PRESENTATION OF SUPREME PROJECT

Sustainable and flexible powder metallurgy processes optimization by a holistic reduction of raw material resources and energy consumption

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### SUPREME CONSORTIUM

**Sustainable Process Industry through Resource and Energy Efficiency**

<table>
<thead>
<tr>
<th>Participant No*</th>
<th>Participant organisation name</th>
<th>Participant Short Name</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Commissariat à l’Energie Atomique et aux énergies alternatives</td>
<td>CEA</td>
<td>France</td>
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<tr>
<td>2</td>
<td>Outotec Oyj</td>
<td>OUTOTEC</td>
<td>Finland</td>
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<tr>
<td>3</td>
<td>MBN Nanomaterialia</td>
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<td>Italy</td>
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<td>4</td>
<td>Atomising systems Ltd.</td>
<td>ASL</td>
<td>United Kingdom</td>
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<td>5</td>
<td>GKN Sinter Metals</td>
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<td>Germany</td>
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<td>6</td>
<td>Fundación Prodistec</td>
<td>PRODINTEC</td>
<td>Spain</td>
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<td>Centre technique Industriel de la Plasturgie et des Composites</td>
<td>IPC</td>
<td>France</td>
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<td>8</td>
<td>TWI Ltd</td>
<td>TWI</td>
<td>United Kingdom</td>
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<td>9</td>
<td>RHP Technology GmbH</td>
<td>RHP</td>
<td>Austria</td>
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<td>11</td>
<td>Renishaw PLC</td>
<td>RENISHAW</td>
<td>Germany</td>
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<td>12</td>
<td>Innovació i Recerca Industrial i Sostenible</td>
<td>IRIS</td>
<td>Spain</td>
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<td>CRF</td>
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<td>17</td>
<td>European Powder Metallurgy Association</td>
<td>EPMA</td>
<td>France</td>
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</tbody>
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- **5 RTO**
- **6 SME**
- **5 Large companies**
- **1 Non-profit**

**Total cost:** 9.8 M€
**EU contribution:** 8 M€

**Duration:** 3 years
**From 01/09/2017 to 31/08/2020**
POWDER METALLURGY PROCESSES

Part Mass (kg)

Production Volume

Particle size (µm)

HIP

PMD

LMD

L-PBF

MIM

DED processes

PMD

LMD

HIP

MIM

L-PBF

HIP

PMD

LMD

L-PBF

MIM
AGENDA

1. CONCEPT & METHODOLOGY

2. OBJECTIVES

3. EXPECTED IMPACTS
**SUPREME CONCEPT**

- Optimize ferrous and non-ferrous metal **PM processes**, currently individually available at TRL7 and beyond, by cross-sectorial improvements in **material and energy efficiency throughout the supply chain**, from raw materials (fluids, solids or gases, including minerals and water) to finished products in a range of different end-applications.

- **Demonstrate a new integrated and optimized approach of a set of PM production routes in real industrial settings**, from TRL5 to TRL7, i.e. ready for adoption on the PM market.

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**Demonstrator #1**  
**Demonstrator #2**  
**Demonstrator #3**  
**Demonstrator #4**

Courtesy: GKN  
Courtesy: RENISHAW
Located all along the value chain (1 at each step), where KPIs will be monitored to reach the overall SUPREME objectives.
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OVERALL OBJECTIVES

Two main KEY PROCESS INDICATORS (KPI) to quantify material and energy efficiency improvements:

→ **Raw material resources efficiency**: defined either
  (i) absolutely as the amount of material consumption for a given process (typically in kg),
  (ii) relatively, as the raw material yield losses compared to the current practice in the sector.
Several raw material resources will be considered, accordingly to the process requirement and the most significant metrics that can be optimized: solids / fluids (including water) / gases.

→ **Energy efficiency**: defined either
  (i) absolutely as the amount of energy consumption for a given process (typically in kWh),
  (ii) relatively, as the rate of energy losses compared to the current practice in the sector.

Two KEY PROCESS INDICATORS derived from the above main KPIs to track impacts on productivity and CO₂ emissions:

→ **Production rate**: defined as productivity (typically in kg/hour).

→ **Carbon dioxide emissions**: defined either
  (i) absolutely as the amount of carbon dioxide emitted for a given process (typically in kt),
  (ii) relatively, as the rate relative reduction of CO₂ emissions compared to the current practice in the sector.
OVERALL OBJECTIVES

1. Continuous minerals concentration process efficiency improvement applied to metal powder production
2. Batch metal powders manufacturing efficiency based on atomization and ball milling
3. Batch metal part manufacturing process efficiency based on additive manufacturing and direct energy deposition
4. Business validation of yield and energy improvement regarding products performances and costs

CURRENT PRACTICES TO BE COMPARED TO

- Continuous ore grinding, enrichment flotation and water removal
- Batch gas and water atomization
- Traditional machining, forging and casting
- Batch additive manufacturing and near-net shape fabrication
- Traditional machining, forging and casting

KPIs PROCESS CONTROL & MONITORING

- Raw material resource efficiency
- Energy Efficiency
- Production Rate
- Carbon dioxide emissions

ECO-INNOVATION & MATERIAL / ENERGY FLOWS MAPPING

- > 25% improvement
- > 10% improvement
- > 10% improvement
- > 30% reduction

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Objective 2: Reduction of raw material resources and energy efficiency in ferrous (316L, Tool steel, Hard Carbon steel, Fe-based composite) and non-ferrous metal (Hastelloy® C22 and Inconel® 625) powder production processes, i.e. (i) gas atomization; (ii) water atomization and (iii) ball milling

Objective 3: Improvement of raw material resources (316L, 17-4PH, Tool steel, Hard carbon steel, Hastelloy® C22, Inconel® 625 & 718) and energy consumption in L-PBF and DED additive manufacturing processes

Objective 5: To demonstrate at TRL 7 the global integrated PM process optimization from minerals to end parts by a validation on 5 use cases in agreement with material performances, total cost breakdown and market volumes requirements

Objective 6: To develop and implement a quality and process control based on an eco-innovation methodology in order to ensure stable and flexible production routes towards a higher efficiency integrated powder metallurgy approach


**Objective**: Increase the yield and the productivity of 3D manufacturing processes (LMD = Laser Metal Deposition, PMD = Plasma Metal Deposition, and L-PBF = Laser Powder Bed Fusion)

<table>
<thead>
<tr>
<th>WP3 Tasks</th>
<th>Objectives</th>
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<tbody>
<tr>
<td>Task 3.1</td>
<td>Increase L-PBF process efficiency</td>
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<td>Task 3.2</td>
<td>Increase the productivity of LMD and PMD</td>
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<td>Task 3.3</td>
<td>Demonstrate a possible increase of powder reuse with L-BPF and LMD</td>
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<td>Task 3.4</td>
<td>Energy saving by replacing gas atomized powder by water atomized powder</td>
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<td>Task 3.5</td>
<td>Optimize powder granulometry for L-PBF, LMD and PMD</td>
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<td>Task 3.6</td>
<td>Improve the maturity level of Hard C steels with L-PBF</td>
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<td>Task 3.7</td>
<td>Demonstrate the outcomes of WP3</td>
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AGENDA

1. CONCEPT & METHODOLOGY

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**EXPECTED IMPACTS**

<table>
<thead>
<tr>
<th>Exploitation outcomes</th>
<th>SUPREME 2018-2020</th>
<th>2021 - 2025</th>
<th>Impacted industries and organisms</th>
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<tbody>
<tr>
<td><strong>TRL</strong></td>
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<tr>
<td>Outcome 1: Improved technology on mineral concentration</td>
<td>5 → 7</td>
<td>7 → 9</td>
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<td>Outcome 2: Better powder production processes</td>
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<tr>
<td>Outcome 3.1: Improved metal AM processes</td>
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<td>Outcome 3.2: Improved near-net shape processes</td>
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<td>Outcome 4: Lowered cost produced parts (automotive, medical, aero, moulds, cutting tools)</td>
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<td>Outcome 5: New PM process control tools (sensors and software)</td>
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<td>Outcome 6: New PM eco-innovation tools</td>
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**Outotec**

Industrialisation → Commercialisation & Production

**MBA**

Industrialisation → Commercialisation & Production

**Tecnalia**

Industrialisation → Commercialisation & Production

**PRISMADD**

Industrialisation → Commercialisation & Production

**Iris**

Industrialisation → Commercialisation & Production

**CEA**

Industrialisation → Commercialisation & Production

**MBN**

Industrialisation → Commercialisation & Production

**CEP**

Industrialisation → Commercialisation & Production

**CRF**

Industrialisation → Commercialisation & Production

**FBM**

Industrialisation → Commercialisation & Production

**PRISMADD**

Industrialisation → Commercialisation & Production

**CENTRO RICERCHERI FIAT**

Industrialisation → Commercialisation & Production

**FBM**

Industrialisation → Commercialisation & Production

**CEP**

Industrialisation → Commercialisation & Production

**CRF**

Industrialisation → Commercialisation & Production

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**FBM**

Industrialisation → Commercialisation & Production

**PRISMADD**

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**CENTRO RICERCHERI FIAT**

Industrialisation → Commercialisation & Production

**FBM**

Industrialisation → Commercialisation & Production
THANKS FOR YOUR ATTENTION!

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