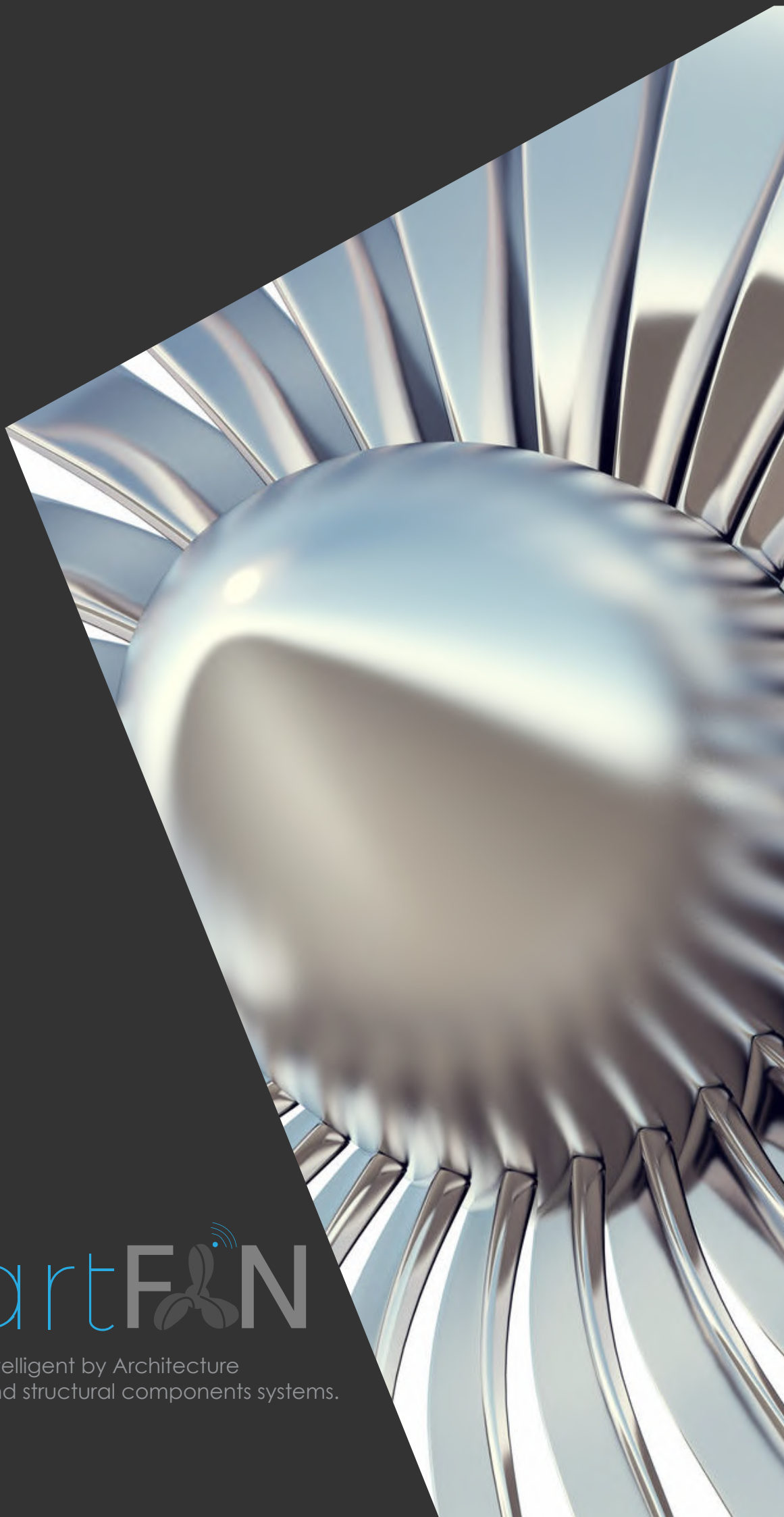
Volume 3



SmartFAN

Smart by Design and Intelligent by Architecture
for turbine blade fan and structural components systems.

Contents

Partners

1.National Technical University of Athens (**NTUA**)

2.Warrant Hub SRL (**WG**)

3.Association pour le Developpement de l'Enseignement et des Recherches Aupres des Universites, des Centres de Recherche et des Entreprises d'Aquitaine/CANOE Platform (**ADERA/CANOE**)

4.Dallara Automobili SPA (**DAL**)

5.Instituto Tecnologico De Aragon (**ITAINNOVA**)

6.Elica SPA (**ELICA**)

7.Foundation for Research and Technology Hellas (**FORTH**)

8.Innovation in Research & Engineering Solutions (**IRES**)

9.Techedge GMBH (**TECHEDGE**)

10.Inegi - Instituto de ciencia e Inovacao em Engenharia Mecanica e Engenharia Industrial (**INEGI**)

11.Politecnico di Torino (**POLITO**)

12.Thales SA (**TRT**)

13.Universita Degli Studi di Roma Tor Vergata (**UNITOV**)

14.The University of Birmingham (**UoB**)

15.3D NewTechnologies for medical and non-medical implementations (**BIOG3D**)

16.Open Source Management Limited (**OSM**)

17.Critical Materials SA (**CMT**)

18.Lavrion Technological and Cultural Park (**NTUA /AMDC**)

Project Overview

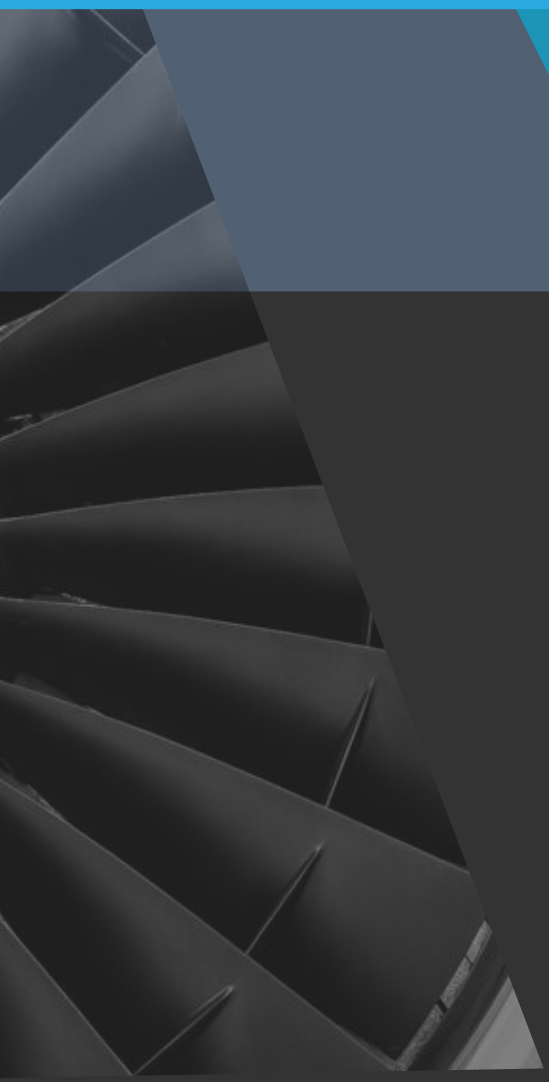
SmartFAN aims at the development of micro and nano componets, which will be used due to their special physico-chemical properties, in order to develop smart (bulk) materials for final application on intelligent structures.

CFs for reinforcement and conductivity varance, CNTs and CNFs for sensing, micro-containers for self-healing, electro-magnetic nanoparticles for fields detection and shielding, colouring agents for marking cracks and defects and piezoelectric materials can be the base for manufacturing new smart materials.

In order to develop lightweight composite materials and transfer the properties of smart components into bulk materials, polymer based matrices, such as Epoxy, PEEK, PVDF etc., will be used because of their compatibility with the above mentioned components, their low cost and their recyclability/reusability.

During synthesis of composite bulk materials several processes should take place in order to preserve the special physico-chemical properties of composites and to achieve the best dispersion in the bulk.

Objectives



SmartFAN proposes the development of "smart" material and product architectures, with integrated functionalities, that will interact with their environment and react to stimuli by employing biomimetic, self-sensing, actuating and damage-repairing technologies. Their smartness is based on bio-inspired engineering and the use of:

- low and high grade carbon fibres (CF)
- CF reinforced polymers (CFRPs)
- nano-/micro-composites with special physicochemical properties, in order to develop smart (bulk) materials, applied on intelligent structures

Special functions of the smart materials involve:

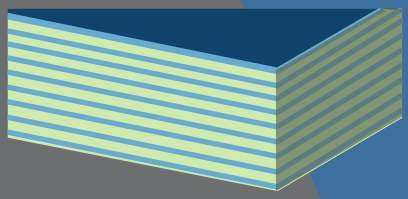
- CFs for reinforcement of the structure and creation of conductivity gradients
- Carbon Nano Tubes (CNTs) and Carbon Nano Fibres (CNFs) for sensing
- Micro-hollow particles for self-healing
- Electro-magnetic nanoparticles that enable field detection and shielding
- Coloring agents for marking cracks and defects
- Intelligent communication through Internet of Things (IoT)

SmartFAN Framework

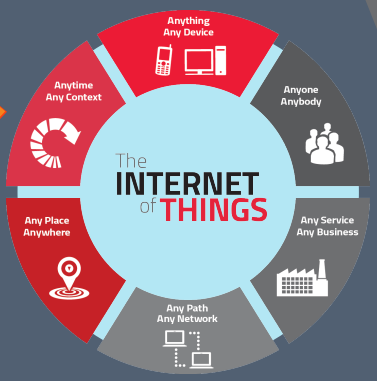
Smart by Design materials

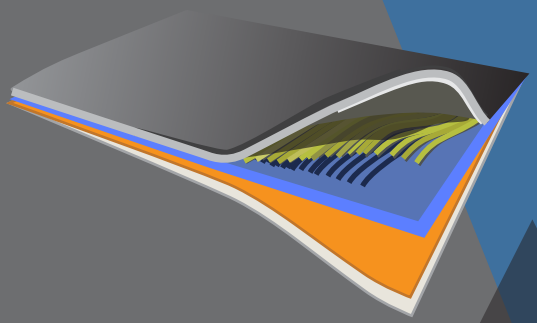
- Self-repair or self-healing materials
- Material for vibration suppression
- Lightweight composites
- Internal damage and process history
- Shape change
- Energy storage
- Functionally graded composite materials (FGCMs)

... now



SmartFAN L&G Concept





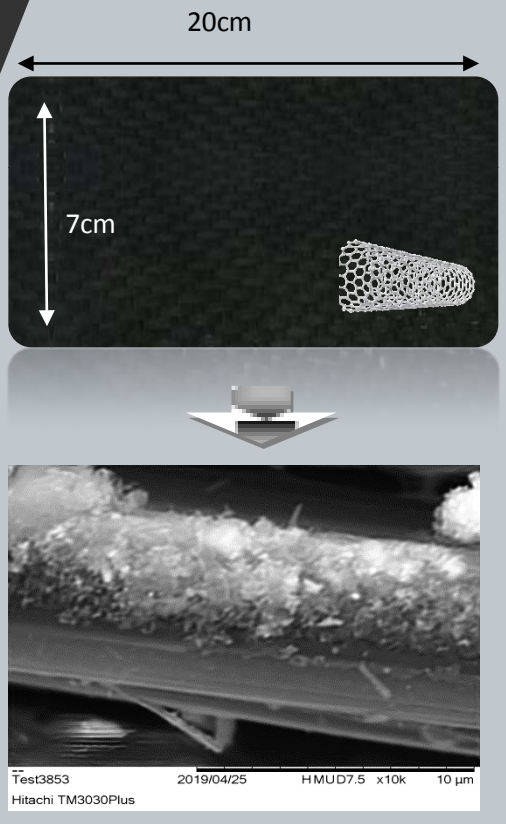
Intelligent by Architecture structures

- Advanced sensors (nanosensor technology)
- Damage detection
- Self-repair, Self-actuation
- Self-sensing, Self-morphing
- Magnetic functionality (for non-magnetic materials)
- Optical functionality
- Sound and vibration damping
- Thermal management in ICT

National Technical University of Athens

CNTs growth on CF fabric: A successful up-scaling

The last 6 months, NTUA has managed to grow successfully multiwalled carbon nanotubes (MWCNT) on carbon fiber (CF) fabrics through Chemical Vapor Deposition (CVD) method. This process took place in a pilot-scale CVD reactor that was designed and set up from scratch by NTUA team. By this, CF fabrics with dimensions higher than 3 cm in width, can be treated and used for the growth of MWCNTs on their surface. Moreover, the length of the fabrics can reach up to 20cm, which enables the manufacturing of composite specimens, according to the specifications of the mechanical testing. According to the above, the CNT modified CF fabrics will be used to manufacture multi-functional composites with higher electrical and thermal conductivity than the conventional ones, combining also increased mechanical properties. In future work, the composites that will be manufactured through vacuum infusion are going to be tested for their self-sensing ability. Electromechanical measurements will take place, where the specimens will undergo tensile, flexural and fatigue stress, while monitoring their electrical response.



SEM image of CNTs grown on single fiber from the CF fabric.

Thermal conductive compounds for FFF additive manufacturing

CANOE is currently developing high thermal conductivity thermoplastic compounds using a combination of different nano-fillers synthetized by FORTH and NTUA.

Formulation tests carried out on the first year of the project enabled to choose thermoplastic – filler nature and ratios to obtain thermally conductive over 1 W.m-1.K-1 determined by University of Birmingham. The compounds have been produced at large scale (>10 kg) to enable demonstrator manufacturing.

After the compounding step, CANOE will manufacture filaments by extrusion with diameters compatible with Fused Filament Fabrication process (FFF). These filaments will be used by BIOG3D in a FFF process to create 3D printed thermal management systems.

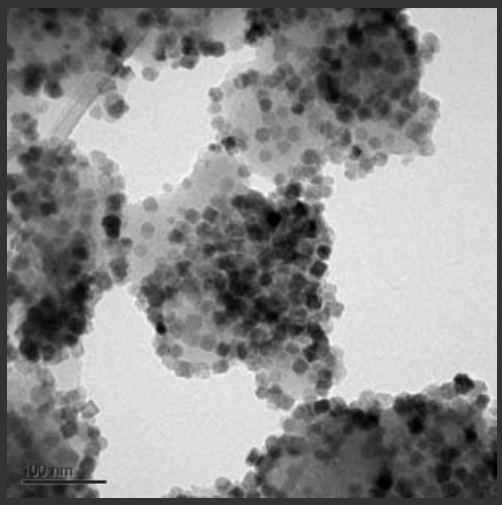
Twin screw extruder and FFF filament spool in CANOE

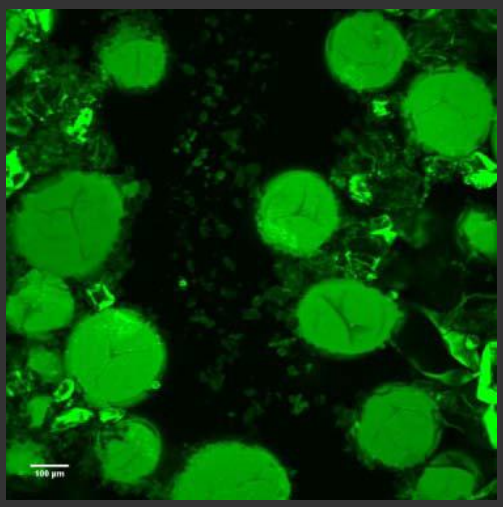
CANOE

ITAINNOVA

Development of magnetic nanoparticles for healing and chromophore microcapsules for damage sensing

During period M12-M18 ITAINNOVA has being investigating different magnetic nanoparticles (MNPs) in order to produce polymers with induction heating capabilities. Both commercial and MNPs synthetized at ITAINNOVA are being evaluated in terms of heating capacity, quality and thermal stability. In addition, the compounding and extrusion processes to obtain filaments for 3D printing are also being studied. On the other hand, the utilization of microcapsules with fluorescent substances as an additional functionality to reveal damage are being evaluated. In this sense, ITAINNOVA is also synthesizing their own microcapsules. First performance trials about this solution have been also carried out during this period.



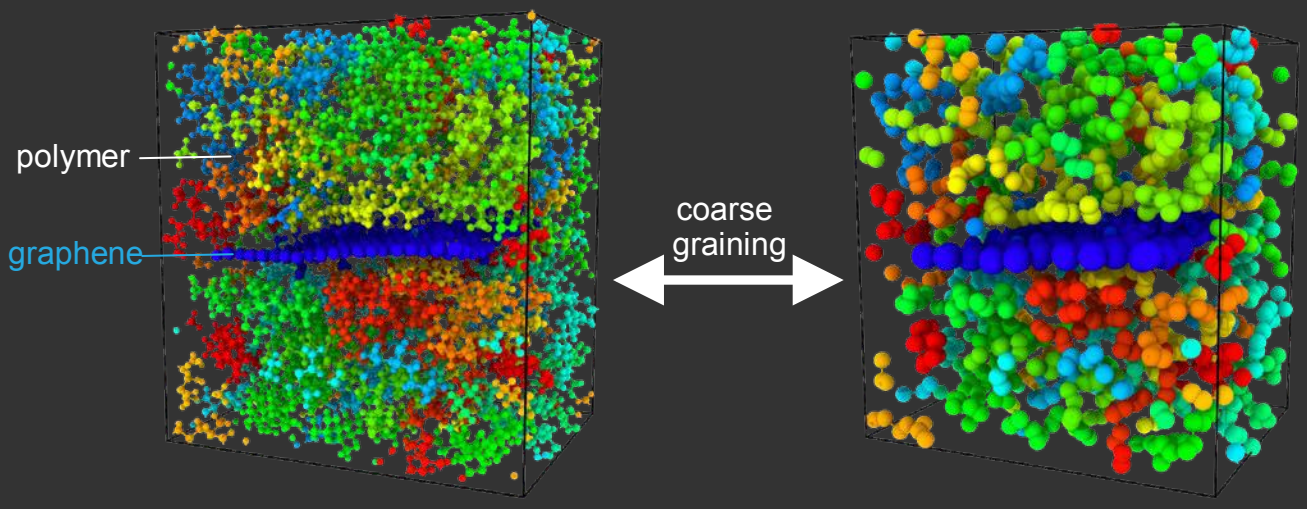


SMagnetic nanoparticles (left) and microcapsules (right) synthetized at ITAINNOVA.

ITAINNOVA

Molecular dynamics modelling

During the same period, ITAINNOVA has being developing molecular dynamics (MD) models to determine interfacial properties of some of the filler/polymer nanocomposite systems being addressed in the project and also to determine coarse graining (CG) potentials needed for the models in the next level (meso) within the multiscale approach proposed.



The CG potentials for PLA (polylactic acid) , PP (polypropylene) and an epoxy resin and for different graphene fillers have been determined and the activity will continue in the next months with focus in the additional CG potentials needed for the fillers/polymers integration.

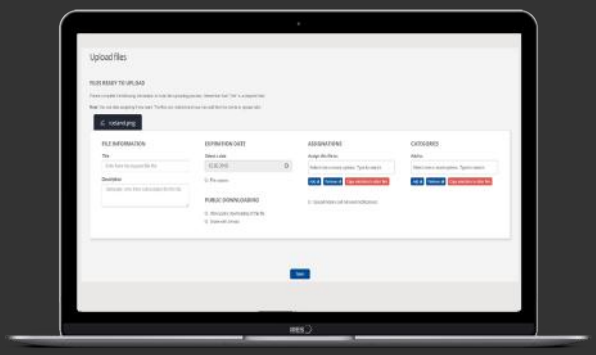
Data Management Platform

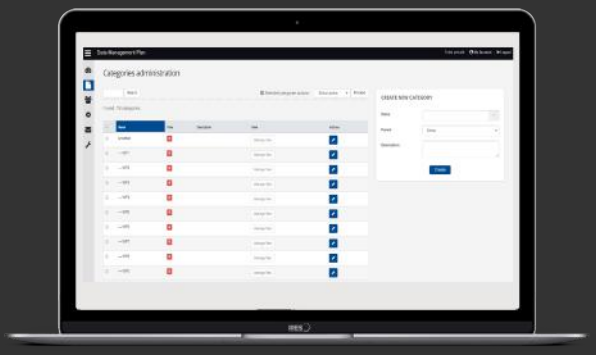
IRES

In the framework of Data Management Plan within SmartFAN project, research data will be easily discoverable, accessible, assessable and intelligible, usable beyond the original purpose for which they were collected, interoperable to specific quality standards, whenever relevant.

The Platform will ensure the ease of communication across all Consortium partners as well as will offer shared access to project documents. This powerful tool was developed by IRES and OSM and enhances knowledge management capabilities for all 18 partners, ease of accessibility to results and monitoring of tests.

The efficient classification of partners' uploads is possible through Platforms' integration of Categories Administration tools. Data will not just be uploaded, but also stored under specific tags such as WP, relevant project's task, scientific domain etc.Via this, Data will be accompanied by Metadata description, making their exploration easier. The DMP Platform is part of the strategy towards making generated Data findable, accessible, interoperable and re-usable (FAIR Data)





SmartFAN's Events

SmartFAN Technical meeting (M12)

30-31 January 2019, Palaiseau, France

The SmartFAN Technical meeting was held on the 30-31 of January, in Palaiseau, France. Focus was given to pending technical issues regarding materials development and characterization, demonstrator cases, correlation of materials to demonstrators, and integrating the main SmartFAN concepts (L & G)

SmartFAN's Partners in Palaiseau

SmartFAN EuroNano Forum 2019

12-14 June 2019, Bucharest, Romania

Smartfan project participated at EuroNanoForum 2019, the largest networking conference focusing on nanotechnologies and advanced materials science, innovation and business. EuroNanoForum 2019, an event of the Romanian Presidency of the Council of the European Union, stands as the most significant European forum that brings together scientists, industrialists and policy makers.

SmartFAN's Partners during the EuroNanoForum in Bucharest

SmartFAN

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