



# MASTRO

# Newsletter

## Issue 3 March 2020

The overall objective of the MASTRO project is to develop intelligent bulk materials for the transport sector incorporating self-responsive properties

From nanomaterials and manufacturing know-how to building self-responsive materials for the aerospace, automotive, and transport sectors



This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement no **76094**. The material presented and views expressed here are the responsibility of the author(s) only. The EU Commission takes no responsibility for any use made of the information set out.

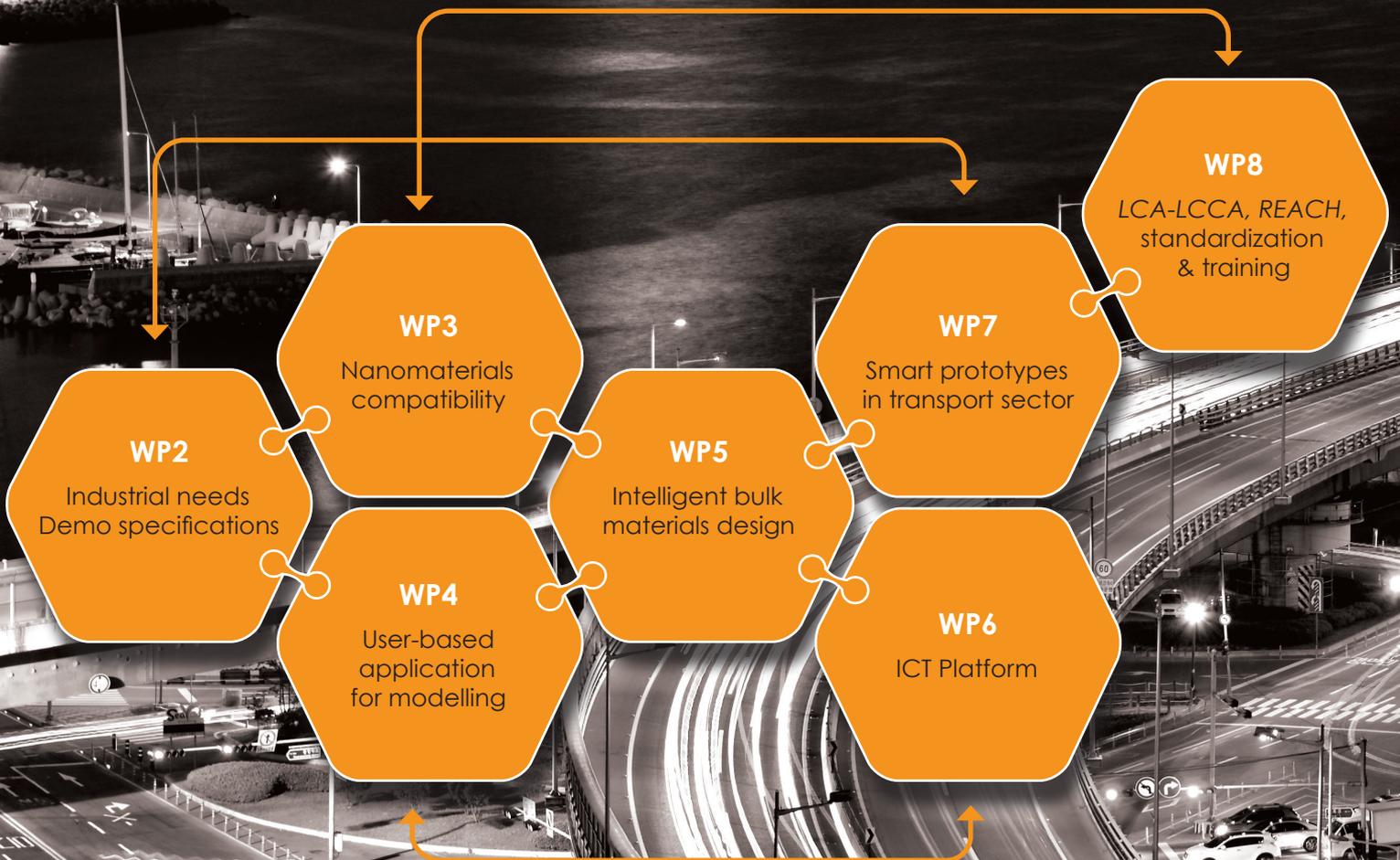


# MASTRO

## 1. Overview

**WP1. PROJECT MANAGEMENT**

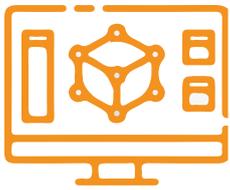
**WP9. Innovation, exploitation, training & dissemination**





# MASTRO

## 2. Progress



### WP4 User-based application for predictive modelling and manufacturing optimization (IPC)

MASTRO project involves a complex structuration of materials combining 3 scale levels : the nanoscale, related to the introduction of nanofillers in a polymeric resin; the microscale, related to the microscopic fillers such as graphite or fibers; and the macroscale, related to the final product structure. During the last few months we have deployed the modelling strategy to simulate joule effect and piezoresistivity for anti-icing and self sensing functionalities.

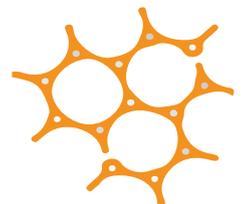
**Nanoscale modelling:** The central idea of the nanoscale modelling is to combine an accurate description of the material through the explicit modelling of the filler and polymer matrix, while the grid based approach is the key step to both make the modelling able to reach larger length-scales and to operate with the microscale. The modelling strategy has been applied to simulate: (a) Morphologies of composite materials through the OCCAM molecular dynamics code, (b) Electrical conductivity calculation through the transfer-matrix method and (c) Joule effect and piezoresistivity calculation by combining explicit molecular picture and mesh based approach through a code developed ex-novo.

**Microscale modelling:** Microscale models are used to describe the behaviour of the material and to better understand multiphysics effects between the constituents. Two kind of models are implemented: (a) A first one based on the computation of thermal, mechanical and electrical equations by a finite element solver and (b) A second one based on mean-fields micromechanics theory. These models are continuum and can be used to predict percolation threshold of a polymer filled with carbon nano fillers to increase to result production.

**Linking:** Different attempts have been done to link nanoscale and microscale results. The first one, based on a direct shape transfer of the conductive network, has been achieved. Nevertheless, the geometry of the network is very complex. Then the mesh for finite elements calculation has to be carried out manually which is not viable regarding usage. The second attempt is to transfer homogenized properties. This solution is much more realistic in the MASTRO project.

### WP5: Intelligent bulk materials design and development (UNISA)

In WP5 several self-responsive materials have been developed. Reversible Hydrogen Bonds (RHB) have been explored to confer self-healing function to multifunctional nanocomposites. The incorporation of MWCNTs presented remarkable mechanical performance, while in terms of self-healing performance and electrical conductivities, incorporation of functionalized and nonfunctionalized MWCNTs was studied, with functionalized ones being optimal. Moreover, nanocomposite materials for structural applications with self-sensing properties have been developed, through suitable processing of epoxy resins filled with carbon nanotubes and expanded graphite. The resulting systems turn out to be very advantageous in strain-sensor applications. Nanocomposites able to confer ice protection to aeronautic and automotive components have also been developed in WP5. Bulk materials containing different carbon-based nanoparticles have proven to be suitable as anti/de-icing materials. A higher value in the expansion of the graphite nanoplatelets allows for obtaining better performance in the heating effect and therefore in the de-icing efficiency. Finally, multi-stage electrocuring processes of Epoxy Resins have been studied and optimized, which were proven to be suitable to save energy and to avoid inhomogeneity during the cross-linking reactions.





# MASTRO

## 2. Progress

### WP6 ICT Platform (ALKE)

In the last months ICT platform was fine-tuned with actions oriented to the improvement of the cloud platform and the communication channels design implementing real life communication tests using the Alkè and Acciona case studies as first test scenarios. Tests performed have given positive results showing good opportunity to spread similar ICT platform design to all project demonstrators.

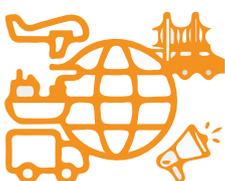


### WP7: Smart prototypes with self-responsive functionalities in transport sector (ACCIONA)

WP7, which has just started last December, will be focused on design, build, test and monitor the smart prototypes which will recap and validated the work performed through MASTRO project during the previous months. WP7 will last one year and a half and the main objective will consist on proving the required performance of the groups of smart products developed in MASTRO in relevant operational environments. Based on the preliminary prototype requirements established in WP2, a detailed design of all the demonstrators foreseen in the Project will be done. At this stage, all the potential and limitations of the different matrices and carbon-based nanomaterials are well known, and then, a detailed design is feasible. The design will include all these aspects: carbon-based nanomaterials selection and percentage, detailed drawings, set-up, ICT platform details, model simulation to optimize the manufacturing process and monitoring and characterization strategy in order to validate the demonstrators.

### WP8 : Life cycle and life cycle cost analysis, REACH analysis, standardization and training (BSRIA)

Over the last period, BSRIA has focused on analysing the influence of different weather conditions throughout European countries on environmental impact of a typical motorway. This will enable the future estimate of potential benefits of MASTRO innovation in the transport infrastructure sector. Additionally, effort has been made to assess life cycle emissions related to synthesis of nanomaterials, which will be crucial information for assessing the sustainability of MASTRO solutions. In parallel, continued training activities have been taking place to enable effective collaboration of the multidisciplinary project team.



### WP9: Innovation strategy, initial exploitation and business plan and dissemination (AXIA)

The official project website is developed (<https://www.mastro-h2020.eu/>) and is being continuously updated with information on publications, dissemination materials, partners news, public deliverables etc. Dissemination material are being updated and circulated to the consortium and beyond (including Newsletters, leaflets etc.) to increase awareness and involvement to targeted audiences. Regarding Data Management Plan an initial plan has been developed and agreed among partners. Moreover, a midterm exploitation plan has been established to plan a market uptake for the groups of products that are being developed under the MASTRO project, using specific business case studies for each partner and product.



# MASTRO

## 3. News - Events

### MASTRO 1<sup>st</sup> review meeting



On 3-4 July 2019, MASTRO partners participated in the fourth project meeting and first review meeting of the project that took place in Brussels. The meeting was held in order to assess the first 18 months of the project and discuss feedback on the activities carried out during this period. During the meeting, the project WP leaders presented their achievements to the Project officer and the reviewers, who provided useful comments on the progress of the project.

### MASTRO reaches out to local authorities in Madrid, Spain

On September 12 elected councillors of the City Council of Madrid visited the premises of PINOUT Solutions in Madrid, Spain. Ignacio del Val Alfaro, the CEO of PINOUT explained to the councillors the overall structure and aims of the MASTRO project, in addition

to the participation and tasks of PINOUT. The councillors discussed with Ignacio and the PINOUT team possibilities of how the MASTRO project results may be used to improve the living standards of Madrid citizens and the city's performance and reputation.





# MASTRO

## 3. News - Events

### MASTRO dissemination in "COMPOSITES EUROPE"

MASTRO project has been disseminated in "COMPOSITES EUROPE" in Stuttgart, Germany, on 10-12th September, 2019. (<https://www.composites-europe.com/en/>) Applynano Solutions has attended this European Trade Fair & Forum for Composites, Technology and Applications, where innovations in products, processes, solutions and the latest developments in the largest composites market in Europe have been presented. More than 300 exhibitors from 30 countries have participated and disseminated

their achievements in materials and technical solutions, in the fields of production and processing of fibre-reinforced plastics. Moreover, the LIGHTWEIGHT TECHNOLOGIES FORUM (LTF) was run in parallel, showcasing how lightweight materials contribute to more efficient and better cars, airplanes and machines. In this framework, the MASTRO project has been presented to the industry representatives and potential stakeholders, describing its goals for the development of new technologies in the transportation sector.



### MASTRO dissemination in "EMERGEMAT"



MASTRO project was present at the "EMERGEMAT", 2nd International Conference on Emerging Technologies in Materials Engineering. The event took place in Bucharest, Romania, on 6-8th November, 2019 bringing together scientists, engineers, industry representatives and stakeholders interested in developing new methods, concepts and materials using new and emerging technologies. Applynano Solutions has presented an oral conference with the title: "CARBON BASED NANOPARTICLES FOR APPLICATIONS IN THE TRANSPORT SECTOR: AUTOMOTIVE AND AERONAUTICS COMPONENTS". The presentation included results obtained with epoxy resin modified with carbon based nanoparticles for electrical conductivity and Joule effect applications in aeronautics and automotive sectors.

### MASTRO dissemination in "COMPOSITES SPAIN"

Applynano has visited "COMPOSITES SPAIN" Exhibition, held in Madrid from 27-28th November 2019. This event is a reference in the markets of composites and advanced materials in Europe, offering the last trends in materials and technologies, together with the opportunity of networking and establish contacts with new customers. More than 500 companies and 9000 potential customers have attended the fair. In this framework, MASTRO has been disseminated through the presentation of leaflets to potential stakeholders and end-users showing the materials and performances developed.





# MASTRO

## 3. News - Events

### MASTRO dissemination in the "4th Composites@Manchester Workshop"

MANCHESTER  
1824

USFD partner gave an oral presentation entitled: Electrical cure of composite suitable for aerospace manufacturing at the 4th Composites@Manchester Workshop. The event took place in Manchester on 25-26 June 2019. This event brings together researchers working with composite materials to share their work and represents an excellent opportunity to network across the university.

### MASTRO dissemination in "Chemistry meets Industry and Society"

CeNTI presented their work performed under MASTRO project with the title "Development of nano and micro structured smart fibre devices" during the "Chemistry meets Industry and Society - A creative showcase conference". The conference was held in 28-30 August 2019, in Salerno Italy and is a new international event opening a new perspective in the interaction between research, industry and society in the field of chemistry.



### MASTRO dissemination in "Confidence In Composites" Conference

USDF participated in the Confidence In Composite Conference that took place during 15-16th October 2019, in Oxford, UK. Their work on "Electrical self sensing of aerospace composites was presented to the experts in the field of non-destructive evaluation and testing technologies, structural health monitoring techniques and approaches for repair of composite materials





# MASTRO

## 4. Publications

1. Nobile, M.R., Naddeo, C., Raimondo, M., Guadagno, L. Effect of functionalized carbon nanofillers on the rheological behavior of structural epoxy resins. 2019 AIP Conference Proceedings 2196,020027. (<https://doi.org/10.1063/1.5140300>).
2. Guadagno, L., Vertuccio, L., Naddeo, C., Raimondo, M., Barra, G., De Nicola, F., Volponi, R., Lamberti, P., Spinelli, G., Tucci, V. Electrical current map and bulk conductivity of carbon fiber-reinforced nanocomposites. 2019 Polymers 11(11),1865. (10.3390/polym11111865).
3. Raimondo, M., Naddeo, C., Vertuccio, L., Lafdi, K., Sorrentino, A., Guadagno, L. Carbon-based aeronautical epoxy nanocomposites: Effectiveness of Atomic Force Microscopy (AFM) in investigating the dispersion of different carbonaceous nanoparticles. 2019 Polymers 11(5),832. (10.3390/polym11050832)
4. Guadagno, L., Vertuccio, L., Naddeo, C., Calabrese, E., Barra, G., Raimondo, M., Sorrentino, A., Binder, W.H., Michael, P., Rana, S. Reversible self-healing carbon-based nanocomposites for structural applications. 2019 Polymers 11(5),903. (10.3390/polym11050903).
5. Arena, M., Viscardi, M., Barra, G., Vertuccio, L., Guadagno, L. Multifunctional performance of a Nano-Modified fiber reinforced composite aeronautical panel. 2019 Materials 16(6),869. (10.3390/ma12060869).
6. Guadagno, L., Naddeo, C., Raimondo, M., Speranza, V., Pantani, R., Acquesta, A., Carangelo, A., Monetta, T. UV irradiated graphene-based nanocomposites: Change in the mechanical properties by local harmoniX atomic force microscopy detection. 2019 Materials 16(6),962. (10.3390/ma12060962).



# MASTRO

## 5. Upcoming Events

### International Conference on Smart Materials & Structures

19 - 20 March, 2020 Berlin, Germany

### Functional Materials Seminar

24 - 25 March 2020 San Sebastián, Spain

### ICEESM 2020

15 - 17 April, 2020 Barcelona, Spain

### ImagineNano 2020

April 28-30 2020, Bilbao, Spain

### International conference on "Cement - Based Materials Tailored for a Sustainable Future"

7-8 May 2020. Istanbul, Turkey

### METAL2020

20-22 May 2020 Brno, Czech Republic

### Nanotech France 2020

23 - 25 Jun 2020 Paris – France

### ECCM19

22-26 June 2020 Nantes, France

### ICCM2020: INTERNATIONAL CONFERENCE ON CEMENTITIOUS MATERIALS AND ALTERNATIVE BINDERS FOR SUSTAINABLE CONCRETE

June 29 to July 1st 2020, Toulouse, France

### 48th European Transport Conference

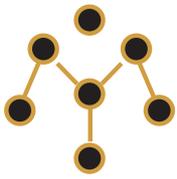
9 - 11 September 2020 Milan, Italy

### 10th EASN International Conference on "Innovation in Aviation & Space to the Satisfaction of the European Citizens"

2-5 September 2020 Salerno, Italy

### ELECTRIC & HYBRID VEHICLE TECHNOLOGY EXPO EUROPE

15 - 17 October, 2020 Stuttgart, Germany



# MASTRO

## 6. Milestones

Selection of the proper carbon based materials and their functionalization processes for each matrix based on preliminary compatibility tests (M12)

Website launched (M2)

Proven link between nanoscale and micro scale modelling (M24)

MS1



MS2



MS10



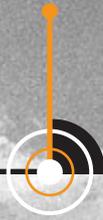
MS16



MS17



MS3



Definition of the technical specifications and KPIs for the demonstrators (M3)

Initial reference architecture for MASTRO's ICT platform (M7)

First updated business plan approved by all partners (M18)

Self-deicing properties proven in different matrices at component level according to defined KPIs (M27)

Self-healing properties proven in different matrices at component level according to defined KPIs (M27)

Final version of MASTRO ICT platform and reference architecture (M27)

MS5



MS6



MS7



MS8



MS9



MS11



Self-sensing properties proven in different matrices at component level according to defined KPIs (M27)

Self-curing properties proven in different matrices at component level according to defined KPIs (M27)

Self-protection properties proven in different matrices at component level according to defined KPIs (M27)



# MASTRO

## 7. Who we are...

MASTRO consortium is a multidisciplinary mix of engineers, materials experts, and high tech companies, from 6 European countries

For more details visit: <https://www.mastro-h2020.eu/partners>

**17** PARTNERS    **6** COUNTRIES    **7** RTDs  
**5** RTDs    **5** LEs    **6M.** FUNDING



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This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement no **76094**. The material presented and views expressed here are the responsibility of the author(s) only. The EU Commission takes no responsibility for any use made of the information set out.