SUPREME

NEWSLETTER

April 2019 | Issue Three

Foreword by Coordinator

We arrived at mid-project; it is an opportunity to inform you about the SUPREME activity of the last five months. Two meetings were organized: the T0 + 15 meeting took place by video conference, whereas for the T0 + 18 meeting the partners came together in Brussels at CLORA's premises. During this last meeting, half a day was dedicated to a workshop preparing the future use-cases. A whole day was spent reviewing the work undertaken and results obtained for the last year and a half.

In this third edition of the SUPREME newsletter, we return to the recent promotion of the project: the chosen demonstrators are described in more detail, as well as how they will be monitored to calculate the Key Process Indicators of the grinding, atomising and laser-power-bed-fusion manufacturing processes. We also present some outstanding technical results. And finally, the detailed presentation of the consortium continues with five more partners.

Enjoy your reading!

Dr Thierry Baffie
SUPREME project coordinator

Introduction

SUPREME aims at optimising powder metallurgy processes throughout the value chain. It focuses on a combination of fast growing industrial production routes and advanced ferrous and non-ferrous metals. By offering more integrated, flexible and sustainable processes for powders manufacturing and metallic parts fabrication, SUPREME enables the reduction of the raw material resources (minerals, metal powder, gas and water) losses while improving energy efficiency and thus carbon dioxide emissions, into sustainable processes and towards a circular economy.

To achieve this goal, an ambitious cross sectorial integration and optimisation has been designed between several powder metallurgy processes; gas and water atomisation as well as ball milling for metal powder production, laser based additive manufacturing and near-net shape technologies for end-parts fabrication. A consortium of 17 partners has been gathered on this purpose under the coordination of the Commissariat à L'Energie Atomique et aux Energies Alternatives (CEA), France. The SUPREME Project kicked off on 21 September 2017.

The SUPREME Consortium

The SUPREME Consortium sees a mixture of organisations covering the full value chain from mineral to end parts applications: Atomising Systems Ltd (United Kingdom), CEA (France), Centro Ricerche Fiat (Italy), Dellas Srl (Italy), European Powder Metallurgy Association (Belgium), Fundación IDONIAL (Spain), GKN Sinter metals (Germany), Innovation Plasturgie Composites (France), IRIS (Spain), MBA Incorporado SL (Spain), MBNnanomaterialia (Italy), Outotec (Finland), Prismadd (France), Renishaw (United Kingdom), RHP Technology GmbH (Austria), Tecnalia Research and Innovation (Spain) and TWI Ltd (United Kingdom).

Promotion

EPMA have continued to advertise and promote the SUPREME project at several exhibitions including: Titanium ITU (Seville, Spain, 14-16 May 2018), EuroAM meeting (Lübeck, Germany, 30 May 2018), AMEF 2018 (Brussels, Belgium, 23-24 October 2018), EuroPM 2018 Congress & Exhibition (Bilbao, Spain, 14-18 October 2018), Advanced Engineering UK 2018 (Birmingham, UK, 31 October-1 November 2018), Formnext 2018 (Frankfurt, Germany, 13-16 November 2018), CTI Symposium (Berlin, Germany, 3-6 December 2018), Advanced Engineering Sweden (Gothenburg, Sweden, 27-28 March 2019).

At all these events, informational flyers and/or foamex boards were displayed, and EPMA staff was as well on hand to answer any queries on the Project.

An article describing the project was included in the proceedings of the Euro PM2018 Congress & Exhibition, and a SUPREME poster was presented by Gilles Gaillard (CEA) at the same conference. A talk was given by Sebastian Blümer (GKN) at the mentioned AM European Forum AMEF 2018. An oral presentation was given by Thierry Baffie (CEA) at MATERIAUX 2018 (19-22 November, Strasbourg, France). Four abstracts were submitted to Euro PM2019 Congress & Exhibition (13-16 October 2019, Maastricht, The Netherlands): an abstract relative to the impact of 316L powder granulometry on microstructure and mechanical properties of L-PBF parts, by Thierry Baffie et al. (CEA); one on the effects of performance and quality parameters on LPBF high carbon steel structures made using water atomized powders, by Sebastian Blümer et al. (GKN); another on the development of the L40 tool steel for L-PBF, and the influence of exposure parameters and powder atomization, by Thomas Joffre et al. (CT-IPC); and finally one on the processing of 17-4PH by additive manufacturing using the Plasma Metal Deposition technique by Enrique Ariza et al. (RHP Technology).

EPMA's Andrew Almond at Advanced Engineering exhibition in Gothenburg

Sebastian Blümer (GKN) giving his presentation at the AMEF 2018

The poster about SUPREME at the Euro PM2018 Congress & Exhibition in Bilbao

Supreme Review Meetings

Two project meetings were organised in this period. The first was carried out via conference call on 18 December 2018, and was the T0+15 Executive Board meeting, a meeting of all workpackage leaders that went through all the issues and achievements in the project at that point.

The T0+18 Mid-Term Review Meeting has just taken place in Brussels, hosted by CLORA (19-20 March). After a Tuesday morning dedicated to technical internal workshops where the relevant partners have updated the colleagues on the ongoing work on the various use-cases, the consortium received the visit of the Project Monitor, who joined the rest of meeting for evaluation of the project status. Also the Project Officer met the consortium briefly on Wednesday morning. All Workpackages have been examined and the achievements reported, highlighting the deliverables already completed by the consortium and the milestones reached. Deviations from the initial workplan have been analysed and countermeasures indicated among the upcoming foreseen activity. A lively dinner at a nearby café was a good occasion for newcomers in the project to make acquaintance with the other delegates and for more discussion and networking.

The next T0+21 meeting will be again a conference call meeting and will take place in June 2019, whereas the next physical meeting will be the T0+24 Meeting in September 2019 in the UK.

The consortium delegates at the SUPREME T0+18 Review Meeting at CLORA, Brussels

Demonstrator Update

Demonstrators monitoring and control system design (IRIS)

The demonstration phase running under WP6 under the lead of IRIS is already advancing further the main objective of SUPREME project, to optimize powder metallurgy processes, enabling the reduction of the raw materials resources (minerals, metal powder, gas and water) losses while improving energy efficiency, production rate and CO2 emissions.

Five groups of processes will be the object of this work. The partners owning a demonstrator are OUTOTEC (LKAB Kiruna) , ASL, RENISHAW, GKN and CRF. The five demonstrators have been previously selected by the Consortium to cover the whole value chain for one use-case in automotive: one is at the metal (iron ore) mine site; one at the powder atomisation, two at the Additive Manufacturing level and one on the automotive assembly line (Figure).

During the next month an action plan has been set up in order to deploy the different monitoring systems in each of the demonstrators and start gathering data to make the final sustainability analysis.

Picture of LKAB grinding plant in Sweden

SUPREME results

New hot gas atomizer commissioned in September (ASL)

As one of the demonstrator locations in the SUPREME project, Atomising Systems Limited (ASL) has designed and built a new, improved gas atomiser in its site in Sheffield, UK. Commissioned in September 2019, the SUPREME gas atomiser represents the next step in ASL's hot gas anti-satellite design. A larger furnace, induction heated tundish and improved gas jet design are all aiming to increase the energy efficiency and powder yield, while improvements on ASLs already highly successful anti-satellite design are winning customers over with improved powder shape.

The design of the atomiser was a complex task, as the system had to fit into an already tight space inside existing factory space. In house modelling was done to determine which sections of the atomiser could be shortened and which had to remain as previously designed, drawing on ASL's experience in designing atomisers for other customers.

Initial results from the atomiser have been promising – the additive manufacturing grade powder (+20-53µm) showed an increase in flow from 14 seconds to 12.5 seconds on a Hall flow meter. More work is ongoing to fully compare powder properties, yield and energy efficiency.

Figure 1: the first melt on the system

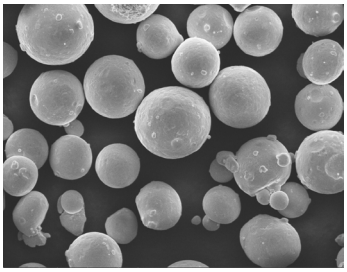


Figure 2: SEM of ASL gas atomised powder

Presentation of 316L optimum granulometry study for L-PBF process (CEA-LITEN)

Laser Powder Bed Fusion (L-PBF) processing of 316L stainless steel powders is now a standard operation and companies specializing in metal additive manufacturing (AM) are able to produce complex and high performance parts. This alloy remains however among the most studied in literature because even if it already offers excellent mechanical properties using this process, it remains to further understand the link between the powders characteristics and the bulk properties.

In SUPREME project, several batches of 316L powders were used to produce samples, including particles characteristics that deviate from those recommended for the L-PBF process. Thus, either gas or water-atomized powders having different particle size distribution (PSD) [see Figure 3] were characterized and consolidated with roller-type and blade-type L-PBF machines under different gas-process (argon or nitrogen). The effects of annealing/quenching on microstructure and mechanical properties (tensile properties, impact toughness and hardness) were investigated and the results were compared to those from the wrought 316L and L-PBF data from the literature in order to refine our understanding of the parameters-properties correlation.

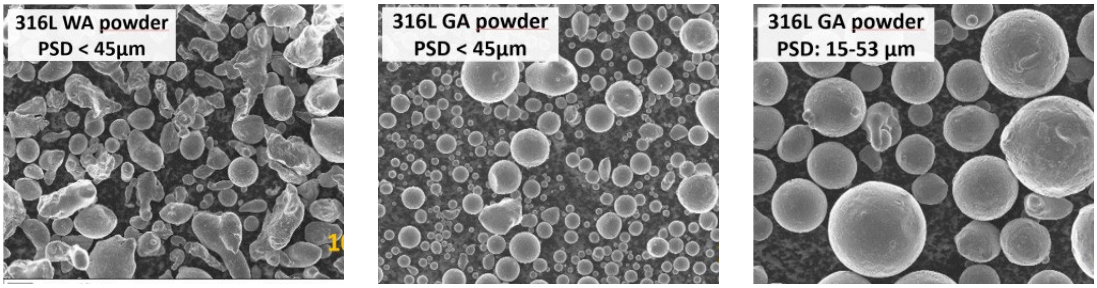


Figure 3 : H2020 SUPREME project – 316L powders for the optimum granulometry study

Presentation of Hard Carbon Steel development for L-PBF (GKN)

Industrial application of Additive Manufacturing Technologies, requires high capabilities regarding process robustness, material properties and part quality within the different areas of application (e.g. industrial, automotive). In H2020 funded SUPREME project GKN focuses on processing low steel alloy powders with a predefined carbon content by using a modified LPBF-process condition and water atomized powders. Two different approaches for process and application development were used to generate a robust LPBF process atmosphere as well as a suitable topology optimized design (figure 4).

The results indicate that a stable process atmosphere for water atomized Hard C Steel alloys on a modified LPBF-system can be achieved. Furthermore, it is part of the study to use the developed process window on a proper use case within the automotive industry. Design studies based on a conventional automotive part, simulations and an extensive topology optimization were performed to generate an optimized part for the LPBF process. A first design draft, which was printed successfully in LPBF-process, showed that 33% of material reduction could be achieved.

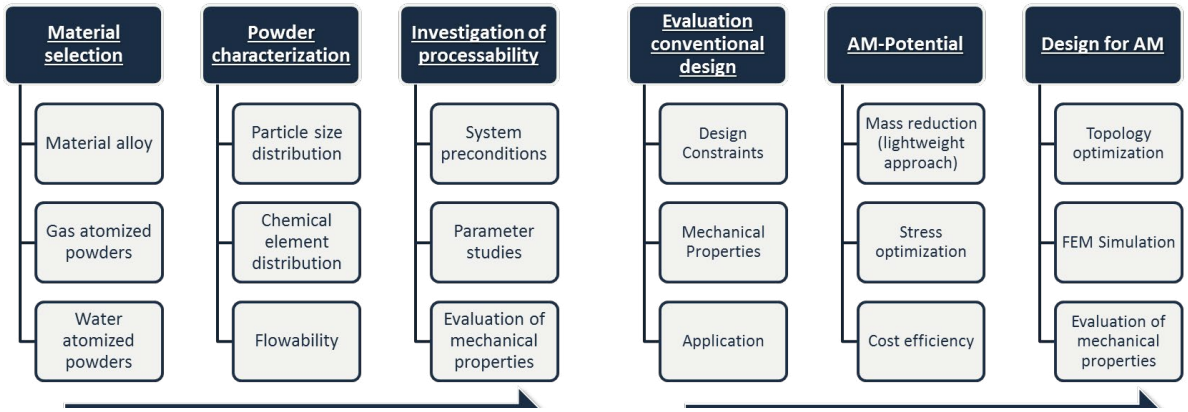


Figure 4: Process and Application development (general approach)

Presentation of PMD process development for 17-4PH steel (RHP)

PMD is a direct energy deposition (DED) method. A plasma jet (pilot) establishes an electrical contact between the electrode and the work piece.

The Main arc is ignited between electrode and work piece. The powder is fed into the melt pool.

Water atomized powder provided by GKN Hoeganaes. The powder is highly irregular, but RHPs PMD-machine is able to feed it into the melt pool. (Figure 6).

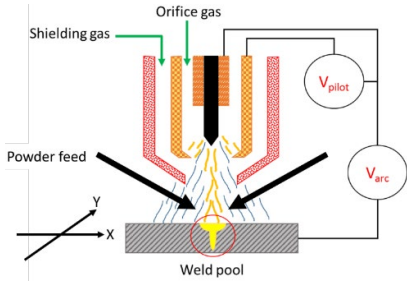


Figure 5: PMD: a direct energy deposition (DED) method.

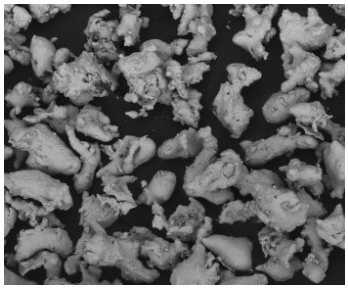


Figure 6: Water atomized powder provided by GKN Hoeganaes

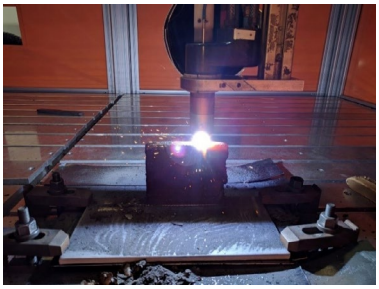


Figure 7: Building process of 17-4 PH in open atmosphere

Figure 7 shows the building process of 17-4 PH in open atmosphere. A deposition efficiency up to 85% was achieved at a rate of 1.4 kg/h and a gas consumption of 18 l/min. To shield the Ar-plasma from the atmosphere a high flow rate is necessary. Within the SUPREME project, a hermetic box was developed to reduce the gas consumption to a minimum level.

From built parts, specimens for analysis were taken. A heat treatment has been applied to compare with as-build conditions and standard. Additionally a heat treatment is often useful to reduce internal stresses that occur due to inhomogeneous heat input while the building process (Figure 8).

Figure 9 shows a cross section (light microscopy) taken from the part above. Almost no porosity is visible. The densification is more than 99%. Since mechanical properties are good compared to ASTM standard for hot rolled plates, there is the opportunity to improve the heat treatment to achieve less hardness.

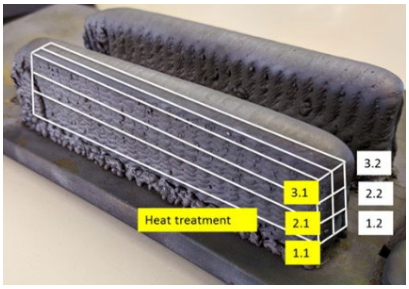


Figure 8: Specimens for analysis

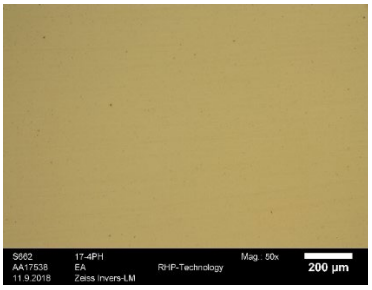


Figure 9: Cross section taken from above

Irregular powder is very suitable for the PMD process. Furthermore the weldability is good and mechanical properties are considerably better than in ATSM specifications. Hardness and elongation should be improved further, e.g. by choosing another heat treatment.

	As build	H1150*	ASTM A693 H1100***
Hardness [HV1]	407	409	305
Densification [%]	99.3	-	-
YS0.2 [Mpa]		>1000**	790
UTS [Mpa]	1122	1115	965
E5 [%]	8	10	10

* H1150: 621°C / 2h / Ar atmosphere
** from tensile tests estimated value
*** min guaranteed values (ASTM A693 hot rolled plates)

Presentation of L-PBF process development for L40 steel (IPC)

Additive manufacturing (AM) is widely used for tooling applications: complex conformal cooling channels are designed to increase and homogenize the cooling rate of a mold insert. The list of available steel grades in laser powder bed fusion is currently very limited and do not satisfy highly mechanically demanding applications: hard metals printable without cracking are lacking.

In the SUPREME project, the exposure parameters of a new tooling steel tailored for AM (L40), have been developed and optimized on an EOS M290 printer based on in situ melt pool monitoring systems and microstructural observations. Several batches of either gas or water atomized powders have been processed and studied. The aim of using water atomized powder is to reduce both the environmental footprint and the cost of the feed material. Dense built parts (over 99% density) were achieved using water and gas atomized powders.

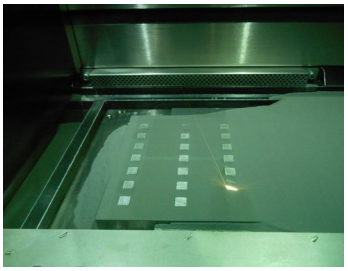


Figure 11: L40 manufacturing during powder removing

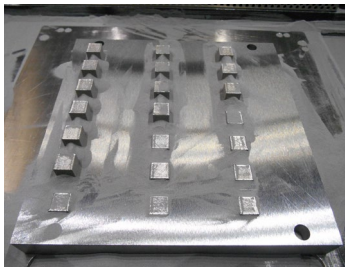


Figure 10: L40 manufacturing during L-PBF process

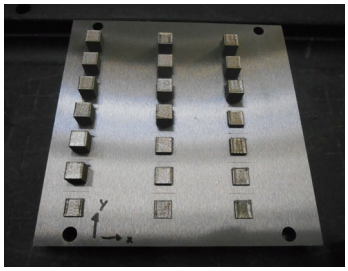


Figure 12: L40 manufacturing after powder removing

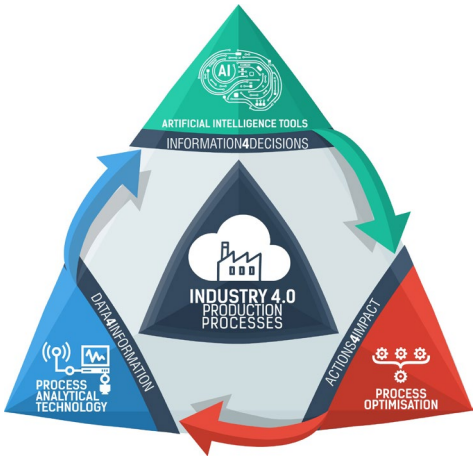
Meet the partners

IRIS

IRIS is an advanced engineering company that specialises in process monitoring, control and optimisation. It develops and integrate turnkey advanced solutions based on: NIR chemical monitoring (patent-pending novel handheld device and in-line solutions); hyperspectral imaging solutions for foreign body detection and chemical composition analysis; data management and embedded Artificial Intelligence solutions, e.g. data mining (including of big production data) to develop predictive models for decision support and to automatize process optimisation. As an enabler for our monitoring solutions, as well as for wider digital transformation in industry, we develop and deploy Industrial SMAC (Social, Mobile, Analytics and Cloud) solutions and IT platforms for numerous industry applications.

In the frame of the Factories of the Future and Sustainable Process Industry, IRIS is working with manufacturers, OEMs and solution providers for industry to transition their product models to the Industry4.0 paradigm, whereby real-time access to data about critical process parameters and product quality attributes can contribute to improved quality and process efficiencies. IRIS' vision for Industry4.0 centres on the conversion of data into business value, and involves:

- Effectively collecting huge volumes of reliable and informative data -not only about the process conditions but also about what is really taking place within the process-, whereby, IRIS specialises in advanced monitoring systems (as opposed to traditional control systems) that e.g. provide compositional information in real time.
- Unveiling relevant information from the data, by supporting the involved ICT tools with Science-based resources, in order to build cognitive-biases-free decision support systems.



IRIS provides a balanced combination of state-of-the-art online analysers and the engineering services for rationally integrating them in between the production line and the factory information system. IRIS also provides digitisation solutions for supporting the use of novel processing and circular economy shift in the industry of the future.

The company was established in 2007 and currently employs 60+ staff with a turnover of > €5 million. We are based over two sites (Barcelona and Dublin) and are fully equipped with engineering and production workshops, wet chemistry and analytical laboratory, optics labs (2), and an electronics/telecommunications lab. IRIS has a multidisciplinary knowledge engineering and science team (including 12 PhD holders and 27 engineers in the fields of electronic, mechatronic, mechanical, industrial design, system engineering, application programming and web development, SMAC technologies, material, environment & food science, chemistry and physics) that can support not only the development of customised solutions but also their optimal validation thanks to a differential scientific and technical breakthrough approach and a deep application understanding.

For more information visit www.iristechnologygroup.com

RHP

The company RHP-Technology GmbH was previously a part of the Department of Advanced Materials and Aerospace Technology of the Austrian Institute of Technology GmbH (AIT). The company started in October 2010 with a main focus on material and technology development including the manufacturing of prototypes and small series production. At the start of the company there were four employees. Meanwhile RHP has more than 40 employees and recently another company, AT Space GmbH was established exploiting the technology developed at RHP for space applications. The team of RHP-Technology GmbH has a long experience in the field of powder technological processing. The former powder technology group of the AIT has been working for more than 15 years in the development of new and advanced materials by using different technologies such as pressing/sintering, gas pressure sintering/infiltration, hot pressing or powder injection moulding. In the past years, several technologies for additive manufacturing of metallic and ceramic parts were installed. RHP-Technology GmbH is a solution provider for powder technology, customized materials and advanced processing techniques. Products and applications include sputtering targets for thin film industry, high thermal conductive heat sink for thermal management applications, customized ceramics and metals for various industries such as space, automotive, industrial as well as jewellery and luxury products ('tiger metals').

CEA-LITEN

CEA-LITEN (Laboratory for Innovation in New Energy Technologies and Nanomaterials) institute is part of CEA, the French Alternative Energies and Atomic Energy Commission, a public body established in October 1945. CEA-LITEN is a major European Research and Technology Organisation (RTO) and a driving force behind the development of the sustainable energy technologies. It maintains a cross-disciplinary culture of engineers and researchers, building on the synergies between fundamental and technological research.

Within LITEN, four laboratories, about 15-20 persons each, have activities related to Powder Metallurgy (PM), through coating, Near Net Shape Manufacturing (NNSM) or Additive Manufacturing (AM) processes. These labs are technology providers and developers; they address process control (microstructure, geometry), topological optimization (weight reduction, heat exchanger, mechanical resistance), multi-functional materials development (components), reduction of environmental footprint (rare or critical materials) and customized parts. The processes addressed in SUPREME project are Laser Powder Bed Fusion (L-PBF) and Metal Injection Moulding (MIM).

R&D ranges from powder development to complex multi-material components, passing by Environment, Health & Safety (EHS) or powders recycling. Production processes of powders and feedstocks aim to optimize the microstructures and properties of final components and create properties beyond the state of the art. The developed components include tiny components with complex shapes, lightweight hollow structures, high-performance magnets, multi-material assemblies as well as energy-recuperation-devices.

The 1400 m^2 powder metallurgy platform POUDR'INNOV represents a €12 million investment, supported by the Auvergne-Rhône-Alpes region, Europe and CEA. It develops high-added value parts and components from metal, ceramic, polymer, semi-conductive and magnetic powders. It includes a complete range of laboratories, semi-industrial and industrial equipment and is capable of completing the entire component production process under one roof, from formulating and blending powders to injection molding, debinding and sintering, and characterization. The platform leverages several decades of powder metallurgy research conducted by CEA and files around twenty patent applications every year. R&D at the platform is currently at the international state of the art.

CEA-LITEN industrial customers are either large groups or SMEs, having applications either in high volume or niche markets.

For more information visit: www.liten.cea.fr

IPC

IPC is an Industrial Technical Centre, IPC, is established on seven locations, whose expertise is dedicated to innovation in plastics and composites in France. IPC is supported by the Federation of Plastics and Composites and its Professional Organizations (partnerships with all technical and scientific stakeholders, competitiveness clusters, universities and engineering schools) to a contribution established to finance R&D, innovation, technology transfer and skills.

Our goal is to improve the competitiveness of our national industry through innovation and the supply of technological means: services for companies/private R&D.

We manage a lot of skills around plastics and composites:

- Material choice, concept studies and lab analysis (formulation and compounding, recycling material, characterization of materials)
- Design and 3D finalization (optimization & mechanical engineering, high value added rheology)
- Full development of manufacturing tool/process (injection moulding, vacuum forming, resin transfer moulding, composites, machining, 3D printing …)
- Training to reinforce performance and invest in the future
- Monitor the environment to develop markets and be more competitive together

New name for PRODINTEC

From 1st January 2019, as a result of the merger between ITMA and PRODINTEC Technology Centers, the new corporate name of the company is Fundación IDONIAL.

For further information on the SUPREME project please contact Sabine Hazoumé at EPMA on **sh@epma.com** or the project leader Dr Thierry Baffie at CEA at **thierry.baffie@cea.fr** or visit the website at **www.supreme-project.com**

This project has received funding from the European Union Horizon 2020 Programme (H2020) under grant agreement no. 78612