MASTRO

Intelligent Bulk Materials for a Smart Transport Sector

Introduction

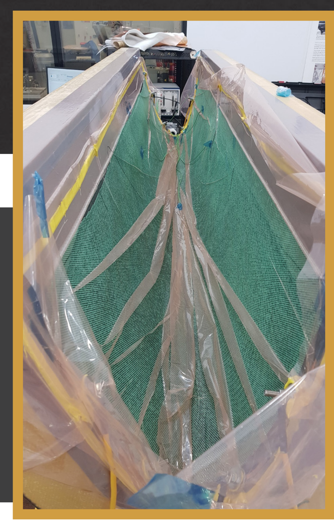
MASTRO Project aims to the development of intelligent bulk materials for the transport sector based on the novel concepts like self-sensing, self-deicing, self-curing, self-healing and self-protection methodologies to increase consumer safety, component life-span and performance while reducing maintenance and manufacturing costs for the sectors of aerospace, automotive and transport networks. The major technical outcomes of the MASTRO H2020 project are presented.

www.mastro-h2020.eu

Large scale self-cured composite for the aerospace and automotive sector:

The University Of Sheffield.

One of the smart functionalities developed for the aerospace and automotive sectors is the self-curing of carbon fibre reinforced polymer components. A large scale, 2 metre by 0.7 metre wing leading edge section was cured using the joule effect at 120 °C. During the cure, the process consumed less than 1000W, using approximately 3kWh in total for the cure, compared to approximately 200kWh in total for an equivalent oven process.



Development of smart bulk materials (epoxy resins) with 5 different self-responsive functionalities (self-sensing, self-deicing, self-curing, self-healing and self-protection)

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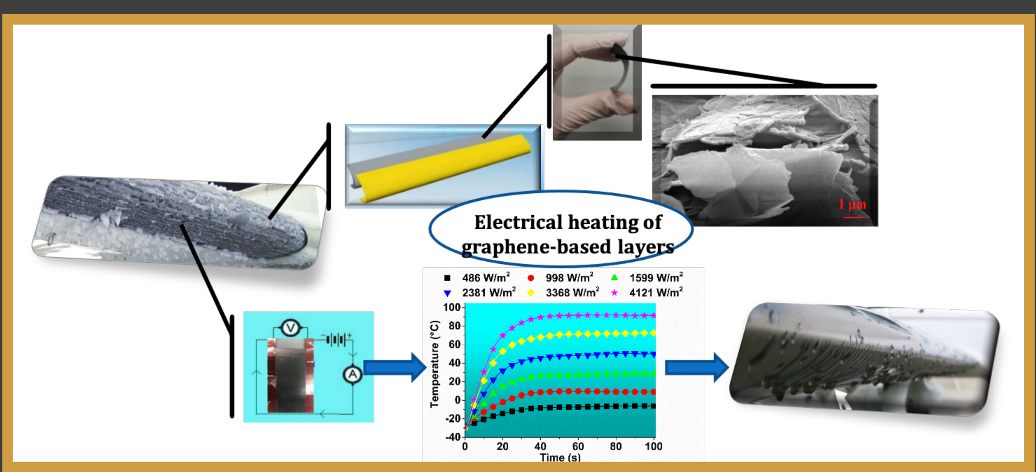
High-performance heater films have been developed. They manifest great applicative potentiality in the de-icing technology of aircrafts and motor vehicles. Self-sensing resins filled with carbon nanotubes and expanded graphite characterized by very different aspect ratios lead to nanocomposite systems with high glass transition temperatures and remarkable values of the gauge factor.



Development of multifunctional asphalt-based materials for specific applications in the area of civil engineering and architecture

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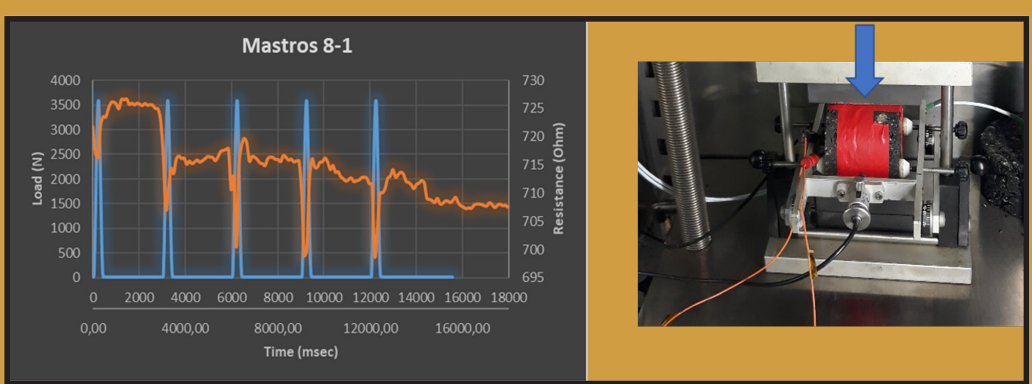
A suitable formulation, D-45 (70/100 +10% coke + 17% ABG 1010), and electrical setup for the self-healing, deicing and self-sensing functionalities on asphalt pavements were developed and will be scaled up for the final pavement prototype.



Reversibility and stability of D45 formulation as piezoresistive sensor

To develop the ICT module focused on the prototypes that will be validated for the infrastructure sector

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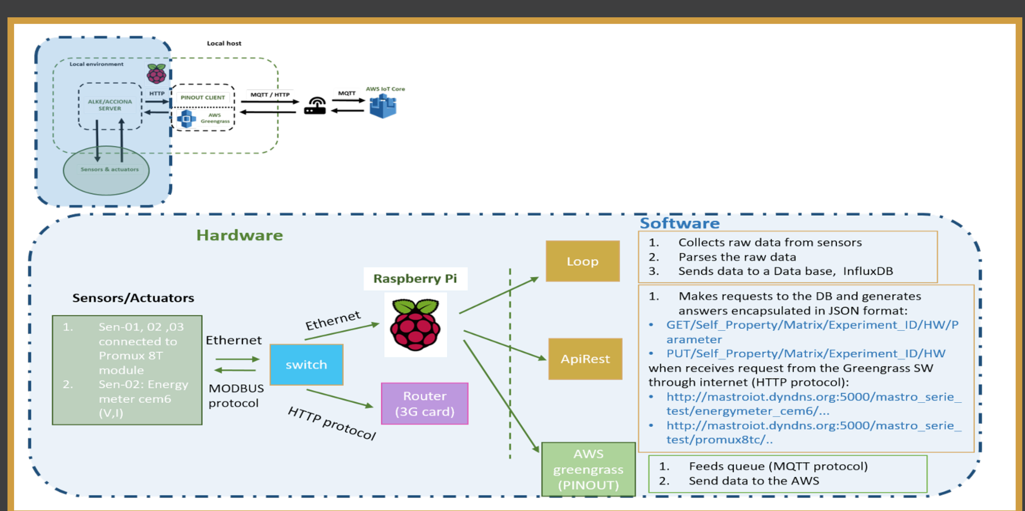
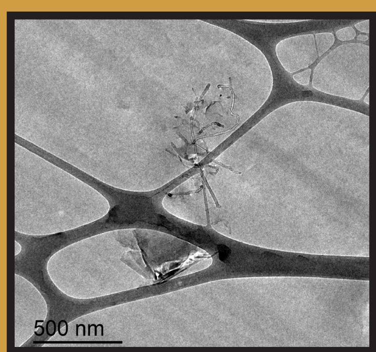
The Infrastructure ICT module covers the needs of these prototypes as follows:



a. Input/output data: Sensors and actuators to be implemented were defined for each demonstrator and each smart functionality.
b. Acquisition, processing, and data transmission systems were defined.
c. Activation, computing, and visualization systems were also defined.

Compatibility of carbon-based nanomaterials

applynano



Optimized dispersion and compatibility obtained with carbon-based nanomaterials as incorporated to the different matrices, achieving the required electrical conductivity for the different applications. Different dispersion technologies and surface functionalization treatments have been optimized.

Life cycle and life cycle cost analysis, REACH analysis, standardization and Training

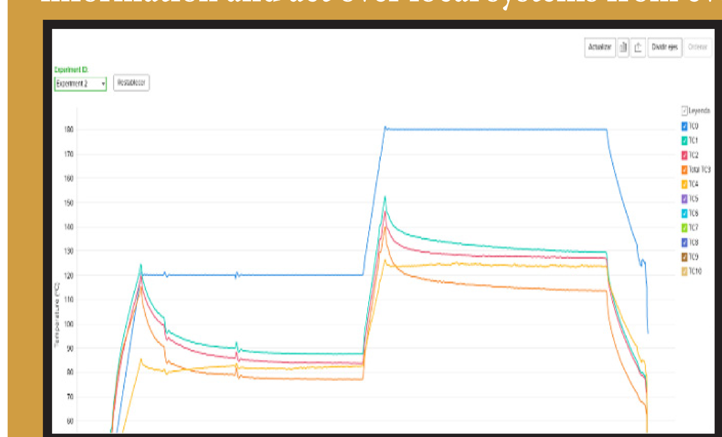
BSRIA

The main objective is to quantify the economic and environmental impacts of the developed materials by Life Cycle Costing analysis (LCC), Life Cycle Assessment (LCA), waste recycling and REACH analysis which will be applied to compare the new products against existing materials. The work also concerns the organization of training activities and fulfilling standardization needs. Achieved results: With initial models for comparison of life cycle environmental and economic impacts having been completed, BSRIA is now focusing on accurate assessment of various demonstrators developed by the MASTRO consortium. Steps have been taken towards standardization of MASTRO materials, by establishing contact with relevant bodies and identifying existing applicable standards.

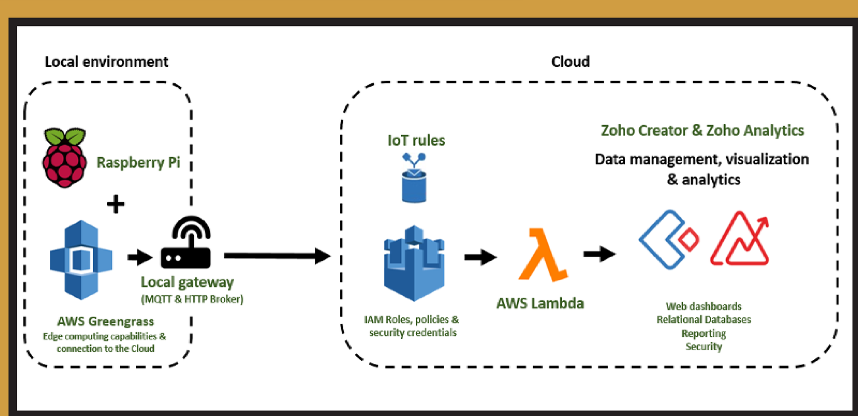
ICT platform

pinout

MASTRO Project counts on its own Cloud Platform for data management and analysis. It integrates some of the latest ICT trends, such as Internet of Things, Edge Computing, Serverless Computing or Mobile Business Intelligence. The Platform applies both near-real time and batch processing to visualize information on attractive and intuitive dashboards, allowing end users to analyze information and act over local systems from everywhere in the world.



Example of web dashboard (self-curing AE sample data)



Example of SW architecture schema

Design and development of the smart thermoplastic and elastomer materials at component level

CETMA

Main Outcomes:

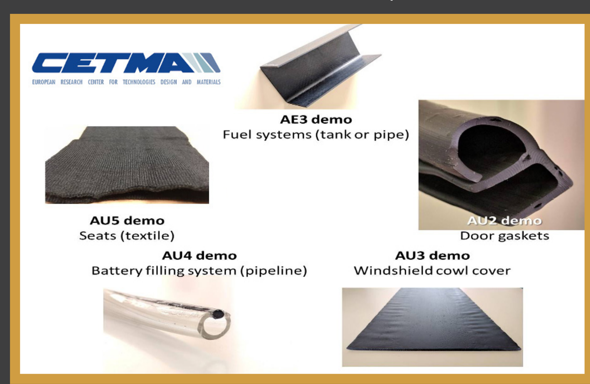
Thermoplastic nanocomposites and related manufacturing processes developed at specimen level.

Self-responsivity measured and general requirements for each case study checked.

With regards to demos based on Joule effect, predictive models were internally developed and used for the purpose of preliminary component design. Full scale prototypes will be possible in all cases.

Aeronautic case study: an electrical conductivity suitable for electrostatic discharge was obtained. The related demonstrator is only required to be dissipative, that is an inherent characteristic of the constituent material, i.e. the smart component is a passive system not requiring any extra equipment.

Automotive demonstrators: a suitable electrical conductivity was obtained for an effective self-heating or deicing behavior with low input voltages (≤ 48 V DC), then safe for users. Typical car battery is 12 V DC but in the addressed sport cars and work vehicles 24 or 48 V DC are commonly available.



Development of adhesive formulations suitable to act as hosting matrices to integrate self-responsive functions.

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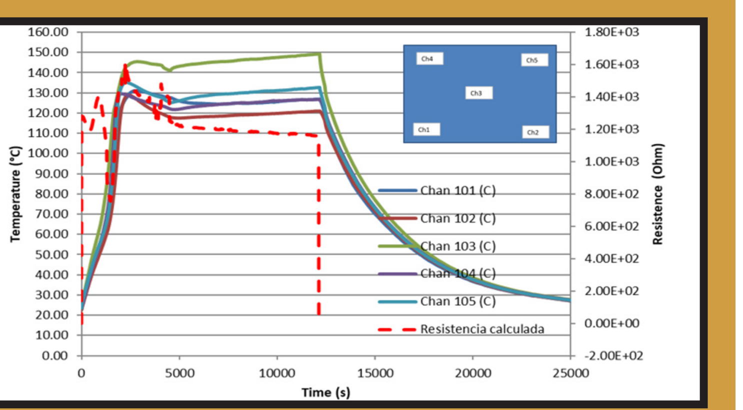
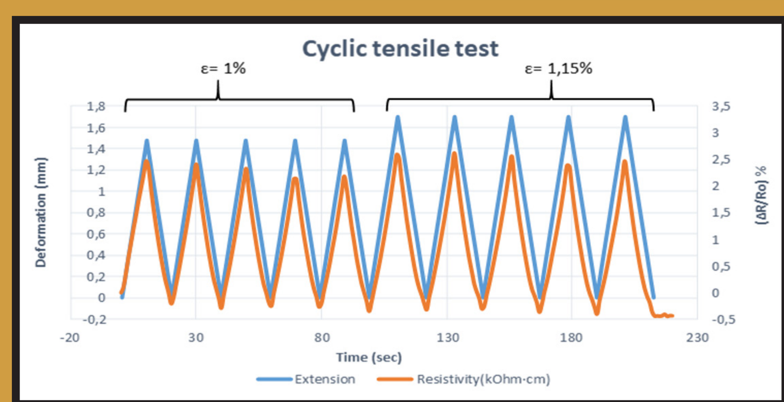
Optimal electrode type, electrode mesh pattern and formulation AW4856 +0.5%w NC7000 +1%w AGB1010 + 10%w dilutant + HW4856 were selected to be used in final demonstrator (joint of composite truss structures).

Conductive Adhesive Self-curing by Joule effect



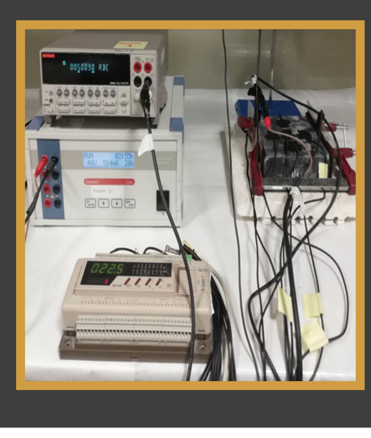


Adhesive Self-sensing

Self-sensing and self-de-icing functions in concrete

Universitat d'Alacant

Particularly interesting smart structural materials are those exhibiting strain-sensing properties, that is, the ability to provide an electrical output that is correlated to their state of strain, also known as piezoresistive property. This function is extremely attractive in the perspective of structural health monitoring (SHM), potentially enabling the development of structures that are able to self-monitor their structural conditions. On the other hand, one of the most powerful and current functions that a conductive cement-based material can perform is the possibility of heating. Heating can be useful and essential for civil structures in view of de-icing, healthy living, hazard mitigation and industrial processing.



Heating function. Sketch of a conductive concrete slab ready to be tested

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