 2, 3], particularly the following five treatments with optimised performance of the carbon fibre reinforced composite, namely: (1) Atmospheric plasma treatment (App)[1]; (2) Active-screen plasma activation (ASP1&ASP2)[2]; (3) Electrochemical treatment (PMAA&15C)[3] .

Performances of the composites made with the optimal treated carbon fibres/fabrics were characterised in terms of the ILSS (interlayer share strength), thermal conductivity, wettability, IFSS (interface share strength. The results revealed improved wettability of the fibre surface and increased adhesion between the fibre and the matrix. Particularly, advanced active-screen plasma treatment can lead to increase single fibre tensile strength, indicating the post-plasma nature of the ASP technology2 can effectively eliminate ions bombardment induced degradation while providing radicals necessary for surface modification as radicals have longer lifetime than ions and electrons.

Upscaling of the surface treatments have made it possible to have large size and quantity materials for making demonstrate components, as shown in the right figure.



a) Active-screen plasma furnace carried out treatments for 9000 meters long CFs; b) composite demonstrators of aircraft propellant tanks made by ASP treated CFs.

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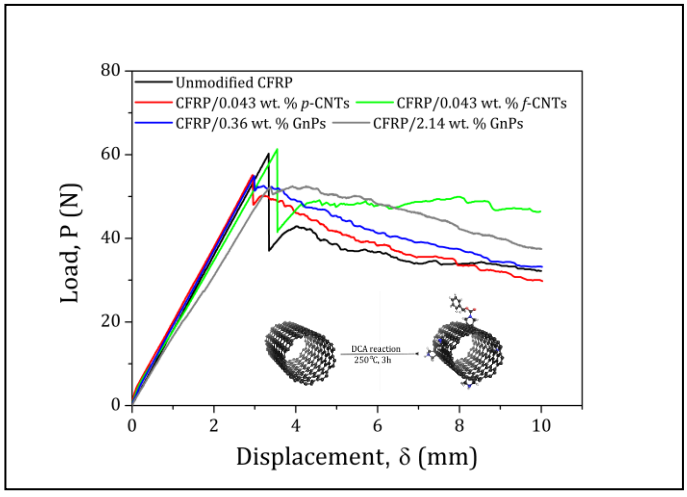
Multiscale carbon fibre reinforced polymer (CFRP) composites

Multiscale carbon fibre reinforced polymer (CFRP) composites showing enhanced multi-functionality and mechanical performance were successfully prepared in the scope of MODCOMP project through the incorporation of carbon-based nanomaterials having different dimensionalities and geometries into thermoset polymers.

The doped resin, with one-dimensional (1D) carbon nanotubes, two-dimensional (2D) graphene nanoplatelets or combinations of both, was further used to produce unidirectional pre-impregnated materials and their composite laminates. The results attained in the framework of MODCOMP project showed that higher electrical conductivities are typically achieved using pristine carbon nanotubes (*p*-CNTs). Since a key step on the processing of continuous carbon fibres (CF) is to ensure a good impregnation of the doped resin on the reinforcement, *p*-CNTs were also combined with graphene nanoplatelets (GnPs) aiming at decreasing their influence on the shear viscosity and exploring synergetic effects.

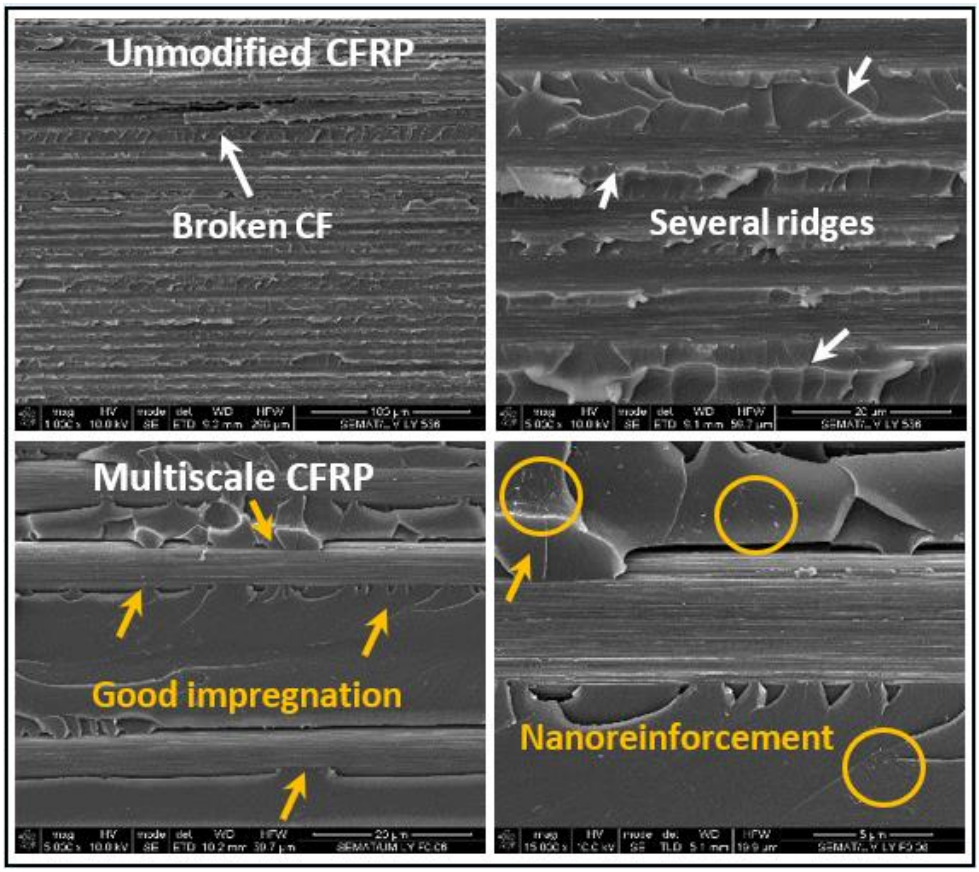
Novel morphologies at the nanoscale were developed, allowing the control of the fracture behavior of CFRP composites by introducing additional energy dissipation mechanisms and improving their overall damage tolerance. The interlaminar fracture toughness under mode I loading, G_{IC}, which is one of the most crucial properties of composite laminates, of modified CFRP composites with GnPs showed a remarkable improvement of 70 %. In addition, functionalized CNTs (*f*-CNTs) with tailored interfaces also showed an enhancement of 44 % for G_{IC} at ultralow contents (0.043 wt. %) that is so far the best reported value in the literature.



These results are in part reproduced at: Raquel M. Santos, Diogo Vale, Jessica Rocha, Carla Martins, Sacha T. Mould, Nuno Rocha. *Multiscale carbon fibre reinforced polymer (CFRP) composites containing carbon nanotubes with tailored interfaces*. Special Issue – Engineering Against Failure, Fatigue & Fracture of Engineering Materials and Surfaces, Wiley 2019 (DOI: 10.1111/ffe.13006).

In addition, the influence of hybrid filler systems was also investigated within MODCOMP project.

Synergetic effects were found for transverse tensile properties (90°) of CFRP composites containing combinations of CNTs with GnPs (75:25) at an overall concentration of 0.043 wt. %, due to the formation of a three-dimensional (3D) architecture that facilitates the electron transport throughout the polymer, and improves the stress transfer between the matrix and the nanoreinforcement.



These activities were developed by INEGI's team, focused on the production of high performance fibre-based structures. Some of these results are in part reproduced at: Silva, M. Vale, D., Rocha, J., Rocha, N., Santos, R. M. *Synergetic effects of carbon nanotube-graphene nanoplatelet hybrids in carbon fibre reinforced polymer composites*, MATEC Web of Conferences, 2018 (10.1051/matecconf/201818801015).

Based on the most promising materials developed, additional amounts of doped resin with hybrid filler systems were prepared for the manufacturing of MODCOMP demonstrators, including the sailing boat component "SleekFast" prototyping and the "SecureShel" Personal Vehicle Storage – Prototyping. These activities were performed by INEGI's team in strict collaboration with AP&M and GSG partners.

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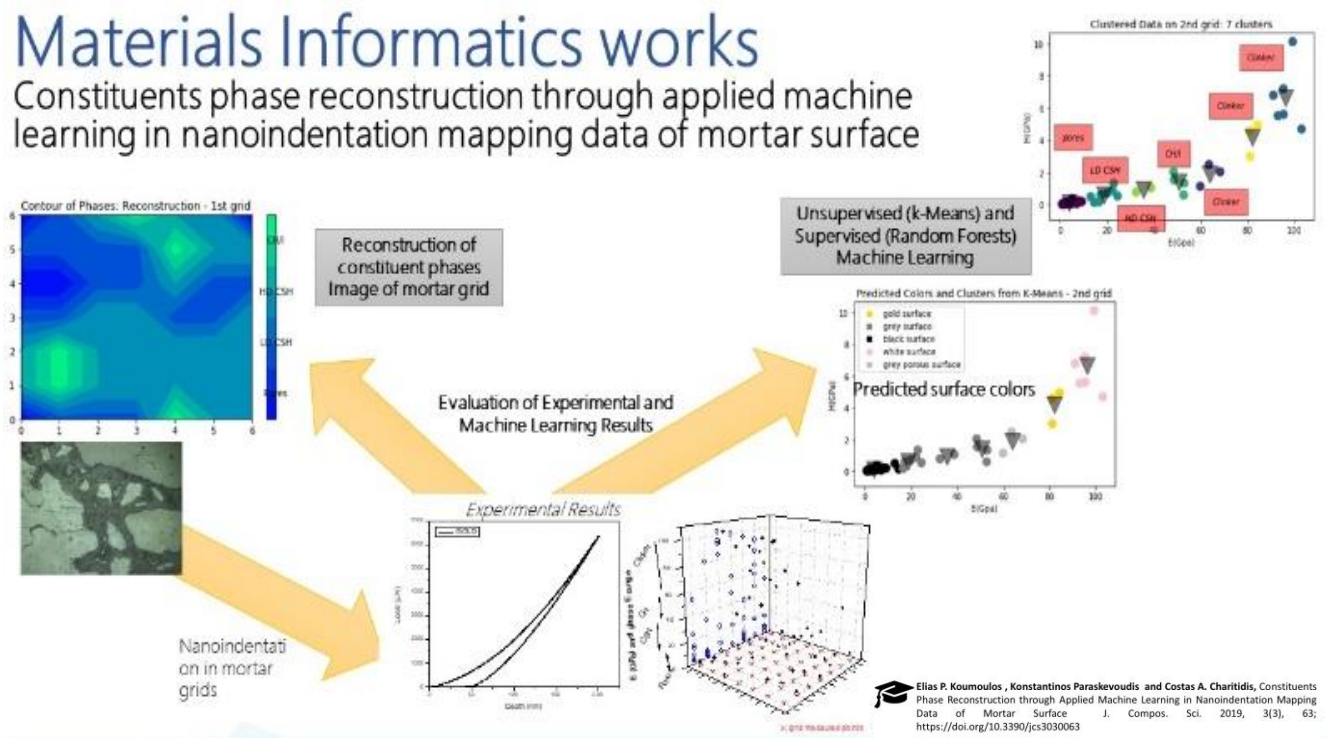
Data Management Plan as prerequisite for FAIR Data and Machine Learning



A novel methodology of data documentation in materials characterisation, which has as starting point the creation and usage of any Data Management Plan (DMP) for scientific data in the field of materials science and engineering, followed by the development and exploitation of ontologies for the harnessing of data created through experimental techniques has been developed.

Nanoindentation is the selected case study, a widely used method for the experimental assessment of mechanical properties on a small scale. Except for technology development and synthesis of new materials and hybrid composite structures, the need of developing new evaluation methodologies is highlighted to assist and accelerate developments.

Artificial Intelligence (AI) is a promising candidate to bridge the gap between Research and Development (R&D) and industry by establishing unbiased relations between microstructure and properties. This is majorly appreciated in case of Safe-by-Design requirements regarding

mechanical performance, and real-time characterisation. Being representative, k-means, Random Forrest (RF), Support Vector Machines (SVM), k-Nearest Neighbours (KNN) are common Machine Learning (ML) algorithms used in multiclass classification problems for automated classification of microstructures.

This work contributes to nanocomposites design and quality control associated with identifying the optimum inclusion in nanomaterials reinforcement by microstructure assessment. In this direction, Artificial Intelligence can provide a module for enabling fast, in-line, and real-time metrological characterisation of nanoindentation data.

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Prototype to perform electrophoretic deposition (EPD) of carbon nanotubes (CNTs)

During the MODCOMP project, RISE SICOMP has successfully designed and developed a prototype to perform electrophoretic deposition (EPD) of carbon nanotubes (CNTs) onto the surface of carbon fibre weave reinforcement in a continuous way, which leads to a uniform CNT deposit with reduced CNT raw material consumption and energy use as well as environmental impact. To produce the CNT-deposited CF weave (13 layers) for a hand brake lever following the real product geometry via this prototype takes less than 30 min.

Hand brake lever demonstrators completely made of CFRP, using virgin CF weave and CNT-deposited CF weave, have also been manufactured at SICOMP, following the geometry and load-bearing requirement from Brembo. The CFRP lever is ~ 40% lighter than the aluminum

lever (real product). Furthermore, all CFRP lever demonstrators have passed the tests prescribed by Brembo. The CNT deposit density following the deposition conditions optimized in the duration of MODCOMP project is ~0.54 g/m2. This leads to no detectable weight increase in the levers with CNT-deposited CF weaves but a better mechanical resistance relative to the levers with virgin CF weave – the average force to break the lever is almost 100 N more in the levers with CNT-deposited CF weaves than in the levers with virgin CF weaves.

The improvement of structural properties of CFRP especially at demonstrator or prototype level by CNT, has seldom been reported in EU projects to the best knowledge of the responsible researchers, particularly the CNT-modified CF reinforcement is produced in a continuous way. This could showcase the benefits and competitive advantages of nanotechnology in the advanced composites area as well as the innovation capability of Europe in this field. Related achievement will be continuously disseminated to a wider range of stakeholders in an international level to facilitate scaling-up of the technologies.

Senior Scientist (polymer materials and composites), Guan Gong, at RISE SICOMP is responsible for the technology development as well as providing contact details for anybody interested in more information. Researcher, Maxime Noël; Senior Engineer (composite manufacturing & testing), Erik Sandlund and Daniel Eklund; part-time technician, Mona Bergstedt, at RISE SICOMP, are most appreciated for carrying out the work.

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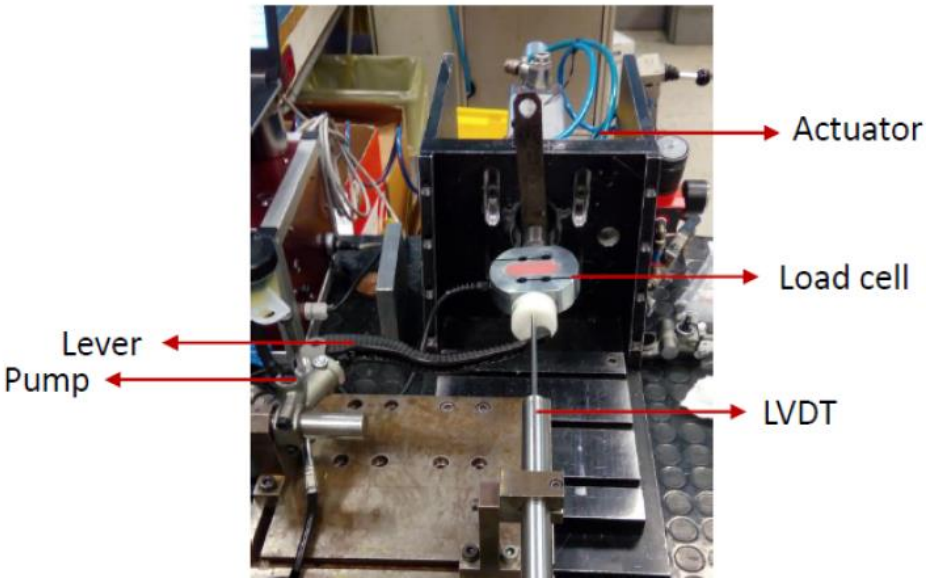

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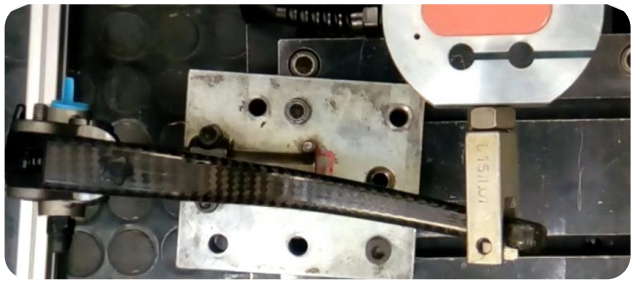
MODCOMP's Automotive Demonstrators: Handbrake lever and steering knuckle

More handbrake levers for motorcycles made by composite material have been manufactured by RISE SICOMP after the co-design done with Brembo.
C-Weave 400 T 6K HS X 125CM (woven carbon fabric) with Bodopox AF-1200 (base resin) and Bodocure INF 32 medium (hardener) were used to produce the levers. Some of these levers were done also with CNTs using electrophoretic deposition (EPD). The CNT deposit density following the deposition conditions optimized in the duration of MODCOMP project is ~0.54 g/m2.

The levers have been tested by Brembo applying forces in different directions by a small bench consisting of a load cell, an actuator and a data acquisition system. All the demonstrators have passed the tests recommended by Brembo however the levers made by the treated material have demonstrated a better mechanical resistance also with a very small amount of CNTs. The force needed to break the levers with CNTs in one specific direction was about 15% higher than the force needed to break the levers, in the same direction, without CNTs. The improvement of structural properties of CFRP especially at demonstrator or prototype level by CNT, has seldom been reported in EU projects to the best knowledge of the responsible researchers, particularly the CNT-modified CF reinforcement is produced in a continuous way. This could showcase the benefits and competitive advantages of nanotechnology in the advanced composites area as well as the innovation capability of Europe in this field.

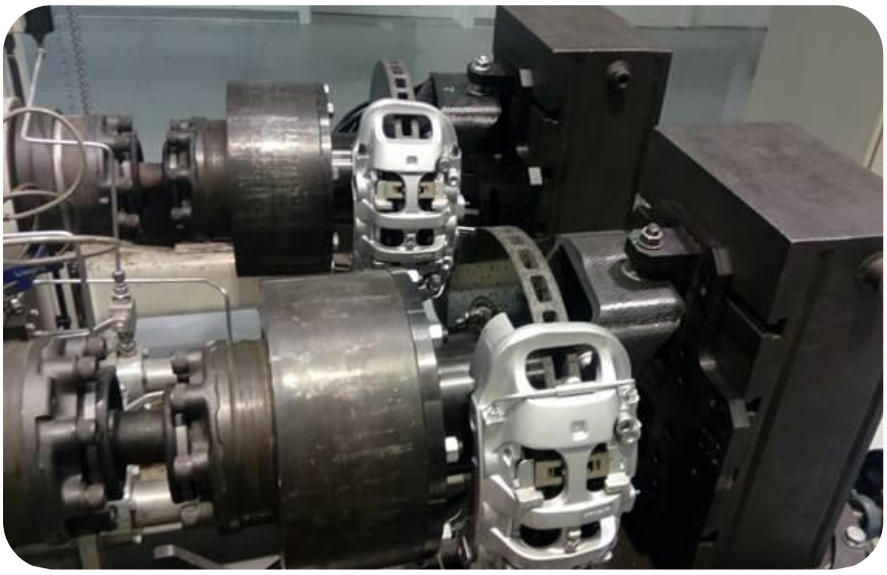


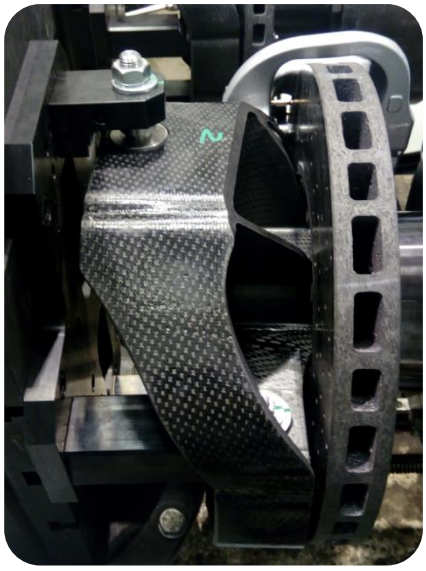
The handbrake levers are usually done by aluminum. Using CFRP instead aluminum it has been possible to get a reduction of about 40 % of the weight (grip weight).

Three steering knuckles for a car made by composite material have been manufactured by Yuzhnoye SDO after the co-design done with Brembo. G0926 (carbon fabric) with Araldite LY 556 (epoxy resin), Aradur 917 (hardener), DY 070 (accelerator) were used to produce these

knuckles. One of these knuckles was manufactured modifying the resin with nanodiamonds.

Brembo has completed the design and the manufacturing of the interface with the disc and with the bench and now Brembo is testing simultaneously two knuckles under the braking condition. One of them is made with modified resin. The two knuckles have already made thousands of cycles with high pressure in the caliper and high torque. About 700 cycles are currently applied in one hour. Tests on the knuckles will end in the beginning of March 2020.





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Modelling to support materials developments

The MODCOMP project is coming to an end. Throughout the entire project, the modelling activities have been helping to get a better understanding of how an addition of carbon nanotubes (CNTs) can affect the thermal, electrical and mechanical properties of composites (analysing different parameters as concentration, diameter, length, defects, functionalizations, …), in what manner different surface treatments over the carbon fibers can improve the materials performance (as the out-of plane strength, related with the delamination resistance) and to what extend the nano-particles may have also an impact in terms of manufacturing. This information has been relevant for the demonstration cases.
At the end of the project, a demonstration about how modelling can help to understand complex coupled phenomena has been also performed. This has been done through the development of a physically based constitutive model able to integrate mechanical and functional responses (mechanical damage and thermal behaviour) of modified CFRP hat stringer under the influence of CNTs in macroscopic level. The modelling activities have been performed through the collaboration of ITAINNOVA, POLITO, RISE-SICOMP and NCC.

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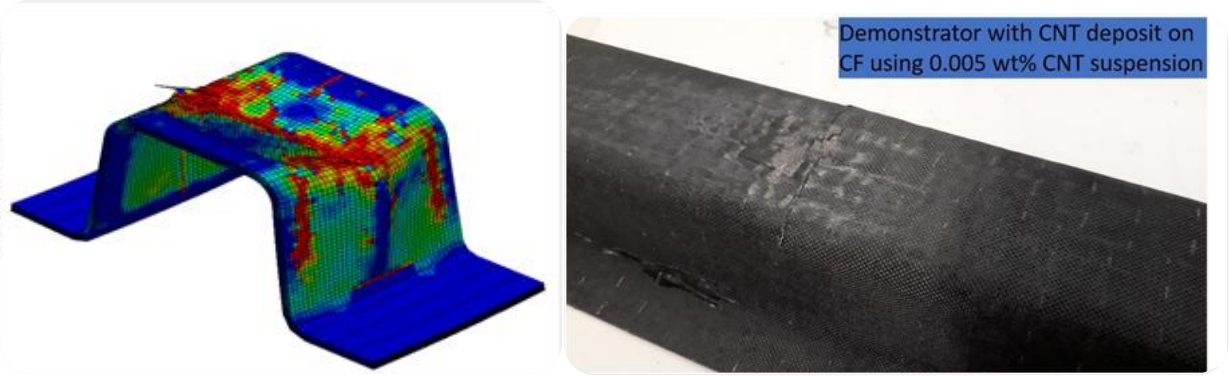

Simulation of damage generation on a hat stringer in a 3P bending test (left).
Real demonstrator tested experimentally (right). (RISE-SICOMP)

Modelling of bird strike on aircraft leading edge, using nanotechnology materials

Aircrafts certification includes impact scenarios of high energy for allowing permission for flight of aeronautical components such as stabilizers and flaps. One of these important impacts is the Bird Strike. During the traditional assessment methods, the design of the component was oversized, as the only way for validating the design, was performing real full-scale test of the component, repeating the experimental tests till declaring it was successful design. This methodology had elevated cost and a high risk to get a certified design. This is mainly due to the continuous changes in the design phase procedures and each change should be tested one by one to check the influence of each factor on the design of the structure. Currently, with the wide implementation and increased power of numerical simulation tools, a qualitative predictions of the test behaviour, can be applied to reduce the number of bird impact experimental tests. Using SPH (Smooth Particle Hydrodynamics) bird model capabilities of current software, quantitative prediction can be obtained of the bird strike. AERNNOVA has developed a methodology that considered all stages of "Building Block Approach". This procedure includes use of novel bird model capabilities, high strain rates on composites taking into account intralaminar damage models, and cohesive elements. This approach was applied for obtaining a predictive bird impact strike model over the Leading Edge of a Horizontal Tail Plane in One-Shot by RTM process, reducing the number of necessary real full scale tests for certifiable design of an aeronautical structure.

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MODCOMP's Large Scale Demonstrators: sailing boats, shelters and personal vehicle storage

What do sailing boats, shelters and personal vehicle storage all have in common?

They have all been large-scale proof of concept demonstrators, subjects of the scientific research and innovation work being undertaken by the MODCOMP project!

In all cases, the materials used in demonstrator manufacture have been G0926 CF fabric and Sicomin 1500 CNT doped resin. In recent months, MODCOMP's scientific partners have been testing the materials' properties which are showing favourable results in line with expectations, while the SME partners AP&M and GSG have carried out extensive (real-life) testing of the demonstrators in terms of them being products fit-for-end-users.

SleekFast has undergone, and continues to be subjected to, a tranche of sea- and still-water trials in varying weather conditions and with a variety of different sized sailors on board. The continued feedback received is being recorded and used to fine tune modifications to major components, to enhance the end user experience and enhance the product in terms of its commercial potential. Discussions and demonstrations continue with target end-users.

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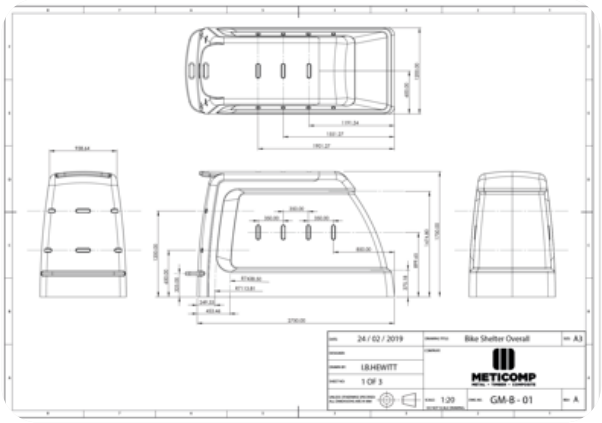
Testing of the AdShel unit seeks to ensure the product will be rugged enough 'in the field' and that it will comply with UNHCR Emergency Handbook guidelines. We have undertaken repeated build and breakdown of the unit to identify any possible material and/or component weaknesses including specific attention to loaded internal frameworks, door hinge and lock wear and the relationship between the different materials used in construction, and the entire unit has been exposed to aggressive external conditions such as extreme heat, wind and salt water conditions to evaluate and validate the concept.

SecureShel personal vehicle storage is being assessed for accreditation to the Loss Prevention Certification Board standard. The current SecureShel unit has been developed to comply with the original specifications within the MODCOMP DoA. The development of the mobile unit capable of being transported by trailer has been proven and has opened additional markets to enhance commercialisation potential. The current mobile model has been subjected to rigorous real-life testing which saw it travelling over 3,500kms over mixed terrain, at various speeds and in different weather conditions.



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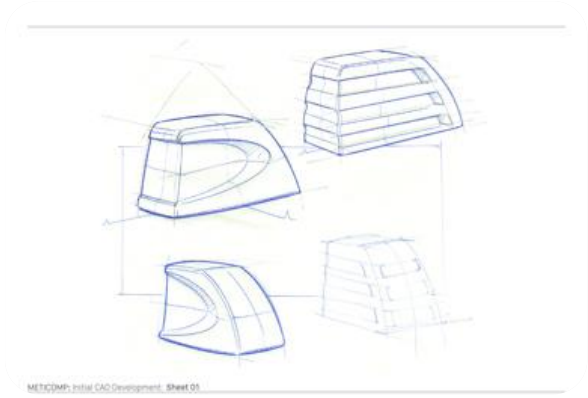
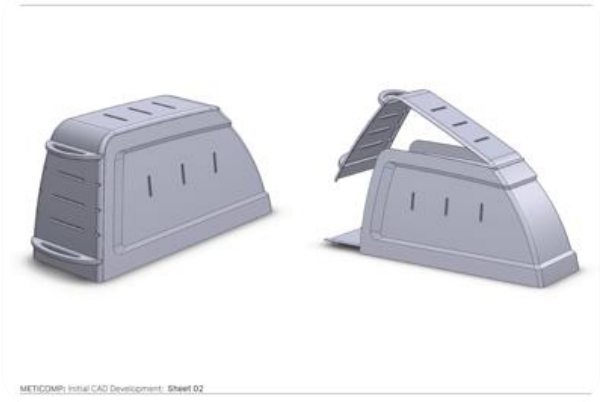
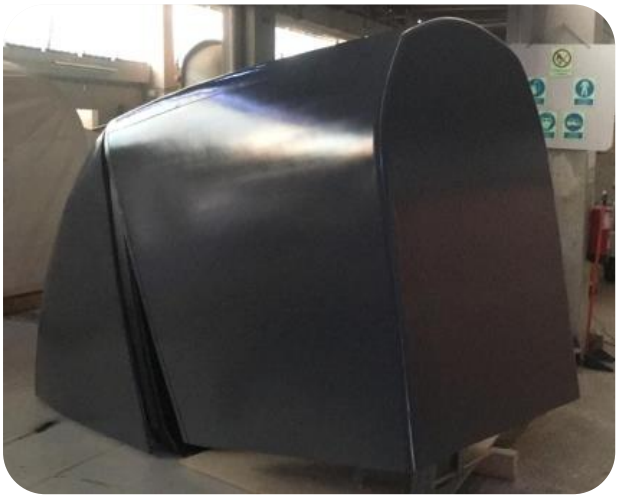




In the lead up to project completion, further testing of all the products will continue to support the development and refinement of commercialisation plans by SME partners AP&M and GSG.



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Participation in Conferences, Workshops and Events

8th MODCOMP project meeting, Lagos, Portugal

The 42M project meeting took place on the 1st and 2nd of October 2019 in Lagos, Portugal.

The main focus was on the tasks and deliverables accomplished during the last months of the project.
The following topics were presented: Functionalization and surface modification of fibres, Production of high-performance fibre-based structures, Characterisation and testing of performance, Characterisation and testing of performance, Modelling, Life Cycle Analysis, Nanosafety and Risk analysis, Scale up / Demonstration, Characterisation of demonstrators, Exploitation and Dissemination activities and Management of the project and all the obligations towards the European Commission.
Technical, modelling and demonstration progress assessment was also raised.
After the formal part of the meetings, there were also group and bilateral meetings between technical, modelling and demonstrator Work Package leaders.

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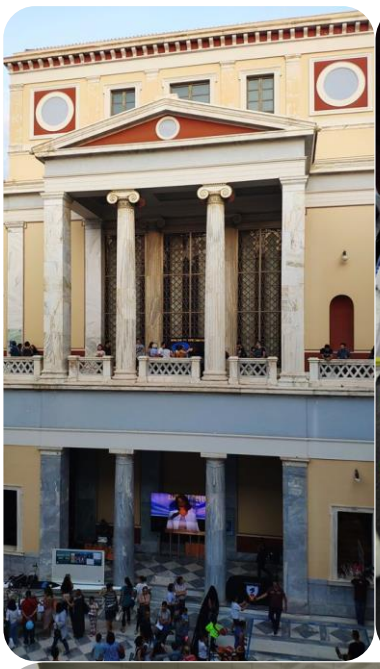
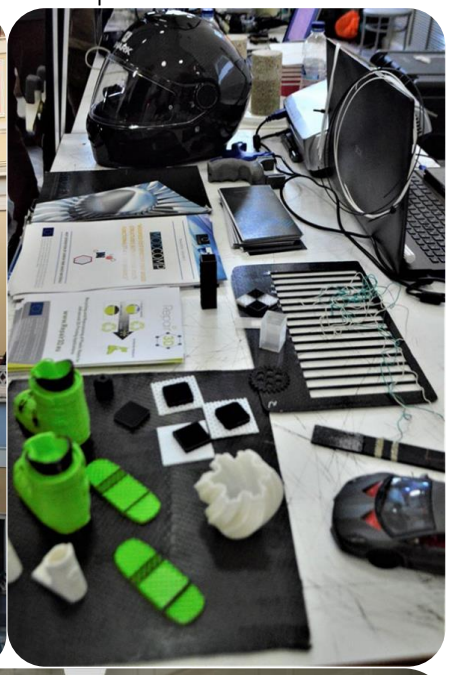
Researcher's Night 2019

NTUA attended the Researcher's Night 2019 demonstrating composite materials developed within MODCOMP, which can be used in sports equipment. Automotive applications were also presented, where advanced composites fulfil the industry requirements. The event was open to the public and students came into contact with new developments in composite material science.





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Project members of IRES attended various events in Brussels

MODCOMP project partners IRES, attended the following events in Brussels in the last 6 months:

1. R&I Days-Conference CODESIGN 24-26-September 2019, Brussels, Belgium.
2. NanoSafety Cluster Week Building confidence in risk assessment and governance of nanomaterials innovation, 7-10-October 2019, Copenhagen, Denmark.
3. Workshop on Industrial Symbiosis, 4 November 2019, Brussels, Belgium.
4. CEN-CENELEC Standards + Innovation: Boosting Innovation Through Standards Conference, 13 November 2019, Brussels, Belgium.

Bernal Institute event, University of Limerick, Ireland

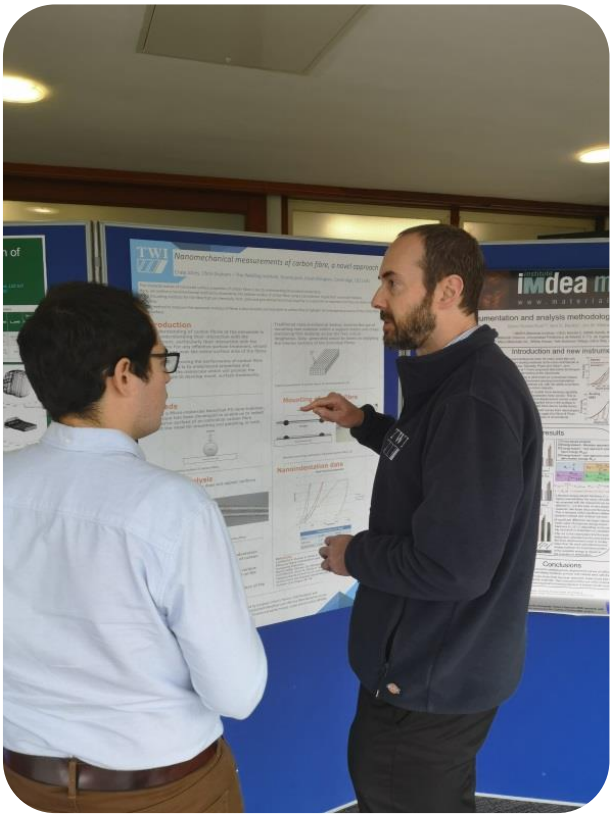
Mr. Pietro Asinari attended Bernal Institute in October 2019, where he has a talk titled: "Modelling the Impact of Molecular Interfaces Beyond the Atomistic Scale".

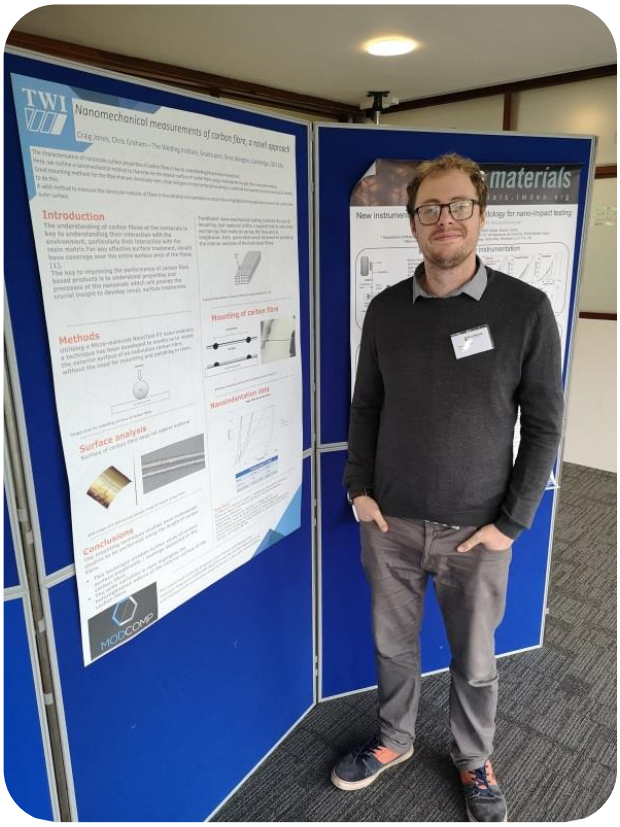
Further information please, click here.

Micro Materials Limited (MML) Nanoindentation Conference and Workshop, University of Southampton 16-17 December 2019

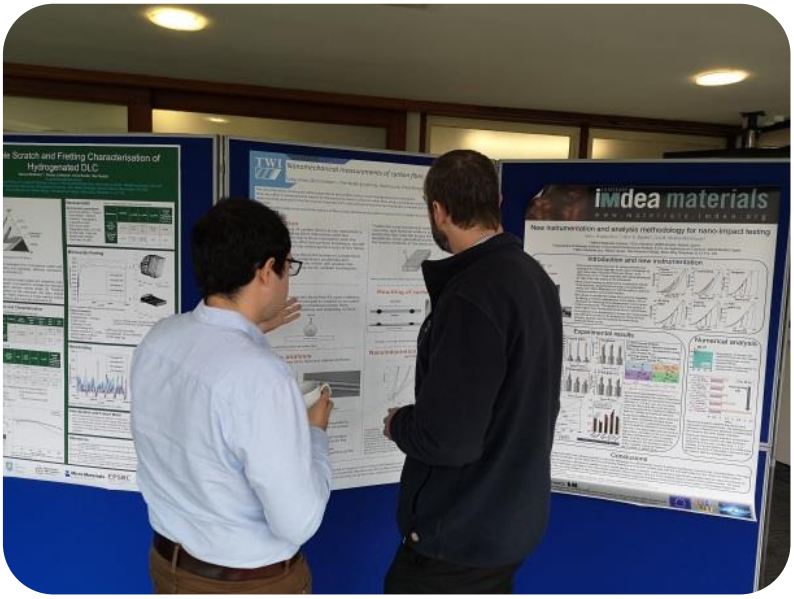
The Micro Materials Limited Nanoindenation conference and workshop took place on 16-17 December 2019, in Southampton, UK.

The event brought together researchers working within the field of nano-indentation and more than 100 delegates participated in the workshop. Project partners from TWI attended the event and participated in the workshop.





MODCOMP partners attended the event and were able to present a poster of some of their work undertaken during the project.



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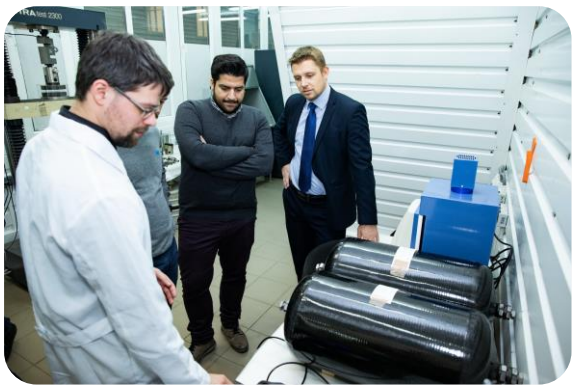
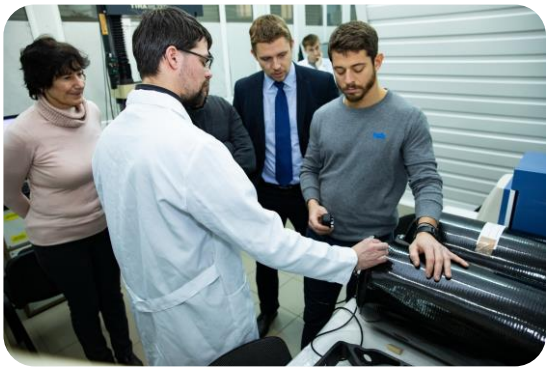
Bilateral meeting between National Technical University of Athens and Yuzhnoye SDO in Dnipro, Ukraine

In December 2019 ModComp partners from National Technical University of Athens visited their colleagues Yuzhnoye SDO at their premises in Dnipro, Ukraine. They had fruitful meeting with joint training and knowledge exchange.





Publications in Journals, Conference proceedings and Workshops

Prof. A. Tagliaferro and Prof. C. Charitidis,
Guest editors in Micromachines Journal

Special Issue:
Carbon Based Electronic Devices

For more than 50 years, silicon has dominated the electronics industry. However, this growth will come to an end, due to resources limitations. Thus, research developments need to focus to alternative materials, with higher performance and better functionality. Current research achievements have indicated that carbon is one of the promising candidates for its exploitation in the electronics industry. Whereas the physical properties of graphite and diamond have been investigated for many years, the potential for electronic applications of other allotropes of carbon (fullerenes, carbon nanotubes, carbon nanofibres, carbon films, carbon balls and beads, carbon fibers, etc), has only been appreciated relatively recently. Carbon-based materials offer a number of exciting possibilities for new applications of electronic devices, due to their unique thermal and electrical properties. However, the success of carbon-based electronics depends on the rapid progress of the fabrication, doping and manipulation techniques. In this Special Issue, we focus on both insights and advancements in carbon-based electronics. We will also cover various topics ranging from synthesis, functionalisation, and characterisation of carbon-based materials, for their use in electronic devices, including advanced manufacturing techniques, such as 3D printing, ink-jet printing, spray-gun technique, etc.

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Journal Articles on MODCOMP research and results

1. Article in Journal Elsevier BV: Evaluation of the creep behaviour of the carbon fibre in an unidirectional pultruded reinforced composite using nano-indentation technique, authors: Zhenxue Zhang, Santiago Corujeira Gallo, Xiaoying Li, Hanshan Dong, Dimitrios Dragatogiannis, Costas A. Charitidis

2. Article in Journal Emerald Group Publishing Ltd.: Enhancement of mechanical integrity of advanced composites using PMAA-electropolymerised CF fabrics, Authors: Dionisis Semitekolos, Panagiotis Goulis, Despoina Batsouli, Elias P. Koumoulos, Loukas Zoumpoulakis, Costas A. Charitidis

3. Article in Journal IOP Science: Deposition of graphene and related nanomaterials by dynamic spray-gun method: a new route to implement nanomaterials in real applications, Authors: Paolo Bondavalli, Didier Pribat, Pierre Legagneux, Marie-Blandine Martin, Louiza Hamidouche, Lilia Qassym, Gilles Feugnet, Aikaterini-Flora Trompeta, Constantinos A Charitidis

4. Article in Journal Composite Science: Constituents Phase Reconstruction through Applied Machine Learning in Nanoindentation Mapping Data of Mortar Surface, Authors: Elias P. Koumoulos, Konstantinos Paraskevoudis, Costas A. Charitidis

5. Article in Journal Wiley - V C H Verlag GmbbH & Co.: Enhanced properties of PAN ‐ derived carbon fibres and resulting composites by active screen plasma surface functionalisation, Authors: Yana Liang, Xiaoying Li, Dionisis Semitekolos, Costas A. Charitidis, Hanshan Dong

6. Article in Journal Composite Science: Research and Development in Carbon Fibers and Advanced High-Performance Composites Supply Chain in Europe: A Roadmap for Challenges and the Industrial Uptake, Authors: Elias P. Koumoulos, Aikaterini-Flora Trompeta, Raquel-Miriam Santos, Marta Martins, Cláudio Monterio dos Santos, Vanessa Iglesias, Robert Böhm, Guan Gong, Agustin Chiminelli, Ignaas Verpo-est, Paul Kiekens, Costas A. Charitidis.

7. Article in Journal Fibers: Applying Machine Learning to Nanoindentation Data of (Nano-) Enhanced Composites, Authors: Elias P. Koumoulos, George Konstantopoulos, Costas A. Charitidis.

Presentations/Posters on conferences and events

1. Publication in Workshop PESXM: title: Design of Vertical CVD Reactor for Continuous Production of CNTs: Challenges and Perspectives, Authors: A.F. Trompeta, A Ntziouni, G. Konstantopoulos, C. Kordatos, C.A. Charitidis

2. Publication in Workshop PESXM: Growth of exotic carbon based nanomaterials on challenging substrates through CVD, Authors: S. Termine, A.F. Trompeta, C.A. Charitidis

3. Publication in Workshop PESXM: Development of a nano-risk assessment tool based on a holistic approach, Authors: P. Karayannis, E.P. Koumoulos, C. A. Charitidis

4. Publication in Conference EuroNanoForum2019: Applying machine learning to process and characterisation data of nanomaterials: A means for prediction, Authors: E.P. Koumoulos, C. A. Charitidis

5. Poster in Conference EuroNanoForum2019: Combining LCC and LCA for sustainability assessment in nanoenhanced high performance composites, Authors: A. Gkika, F. Petrakli, N. Romanos, V. Stergiou, A.F. Trompeta, E.P. Koumoulos, C. A. Charitidis

6. Publication in Conference EuroNanoForum2019: Composite material circular economy: the case of "green" fibres and nanoenhanced fibrous polymer composites, Authors: A.F. Trompeta, T. Kosanovic-Milickovic, E.P. Koumoulos, C. A. Charitidis

7. Presentation in Conference EuroNanoForum2019: Using a Data Man agement Plan for Materials Characterisation in Nanoindentation, authors: M. Kalogerini, N. Romanos, E.P. Koumoulos, C. A. Charitidis

8. Presentation in Conference EuroNanoForum2019: Towards novel exposure & risk assessment techniques for nanomaterials, authors: P.T. Karagiannis, E.P. Koumoulos, C. A. Charitidis

9. Presentation at the conference Future Materials 2020, International Conference, 26-28th February 2020, Lisbon, Portugal: Nano-modified fibre-based structure for enhanced reliability, authors: M. Holt, G. Simmonds, G. Monaghan, S. Bancroft, R. M. Santos, N. Rocha, C. Graham, C. Jones and C. Lira.

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Next Events

JEC World 2020

The Research Lab of Advanced, Composite, Nanomaterials and Nanotechnology (NTUA), under the Direction of Prof. Costas Charitidis, will participate in **JEC World 2020 which will take place at Paris, on 12th-14th May 2020**, to represent **MODCOMP and its achievements**.

JEC is the leading International Composites Show, featuring ground-braking novel technologies, unique manufacturing techniques and applications of composites materials.

NTUA is kindly inviting all MODCOMP partners to attend and actively participate in the Exhibition!

You will find us at Hall 6, Booth No. R-05:

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MODCOMP Final Event - 2020

MODCOMP

We are happy to invite you to the MODCOMP WEBINAR

Due to the current situation in the Europe, MODCOMP Consortium will organise the MODCOMP ONLINE final conference.

The exact date will be published in April 2020.

The aim of the webinar is to present:

- MODCOMP project: aim and presentation of our specific goals.
- Strategy and main results about treatments on fiber and resin (mainly focused on strategy used with video already available).
- Present and explain the demonstrators.

The MODCOMP webinar is free of charge.

For more information about the webinar, please follow http://modcomp-project.eu/ and our social media. If you are already registered to the final event, we will notify you about the details on your best e-mail.

Welcome!

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