Catalogue of services

OASIS
Structure of the catalogue

• Showcases
  • Examples of projects led by industrial partners utilizing a combination of multiple OASIS service

• Catalogue of services
  • Technical services
    • Pilot line products
      • Nano-materials
      • Nano-intermediates
      • Nano-enabled products
    • Product process engineering
    • Design, modelling and simulation
      • Design
      • Modelling and simulation
    • Testing and characterization
  • Sustainability
  • Business support services
Open access single entry point for scale-up of innovative Smart lightweight composite materials and components. This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 814581.

Showcases:

- **SC1** Nano-enabled pultrusion for lightweight construction
- **SC2** Structural Nanoreinforced aluminum castings
- **SC3** Multifunctional RTM composite panels
- **SC4** Smart battery casing in nanocomposites
- **SC5** Multifunctional nanobased layers
- **SC6** Energy storage in prefabricated walls
Showcase #1: Nano-enabled pultrusion for lightweight construction

<table>
<thead>
<tr>
<th>The problem</th>
<th>The solution</th>
<th>The services used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Current gaps in the technology:</td>
<td>1. Rebar with enhanced mechanical performance at elevated temperatures</td>
<td>1. Rebar with enhanced mechanical performance at elevated temperatures</td>
</tr>
<tr>
<td>• Mechanical performance at elevated temperatures</td>
<td>• Enhanced mechanical performance <strong>nano-particles</strong> specified to this need are used. A multifunctional</td>
<td>+</td>
</tr>
<tr>
<td>• Slow productivity</td>
<td>tool particle is created using layered double hydroxides as flame retardant component.</td>
<td>2. <strong>Higher productivity of the rebar pultrusion:</strong></td>
</tr>
<tr>
<td>• Durability to aggressive conditions</td>
<td>2. <strong>Higher productivity of the rebar pultrusion:</strong></td>
<td>• Production of magnetic particles and layered double hydroxides, as well as the combination to</td>
</tr>
<tr>
<td>Requirements and specifications:</td>
<td>• Enhanced productivity and lower costs <strong>nano-particles</strong> specified to this need are used. A</td>
<td>multifunctional tool particle.</td>
</tr>
<tr>
<td>1. Rebar with enhanced mechanical performance at elevated temperatures</td>
<td>multifunctional tool particle is created using inductively heatable magnetic particles.</td>
<td>• Process evaluation and modification of the pultrusion process with nanomodified resins</td>
</tr>
<tr>
<td>2. Higher productivity of the rebar pultrusion</td>
<td>3. <strong>Corrosion resistant nano-enabled coating for RC elements</strong></td>
<td>• Thermal, mechanical testing of reinforced concrete beams</td>
</tr>
<tr>
<td>3. Corrosion resistant nano-enabled coating for RC elements</td>
<td></td>
<td>• Design of fire resistance solutions for FRC reinforced concrete beams</td>
</tr>
<tr>
<td>Technical requirements:</td>
<td></td>
<td>3. <strong>Corrosion resistant nano-enabled coating for RC elements</strong></td>
</tr>
<tr>
<td>• Curing: &gt; 98.99% curing degree</td>
<td>1. Production of magnetic particles and layered double hydroxides, as well as the combination to</td>
<td>• Production of nanomodified coating</td>
</tr>
<tr>
<td>• Production speed: &gt; 20cm/min for a 16mm rebar</td>
<td>multifunctional tool particle.</td>
<td>• Testing of the corrosion resistance</td>
</tr>
<tr>
<td>• Material specifications:</td>
<td>• Thermal, mechanical testing of reinforced concrete beams</td>
<td></td>
</tr>
<tr>
<td>• Glass fibre type E</td>
<td>• Design of fire resistance solutions for FRC reinforced concrete beams</td>
<td></td>
</tr>
<tr>
<td>• Rebar diameter 16 mm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Fibre fraction (in weight) &gt; 70%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Tg &gt; 90°C</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Specific gravity &gt; 1.25 gr/cm3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Tensile strength 70MPa</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Elastic modulus &gt; 50GPa</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The problem:
- Current gaps in the technology:
  • Mechanical performance at elevated temperatures
  • Slow productivity
  • Durability to aggressive conditions

Requirements and specifications:
1. Rebar with enhanced mechanical performance at elevated temperatures
   • Enhanced mechanical performance **nano-particles** specified to this need are used. A multifunctional tool particle is created using layered double hydroxides as flame retardant component.
2. Higher productivity of the rebar pultrusion:
   • Enhanced productivity and lower costs **nano-particles** specified to this need are used. A multifunctional tool particle is created using inductively heatable magnetic particles.
3. Corrosion resistant nano-enabled coating for RC elements

Technical requirements:
- Curing: > 98.99% curing degree
- Production speed: > 20cm/min for a 16mm rebar
- Material specifications:
  - Glass fibre type E
  - Rebar diameter 16 mm
  - Fibre fraction (in weight) > 70%
  - Tg > 90°C
  - Specific gravity > 1.25 gr/cm3
  - Tensile strength 70MPa
  - Elastic modulus > 50GPa

The solution:
1. Rebar with enhanced mechanical performance at elevated temperatures
2. Higher productivity of the rebar pultrusion:
3. Corrosion resistant nano-enabled coating for RC elements

The services used:
1. Rebar with enhanced mechanical performance at elevated temperatures
2. Higher productivity of the rebar pultrusion:
3. Corrosion resistant nano-enabled coating for RC elements

The problem: The current gaps in the technology include mechanical performance at elevated temperatures, slow productivity, and durability to aggressive conditions.

Requirements and specifications:
1. Rebar with enhanced mechanical performance at elevated temperatures
2. Higher productivity of the rebar pultrusion
3. Corrosion resistant nano-enabled coating for RC elements

Technical requirements:
- Curing: > 98.99% curing degree
- Production speed: > 20cm/min for a 16mm rebar
- Material specifications:
  - Glass fibre type E
  - Rebar diameter 16 mm
  - Fibre fraction (in weight) > 70%
  - Tg > 90°C
  - Specific gravity > 1.25 gr/cm3
  - Tensile strength 70MPa
  - Elastic modulus > 50GPa

The solution:
1. Rebar with enhanced mechanical performance at elevated temperatures
   - Enhanced mechanical performance **nano-particles** specified to this need are used. A multifunctional tool particle is created using layered double hydroxides as flame retardant component.
2. Higher productivity of the rebar pultrusion:
   - Enhanced productivity and lower costs **nano-particles** specified to this need are used. A multifunctional tool particle is created using inductively heatable magnetic particles.
3. Corrosion resistant nano-enabled coating for RC elements
   - Production of magnetic particles and layered double hydroxides, as well as the combination to multifunctional tool particle.
   - Process evaluation and modification of the pultrusion process with nanomodified resins.
   - Thermal, mechanical testing of reinforced concrete beams.
   - Design of fire resistance solutions for FRC reinforced concrete beams.
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   - Design of fire resistance solutions for FRC reinforced concrete beams.

The services used:
1. Rebar with enhanced mechanical performance at elevated temperatures
2. Higher productivity of the rebar pultrusion:
3. Corrosion resistant nano-enabled coating for RC elements
Showcase #1 Workflow

Nanoscale
- PL3: Magnetic nanoparticles for inductive heating
- PL3: Flame retardant nanoparticles with modified surface
- PL1: Nanomodified agent to waterproof concrete surface

Intermediate scale
- PL 12: Nano-enabled pultruded rebars for reinforced concrete

Component scale
- Nanosafety
- Nanomodified reinforced concrete structures
- Physical- and fire-testing and evaluation
Showcase #2: Structural nano-reinforced aluminium castings

<table>
<thead>
<tr>
<th>The problem</th>
<th>The solution</th>
<th>The services used</th>
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</thead>
</table>

**Current gaps in the technology:**

1. **High Pressure Die Casting (HPDC) aluminium parts** are heat treated to obtain high mechanical requirements → heat treatment adds higher cost to the part manufacturing process.

2. **Silicon free aluminium-magnesium alloys** can achieve mechanical requirements without heat treatment → die wearing decreases die’s life, increasing the overall cost of the process and decreasing productivity due to higher maintenance.

3. **Part lightweighting** can be achieved with new designs that have to fulfill the castability conditions imposed by the HPDC process → the design process is usually very laborious and the results often do not meet target requirements.

**The solution:**

1. **Nano-reinforced alloys**
   - Manufacturing of nano-reinforced aluminium ingots by SIMPnano process.
   - HPDC process via Met cast process.

2. **High resistance die materials**
   - High resistance cermet coatings deposition on the die for HPDC process with high corrosive aluminium alloys.
   - Materials and coating in die insert form assembly in test mold and Met cast pilot.

3. **Bionic-based design**
   - Solution to develop new complex structural design is based on the Elise algorithm.
   - Designing and modelling solution based on a bionic database
   - Validation of the design and in Met cast pilot.

**The services used:**

1. **Nano-reinforced alloys**
   - Production of nano-reinforcements
   - Production of nano-reinforced aluminium
   - Reinforcement characterization
   - Material characterization
   - Nano-reinforced aluminium HPDC

2. **High resistance die materials**
   - High resistance die coatings
   - High resistance die material and coating test

3. **Bionic-based design**
   - Bionic –based structural part design
   - Castability analysis of bionic-based designs
## Showcase #3: Multifunctional RTM composite panels

<table>
<thead>
<tr>
<th>The problem</th>
<th>The solution</th>
<th>The services used</th>
</tr>
</thead>
</table>
| Development and manufacturing of a smart and lightweight composite panel complying with fire regulations and with the following targets: | 1. Smart lightweight and robust composite panel.  
Redesign of the structure so as to save weight and incorporation of:  
- Nano-structured fire retardants to avoid fire propagation.  
- Carbon Nano-Tube (CNT) doped veils for surface finishing and impact resistance.  
- Thermal sensors for temperature measurements and actuators.  | 1. Smart lightweight and robust composite panel.  
- Production of nano-particles for fire retardancy.  
- Production of nano-powdered dry plies with enhanced fire performance.  
- Production of tailor made printed sensors/actuators.  
- Production of CNT doped veils.  
- Mechanical justification for reducing the weight of the panel.  
- Evaluation of the fire performance of composite material with embedded nano-particles.  |
| 1. Reduction of cycle time by 15%.                                         | 2. Increased thermal comfort.  
- By using aerogel foams for the insulation and buckypapers as heating elements.  | 2. Increased thermal comfort.  
- Production of aerogel foams.  
- Production of buckypapers as resistive element.  
- Thermal justification aiming at increasing the overall thermal insulation of the panel.  |
| 2. Production cost maximum: no increase.                                   | 3. Smart monitoring functionality.  
- During the lifetime of the product by incorporating printed sensors and during the manufacturing process by using online control.  | 3. Smart monitoring functionality.  
- Material integration and process monitoring.  |
- In the field of processing and nanosafety.  | 4. Support for the production of nano-enabled structures.  
- Nanosafety assessment.  
- Process simulation support.  |
Showcase #3 Workflow

Tech services:
- **UoP**: Design & FEM; coupon scale characterisation of mech. properties
- **TEC**: Fire testing
- **CEA**: Technical support on safety & regulation compliance (processing nano)
- **IPC**: Processing support

Nanoscale
- **Aerogels Material**
  - UCLM
- **Flame retardant nanoparticles**
  - Fraunhofer

Intermediate scale
- **Dry plies with nanopowder**
  - Adamant
- **Printed sensors / Actuators**
  - CEA

Component scale
- **Impact resistance & surface finishing**
  - TMBK
- **Material integration & process monitoring**
  - IPC

Other goods
- **Heating elements**
  - TEC
- **Other goods**

Open access single entry point for scale-up of innovative Smart lightweight composite materials and components
This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 814581
Showcase #4: Smart battery casing in nanocomposites

<table>
<thead>
<tr>
<th>The problem</th>
<th>The solution</th>
<th>The services used</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of a smart, lightweight and robust nano-enabled composite casing for an avionic battery module with the following targets: 1. Increased gravimetric energy density of the battery module by 10-20%. 2. Resistance to thermal runaway of one cell in the battery module reducing the risk of fire propagation. 3. Reduction of thermal runaway risk by anticipated detection.</td>
<td>1. Smart lightweight and robust casing for battery module  • Selection of the right polymer matrix that will resist thermal, mechanical and chemical contraints.  • Inclusion of nano-structured fire retardants to avoid fire propagation. 2. Smart monitoring functionality  • Printed sensors incorporated in the casing structure or on the cells</td>
<td>1. Smart lightweight and robust casing for battery module  • Definition of specifications for casing materials  • Thermal and mechanical testing of materials  • Thermal, mechanical and combined modelling  • Design of battery casing  • Process adjustment and casing production 2. Smart monitoring functionality  • Design and production of printed sensors  • Sensors integration into casing  • Sensors characterization</td>
</tr>
</tbody>
</table>
Open access single entry point for scale-up of innovative Smart lightweight composite materials and components

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Showcase #4 Workflow

Nanoscale

Battery Design
CEA

Battery WP

Intermediate scale

Sensors Design and Realization
CEA (PL#7)

Material Choice based on Spec written by CEA/TAS. IPC (PL#11)

Casing Design tuning
IPC (PL#11)

Casing Molding
IPC (PL#11)

Component scale

Sensors WP

Material WP

Battery WP

Design Flux

Material Flux

Not OASIS PL

IPC (PL#11)
**Showcase #5: Multifunctional nanobased layers**

**The problem**
Repairing defects or damages occurring in composite structure of aircrafts.
Current methods are limited in size and shape:
- Not flexible enough (thermal blankets)
- Not effective over 100% of the surface (hot air boxes)
- The complete composite part has to be heated when curing (production and repairing), which makes it costly.

**Requirements and specifications**
1. External flexible heater blanket
2. Integrated heater element for curing offering additional functionality, e.g. Structural Health Monitoring (SHM) capabilities.

**Technical requirements**
- Processing parameters
  - Curing temperature: 180°C ± 5°C for 2-3 hours
  - Heating rate: 0.5-2.5°C/min
  - P: 7 bars for fresh prepreg curing. 3 bars for bonding of precured panels.
  - Integrated solutions, system weight <100gsm.

**The solution**

<table>
<thead>
<tr>
<th>1. External flexible heater blanket</th>
</tr>
</thead>
<tbody>
<tr>
<td>Based on buckypapers (BP).</td>
</tr>
<tr>
<td>- For part curing</td>
</tr>
<tr>
<td>- For repair curing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Integrated heater element</th>
</tr>
</thead>
<tbody>
<tr>
<td>Based on buckypapers.</td>
</tr>
<tr>
<td>- For part curing</td>
</tr>
<tr>
<td>- With additional functionality (e.g. SHM)</td>
</tr>
</tbody>
</table>

**The services used**

<table>
<thead>
<tr>
<th>1. External flexible heater blanket</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Production of BPs</td>
</tr>
<tr>
<td>- BPs as external resistive heating system for autoclave part curing and repair curing</td>
</tr>
<tr>
<td>- Thermal, mechanical and combined modelling</td>
</tr>
<tr>
<td>- Characterization of repaired and cured composites by BP</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2. Integrated heater element</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Production of BPs</td>
</tr>
<tr>
<td>- BP as integrated resistive heating system for curing and multifunctional layer</td>
</tr>
<tr>
<td>- Thermal, mechanical and combined modelling</td>
</tr>
<tr>
<td>- Characterization of cured BP composites with multifunctional properties</td>
</tr>
</tbody>
</table>
Showcase #5 Workflow

Production of thermoplastic veils of BPs as external flexible heater blanket for autoclave repair and curing
TMBK (PL#5)

Production of BPs to be used as a resistive heating element
TEC (PL#4)

Roll-to-roll processing
ADA (PL#6)

Tech services:
- **UoP**: Modelling; coupon scale characterisation
- **ADA**: Pilot line for large scale BP encapsulation. Production of nanotreated prepregs
- **TMBK**: Production of thermoplastic veils; BP encapsulation trials using veils; coupon scale characterisation
- **TEC**: BP manufacturing; BP encapsulation trials; Modelling; Resistive Heating tasks; coupon scale characterisation

Thermal, mechanical and combined modelling for external and integrated heating systems
UoP, TEC

BP encapsulation for external and integrated heating systems manufacturing
TEC, TMBK, ADA

Resistive Heating curing and repair for autoclave part using BP as external and integrated system
TEC

Characterization of composites cured by BP based external and integrated resistive heating system
UoP, TMBK, TEC

Manufacturing of DEMO using BP based resistive heating system
AIR, TEC

BP encapsulation for external and integrated heating systems manufacturing
TEC, TMBK, ADA

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Showcase #6: Energy storage in prefabricated walls

<table>
<thead>
<tr>
<th>The problem</th>
<th>The solution</th>
<th>The services used</th>
</tr>
</thead>
</table>

**Development of a prefabricated lightweight wall with integrated energy storage capabilities and advanced functionality (environmental sensing and safety).** Li-ion energy storage systems (Li-ion batteries) are problematic in the long run, with the key issues being:

- High cost
- Limited durability of all batteries (< 6000 cycles)
- Performance degradation (50% in first 3-5 years)
- Not environmentally friendly

**Requirements and specifications**

1. **Li-ion battery and/or supercapacitor cell**
2. Prefabricated walls (Smart Environmental System Development)
3. Prefabricated wall demonstrator development (including fire retardancy)

**Technical requirements**

**Electrode:** Specific gravimetric capacity (mAhg-1) > 350

**Cell:** Cell capacity (mAh): 500-1000; specific gravimetric energy density (Wh/kg): > 100

**Module:** Capacity (Ah): 2-5; specific gravimetric energy density (Wh/kg): > 100; power density (W/kg): 2000-3000; leakage current (mA): 50-70

1. **Li-ion battery and/or supercapacitor cell**
   - Buckypaper (BP) based energy storage system designed for safe and compact integration in building’s inert elements
   - Electrode materials | BPs
   - Packaging | Pouches, Cases
   - Electrolyte
   - Separators | PE, PP
   - Binders
   - Cell casing | Copper, Nickel, Aluminium

2. **Smart environmental system**
   - Successful integration of the developed modules in a system (prefabricated energy storage walls) together with proper electronics and smart environmental sensors

3. **Prefab energy storage walls**
   - Prefab energy storage walls including fire resistant nano-particles

**The services used**

1. **Li-ion battery and/or supercapacitor cell**
   - Production of BPs with/without modifiers (e.g. Metallic oxides) for energy storage electrodes
   - Roll-to-roll lamination process for manufacturing of BP based electrodes for high-end battery/supercapacitor cells
   - Electrochemical testing and morphological characterization of novel nano-based electrode materials

2. **Smart environmental system**
   - Sheet to sheet smart printed sensors for integration in prefabricated lightweight walls

3. **Prefab energy storage walls**
   - Fire retardant nano-particles
   - Carbon Nano-Tube (CNT) based veils
   - Eco-friendly/recyclable fiber reinforced composite materials with integrated sheet to sheet smart printed sensors
Showcase #6 Workflow

Nanoscale
- Material characterization and testing
  - UoP
- Buckypaper electrode (PL4)
  - TEC
- Flame retardant nanoparticles (PL3)
  - Fraunhofer

Intermediate scale
- Cell/module design; architecture + optimisation
  - ADA
- R2R lamination of supercap cells
  - ADA
- Prepreg composite wall panels (PL6)
  - ADA

Component scale
- Manufacture of prefabricated lightweight energy storage walls
  - PLE/ADA
- Sheet 2 sheet printed sensors (PL7)
  - CEA
- CNT veils for prefab walls
  - TMBK

Tech services:
- PLE: cell and module design, architecture and optimization
- TEC: BP based supercap electrodes
- UoP: Material characterisation and testing
- CEA: Printed sensors
- TMBK: CNT veils
- ADA: R2R lamination; manufacture of prefab composite

Other items
## Pilot line products

Subcategory: Nano-materials

### SiO2 nano-reinforced aerogel panels

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>• High thermal insulating and low density materials</td>
<td>• 0.76 m² to 2 m² aerogel / batch</td>
<td>1. SC3 - Highly insulating and low density aerogel for use in smart lightweight composite panels.</td>
</tr>
<tr>
<td></td>
<td>• Thermal conductivity values are between 0.028 and 0.052 W·m⁻¹·K⁻¹</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Density values are in the range of 46 to 118 g·L⁻¹.</td>
<td></td>
</tr>
</tbody>
</table>
Pilot line products
Subcategory: Nano-materials

**Wet chemical nanoparticles and nanomaterials syntheses for nano-reinforcements**

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Tracing</td>
<td>• Large scale nanoparticle synthesis, separation and purification processes (example: AlSi10MnMg nano-reinforced)</td>
<td>1. SC2 - Synthetic nanoparticles and nanomaterials for nano-reinforcements</td>
</tr>
<tr>
<td>• Thermal/electrical conductivity</td>
<td>• Up to 25 L/day semi-continuous processes</td>
<td></td>
</tr>
<tr>
<td>• Mechanical strength</td>
<td>• Particle separation by centrifugation/nanofiltration (5 /10 L) implying several g to kg scale production</td>
<td></td>
</tr>
</tbody>
</table>
# Pilot line products
## Subcategory: Nano-materials

### Magnetic and flame retardant nanoparticles and nanocomposites

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Inductive heat</td>
<td>• Continuous and batch wet chemical synthesis of nanoparticles up to a 100l scale. Combination of nanoparticles to nanostructured microparticles via spray drying.</td>
<td>1. SC6 - Prefabricated lightweight walls based on eco-friendly / recyclable fibre reinforced composites materials with integrated sheet to sheet smart printed sensors, flame retardant nanoparticles and Carbon Nano-Tube veils</td>
</tr>
<tr>
<td>• Flame retardant</td>
<td></td>
<td>2. SC1/SC3 - Flame-retardant material for building applications or applied to smart lightweight composite panels</td>
</tr>
<tr>
<td>• Corrosion-inhibition</td>
<td></td>
<td>3. SC1 - Fast induction heating for thermoset composite rebars</td>
</tr>
</tbody>
</table>
## Pilot line products

**Subcategory: Nano-intermediates**

<table>
<thead>
<tr>
<th>Buckypapers (BP) - self-supporting sheets comprised of entangled carbon nano-tubes (CNT)</th>
</tr>
</thead>
</table>

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
</table>
| • Enhanced mechanical and electrical properties | • CNT based continuous sheets, “Buckypapers"  
• Lengths up to 100 m  
• Widths up to 300 mm  
• Thickness – down to 10-30 microns (for supported BPs) and between 30-200 microns (for supported and/or free-standing BPs)  
• Weights between 30-200 gm²  
• Capacity up to 1000 m² per year | 1. SC6 - BP-based electrodes for high-end battery/supercapacitor cells, integrated resistive heating system  
2. SC5 - BP as external resistive heating system for autoclave part repair and curing  
3. SC5 - BP as integrated resistive heating system for autoclave part curing and multifunctional layer  
4. SC3 - Production of BP as cable wiring and/or resistive element |
## Pilot line products
### Subcategory: Nano-intermediates

<table>
<thead>
<tr>
<th>Carbon Nano-Tube (CNT) doped veils - lightweight and thermoplastic nonwovens based on copolyimide/copolysters/polyamides containing CNTs</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Functionalities</strong></td>
</tr>
<tr>
<td>• High flexibility and lightweight</td>
</tr>
<tr>
<td>• Improvement of electrical conductivity and mechanical properties</td>
</tr>
<tr>
<td>• Resistive heating</td>
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### Pilot line products
Subcategory: Nano-intermediates

<table>
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<th>Examples</th>
</tr>
</thead>
</table>
| • High performance mechanical, thermal and wear resistance properties | • Nanoreinforced metal alloy ingot production  
• 100 kg batches | 1. SC2 - Nano-reinforced alloy manufacturing |
## Pilot line products
**Subcategory: Nano-intermediates**

### Sheet to sheet electronic printed devices

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Smart functions, e.g. printed sensors and actuators  | • Maximum size of substrates is 320 x 380 cm²  
• Main materials used to elaborate these sensors are inks with the several following functionalities:  
  - Conductive metal inks (Ag, C)  
  - Conductive polymer inks (PEDOT - poly(3,4-éthylènedioxothiophène))  
  - Dielectric formulations  
  - Organic semiconductor ink  
  - Electro Active Polymer (EAP) inks (PVDF-based)                                                                                                               | 1. SC3/SC4 - Sensor design and integration        |
Pilot line products
Subcategory: Nano-intermediates

Nano-enabled prepregs and dry fabrics for composite products

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
</table>
| • Standard formulations for Mechanical, Electrical and Thermal Properties of polymer composites  
• Customization of formulations for tailored properties (fire, vibration, acoustic, …)  
• Nano-products integration in prepregs and dry fabrics | • Tailoring of composite properties through the nano-enabling of commercial prepregs and dry fabrics.  
• Product performance with standard formulations:  
  - Mechanical: Fracture toughness up to 100% increase  
  - Electrical: Conductivity through thickness up to 1 order of magnitude increase  
  - Thermal: Conductivity through thickness up to 40% increase, In-plane up to 150% increase  
• Product Specifications:  
  - Prepreg Roll width up to 600 mm  
  - Prepreg Roll outer diameter up to 600 mm  
  - Thickness adjustment: 0-25 mm  
• Semi automatic Roll to Roll (R2R) process  
  - Lamination Temperature up to 200°C  
  - Capacity: max 1000 m²/day | 1. SC3 - Production of nano-powdered dry plies with enhanced fire performance for smart lightweight composite panels.  
2. SC5 - Production of Nano-treated aerospace prepregs according to application requirements of BP as integrated resistive heating system for autoclave curing  
Pilot line products
Subcategory: Nano-enabled products

<table>
<thead>
<tr>
<th>High-Pressure Die Casting (HPDC) applied to nano-reinforced aluminium</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Functionalities</strong></td>
</tr>
<tr>
<td>• High performance mechanical, thermal/electrical and wear resistance properties</td>
</tr>
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</tbody>
</table>
Pilot line products
Subcategory: Nano-enabled products

Nano-enabled composite plates for lightweight and multifunctional applications

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
</tr>
</thead>
</table>
| Plates with improved Mechanical, Electrical and Thermal Properties | • Tailored cut-to-shape composite products incorporating nano-enabled intermediates.  
• Plate Product Performance:   
  - Mechanical: increased damage tolerance  
  - Electrical: antistatic and EM shielding applications  
  - Thermal: thermal dissipation and compact heat generating applications  
• Standard thicknesses: 1mm, 2mm, 3mm + (other thicknesses on-request)  
• Sizes:  
  - Max Length 2000mm (Raw Plate)  
  - Max Width 900mm (Raw Plate)  
  - Max dimensions 600x900mm (Cut-to-Shape via CNC) |
# Pilot line products

**Subcategory: Nano-enabled products**

## Stamping/overmoulding process for thermoplastic nano-enabled and/or smart composite products

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Lightweighting and function integration | • 800T horizontal press  
• Reinforcement: glass, carbon, basalt or natural fibre.  
• Organic matrices: PP, PA, PEI, PPS, PEEK  
• Cycle time ~ 1 min / max. part size 1.5 m  
• On-line process monitoring and quality control using infrared camera and terahertz technology | 1. SC4 - production of a smart, lightweight casing for a battery module made of PPS/Carbon material |
### Pilot line products

**Subcategory: Nano-enabled products**

<table>
<thead>
<tr>
<th>Resin Transfer Molding (RTM) process for nano-enabled and/or smart composite products</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Functionality</strong></td>
</tr>
</tbody>
</table>
| Lightweighting and function integration | • 300T vertical press (platen size: 3,0 m x 2,5 m)  
• Bi-component injection machine  
• Thermoset composite parts with complex shapes and surfaces up to 3 m2.  
• Maximum temperature is 400°C  
• Most of the thermoset and thermoplastic resins can be processed on this pilot line. | 1. SC3 - production of a smart lightweight composite panel. |
## Pilot line products

**Subcategory: Nano-enabled products**

### Pultrusion process applied to Nano-enabled Aluminium/composites hybrid products

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Lightweight and smart structures</td>
<td>• 10 t Pultrusion line:</td>
<td>1. SC1 - Nano-enabled pultruded rebars for reinforced concrete</td>
</tr>
<tr>
<td></td>
<td>• Controlled heating: Induction, infrared and electric</td>
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<td></td>
<td>• Closed injection systems and open bath</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Data acquisition</td>
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<td></td>
<td>• Thermal camera</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Thermocouples</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Dosing units: Polyurethane and Amine based epoxy</td>
<td></td>
</tr>
</tbody>
</table>

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 814581.
Product process engineering

### Industrialization – process development

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete definition of how the process should be</td>
<td>VSM (Value Stream Mapping)</td>
</tr>
<tr>
<td></td>
<td>Load – capacity calculation</td>
</tr>
<tr>
<td></td>
<td>Layout definition</td>
</tr>
<tr>
<td></td>
<td>Logistics definition</td>
</tr>
<tr>
<td></td>
<td>Machines and auxiliary installations functional specs development</td>
</tr>
<tr>
<td></td>
<td>Process control definition</td>
</tr>
<tr>
<td></td>
<td>Manufacturing cost calculation</td>
</tr>
</tbody>
</table>
Product process engineering

Technology development (definition of new technology requirements and processing parameters)

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
</tr>
</thead>
</table>
| • Ability of manufacturing at the right cadence with the proper parameters and the necessary knowledge | • Conceptual design of the technology  
• Prototypes construction  
• Run process tests and characterization of processing parameters  
• Design of the final improved concept  
• Develop functional specs of the final improved technology |
# Product process engineering

## Piloting service for novel polymer-based products & technologies

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>• From LAB to FAB, industrial perspective to material technologies to increase the TRL of their material technologies providing flexible and modular manufacturing pilot lines</td>
<td>• A highly modular Roll2Roll Pilot line, equipped with a powder scattering and lamination module for the processing of both thermoset and thermoplastic prepregs, dry fabrics and thermoplastic films.</td>
</tr>
<tr>
<td></td>
<td>• A Liquid Dispersion Pilot Line equipped with ultrasonic mixing and Three Roll Milling for the batch processing of sub-micron &amp; nano materials, resins, epoxies, pastes, silicons, polymers, inks, paints and many more.</td>
</tr>
<tr>
<td></td>
<td>• A Film coating Pilot line, where both doctor blade and spray coating process are available for the batch production of coated surfaces and films.</td>
</tr>
</tbody>
</table>
Product process engineering

<table>
<thead>
<tr>
<th>Composite Parts Prototyping</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Functionalities</strong></td>
</tr>
</tbody>
</table>
| • End-to-end services of processing and manufacturing of standard and nano-enabled composite products | • From wet-layup and vacuum bagging to Autoclave/Prepreg and RTM-based techniques:  
  - Processing room with controlled environment  
  - Processing of space approved materials (Epoxies, Cyanate Esters, Adhesives, etc.)  
  - Autoclave curing up to 200oC  
  - Autoclave dimensions Φ 1000mm, L 2000mm  
  - Curing & Post-curing oven  
  - Quality inspection for Product Assurance  
  - Production Design & Process Development |
### High resistance die coatings

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
</table>
| • Die coating for service life improvement of casting dies | • Cermet coatings deposition by thermal spray  
• Core pins and slender insert protection  
• Extended and tailored coating catalogue | • 1. SC2 - High resistance die material and coating test |
## Design, modelling and simulation
**Subcategory: Design**

### Bio-inspired structural part design

<table>
<thead>
<tr>
<th>Functionalities</th>
</tr>
</thead>
<tbody>
<tr>
<td>• New lighter designs with higher performance, e.g. in terms of mass, stress and/or deformation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Technical specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Designing, modelling and optimization service based on bio-inspired lightweight structure database.</td>
</tr>
<tr>
<td>• Bio-inspired lightweight designs will be generated following the boundary conditions and mechanical requirements of the customer.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. SC2 - design optimization of a structural automotive part submitted to crash impact</td>
</tr>
</tbody>
</table>
Design, modelling and simulation
Subcategory: Design

### Product design and material selection based on customer's specifications

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Customized design that best suits to the customer's specifications</td>
<td>• Design of composite and polymer products using Solidworks CAD software</td>
<td>1. SC4 - design of a composite casing for aerospace battery modules</td>
</tr>
</tbody>
</table>
## Design, modelling and simulation

Subcategory: Modelling and simulation

### Thermal, mechanical and multi-physics and multi-scale modelling

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Virtual performance evaluation based on thermal and/or mechanical criteria</td>
<td>• Composite structure with embedded nanomaterials performance modelling.</td>
<td>1. SC5 - Design of Buckypaper-based external heating system</td>
</tr>
<tr>
<td></td>
<td>• Joule effect prediction modelling of nano-enabled materials.</td>
<td>2. SC5 - Integrated Buckypaper-based heating system</td>
</tr>
<tr>
<td></td>
<td>• Finite element modelling of the product thermal/mechanical performances</td>
<td>3. SC3/SC4 - Design of product (Battery Casing or composite panel)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. SC3 - Increase of the overall thermal insulation of a smart lightweight composite panel</td>
</tr>
</tbody>
</table>
### Design, modelling and simulation

**Subcategory: Modelling and simulation**

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
</table>
| • Design of the process for limiting the risk of generating defects in the production | • Modeling of the stamping/overmolding process  
• Modeling of the RTM process, including the draping, impregnation, and curing of the resin | 1. SC3 - Assessment of flow propagation scenarios for the RTM process of glass/polyester composites  
2. SC4 - Process justification for the stamping/overmolding process of carbon/PPS prepregs |
Testing and characterization

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Design of Fire reaction/resistance solutions.</td>
<td>Design of fire performance solutions</td>
<td>1. SC1 - Definition of test criteria for reinforced concrete beams</td>
</tr>
<tr>
<td>Design of ad-hoc fire performance protocols from small scale to medium, large scale.</td>
<td>Ad-hoc protocols.</td>
<td>2. SC1 - Design of the fire resistance solutions for fiber reinforced composites concrete beams</td>
</tr>
<tr>
<td>Screening of solutions.</td>
<td>Reaction to fire: cone calorimeter, smoke density chamber coupled to FTIR, Oxygen index (L.O.I), UL 94, radiant panel, tubular furnace, inflammability test, calorimeter bomb, non-combustibility test, TGA-EGA. According EN standards (Euroclasses system), IMO, ASTM, ISO, EN 45545-2 between others.</td>
<td>3. SC1 - Correlation of fire performance of materials at small scale with large scale resistance test.</td>
</tr>
<tr>
<td>Compliance with fire testing standards/regulations</td>
<td>Resistance to fire:</td>
<td></td>
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<td></td>
<td>- Vertical, horizontal &amp; experimental furnaces.</td>
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<td></td>
<td>- Possibility to test according UL, ASTM, EN 45545-3, RWS standards between others</td>
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<td>- Propagation of facades BS 8414-1.</td>
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<tr>
<td></td>
<td>Toxicity of fire efluents</td>
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<td></td>
<td>- NF X70-100 (tubular furnace and NBS Smoke chamber)</td>
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<tr>
<td></td>
<td>- ISO 5659-2 + FTIR (anex.C EN 45545-2) test</td>
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</tbody>
</table>
Testing and characterization

### Corrosion resistance assessment

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
</table>
| • Synthesis, characterization and application of nanocoatings for corrosion resistance of concretes in adverse climate conditions | • Artificial weathering in a 6 weeks cycle run (modified from an ASTM D5894 test):  
  - Salt chamber fog at 35 °C for three weeks  
  - UV VA 340 chamber (cycle of UV at 60 °C with 0.65 W/m2 for 4 h)  
  • Adhesion strength by pull off test before and after aging, (ASTM 4541 and UNE 1062 tests).  
  • Measuring the water absorption (UN3 1062-3 test)  
  • Determining the abrasion resistance (EN ISO 5470-1 test). | 1. SC1 - Production of nanomodified release agent  
2. SC1 - Testing of the corrosion resistance |
Testing and characterization

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Microstructure / performance relationship analysis</td>
<td>• General equipment for material characterization is available.</td>
<td>1. SC2 - Reinforcement characterization</td>
</tr>
<tr>
<td></td>
<td>• More information is available on request.</td>
<td>2. SC2 - Material characterization</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3. SC5 - Characterization of composites repaired and cured by buckypaper based external heating system</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4. SC5 - Characterization of composites cured by integrated buckypaper based heating system with multifunctionnal properties</td>
</tr>
<tr>
<td></td>
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<td>5. SC6 - Electrochemical testing of noval nano-based electrode materials</td>
</tr>
</tbody>
</table>
Testing and characterization

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mechanical performance</td>
<td>• 950 Tm HPDC machine&lt;br&gt;• Thermal fatigue test system&lt;br&gt;• Molten aluminium corrosion and soldering test system&lt;br&gt;• Surface characterization laboratory&lt;br&gt;• Tensile&lt;br&gt;• Flexural&lt;br&gt;• ILSS&lt;br&gt;• (and other test facilities upon demand)</td>
<td>1. SC2 - High resistance die material and coating test&lt;br&gt;2. SC4 - Mechanical testing of materials</td>
</tr>
</tbody>
</table>
## Nano-safety

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Technical specifications</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Support for the use of nanoforms and the technology transfer</td>
<td>• Risk assessment and measurement according to EN17058</td>
<td>1. SC1 – Nano-safety assessment</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2. SC3 – Nano-safety assessment</td>
</tr>
</tbody>
</table>
Sustainability

<table>
<thead>
<tr>
<th>Standardization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functionalities</td>
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</tbody>
</table>

- Guide for the use of standardization by test bed users
## Business supporting services

### Business support and coaching

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Specifications</th>
</tr>
</thead>
</table>
| A tailor-made support service to maximize business value | • Defining the value proposition and Unique Selling Points  
• Market overview, competition and segments  
• Prioritization of segments  
• Identification of key customers and their feedback  
• Identification and qualification of supply chain and logistics  
• Distribution channels and agreements  
• Financial analysis and projection (cost analysis, manufacturing) |
## Business supporting services

<table>
<thead>
<tr>
<th>Access to private/public finances</th>
</tr>
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<tbody>
<tr>
<td><strong>Functionalities</strong></td>
</tr>
<tr>
<td>• A tailor-made support service to identify and access funding</td>
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</table>

Open access single entry point for scale-up of innovative Smart lightweight composite materials and components. This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 814581.
## Business supporting services

### Dissemination and marketing

<table>
<thead>
<tr>
<th>Functionalities</th>
<th>Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>• A tailor-made support service to maximize outreach and creation of new leads</td>
<td>• Creation of marketing materials</td>
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<tr>
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<td>• Video shooting</td>
</tr>
<tr>
<td></td>
<td>• Workshops (meetings, contacts) with selected customers</td>
</tr>
<tr>
<td></td>
<td>• Combination of customer specific and OASIS tools and channels</td>
</tr>
</tbody>
</table>