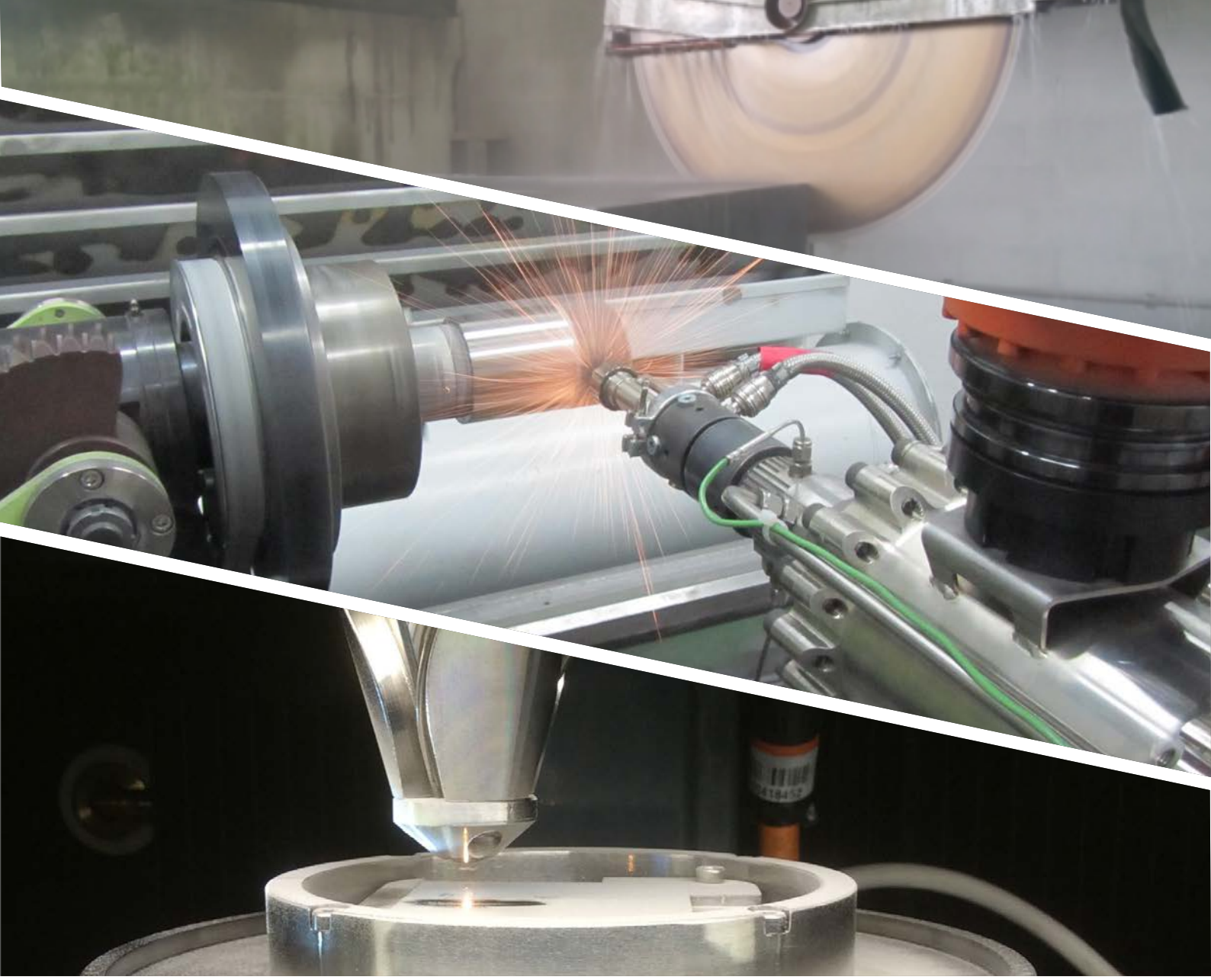


PILOTMANU

Pilot manufacturing line for production of highly innovative materials

European collaboration to reduce barriers to market for highly innovative materials by piloting commercial applications

Introduction

Europe identified within its innovation priorities the necessity to scale up the most promising material production technology to pilot production level in order to progress towards industrial manufacturing using cutting edge materials in novel new processes.

Manufacturing facilities for the production of advance and nano structured materials by high energy ball milling (HEBM) suffers from low productivity and high cost which is a key barrier for its application in the wider commercial market sectors.

PilotManu addressed this manufacturing gap by scaling up and building a new pilot production line for the production of nanostructured and advance materials, based on the consortium's IPR and expertise.

PilotManu cuts across many technology areas including Nanotechnology Advanced Manufacturing Systems and Advanced Materials and has helped to transform the European manufacturing sector.

The Opportunity

PilotManu demonstrated the beneficial use of novel nanostructured materials to create new business opportunities for the consortium's small and medium enterprises (SMEs) which represents the entire supply chain in bringing new products and technologies to market.

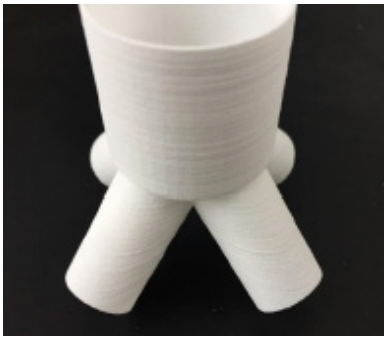
The business opportunities encompassed the production of pilot volumes of cost-effective nanostructured materials used in three product lines: coatings obtained by thermal spraying, polymer and metal composites for rapid prototyping and additive micro manufacturing components, and abrasive tools by sintering.

The new pilot plant developed by PilotManu enabled increased productivity while lowering production costs which was key to allow the adoption of these materials into new innovative applications.

The Product Lines

The benefits of the advanced powders developed by PilotManu are demonstrated in the three product lines; Sintering, Spraying and Additive Manufacturing applications.

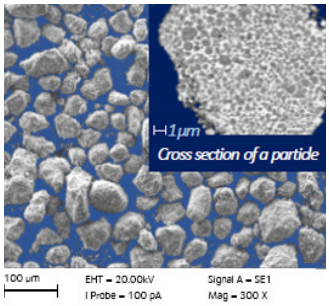
Sintering for Abrasive Tools	Coating by Thermal Spaying	Additive Manufacturing
Free Sintering	Cold Gas Spraying (CGS)	Direct Metal Laser Sintering (DLS)
Spark Plasma Sintering (SPS)	High Velocity Air Fuel (HVAF)	Selective Laser Sintering (SLS)



The Pilot Line

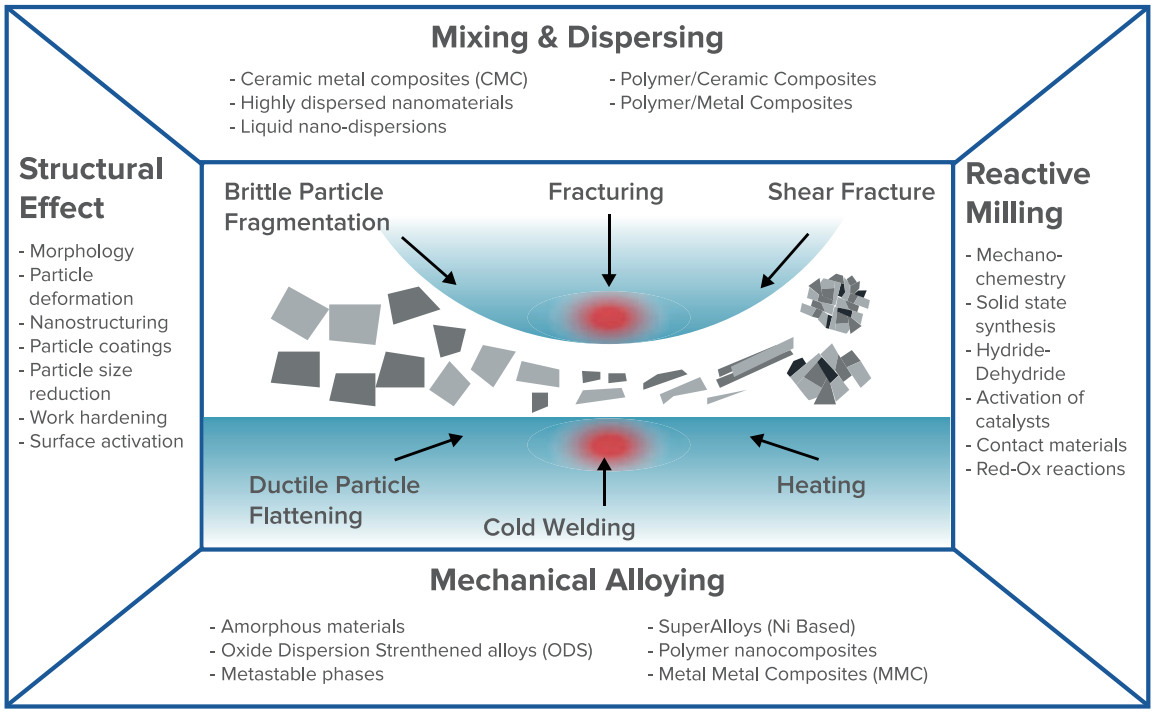
PilotManu produced nanostructured powders based on the HEBM technology. The lead partner MBN has developed proprietary knowledge over the years based on a laboratory scale facility. This facility has now been optimised by a new design and scaled-up to enable pilot scale volume production with fine and homogeneous chemical distribution of elements and “ultrafine” crystalline structure.

The nanoscale features of these powders allow significant improvement of material performance such as physical-chemical-mechanical properties compared against bulk scale materials. The new improved pilot line reduces the power consumption by 50% and scales up the production process by a factor of ten up to 100 tons/year per plant.



The Nanostructured Powder

The nanostructured powders enable new properties to be harnessed in a variety of applications compared to larger micron scale similar composition powders allowing the supply of more affordable material for industry consumption. This has enabled the production of a wide range of novel systems from polymer nanocomposites, to ceramic metal composites and nanostructured metal alloys.



The HEBM Process

The PilotManu Consortium

1. **MBN Nanomaterialia – Italy**
   Lead Coordinator and Pilot Plant Developer
2. **Centre for Process Innovation – UK**
   Market analysis and evaluation
3. **Diam Edil SA – Switzerland**
   Validate nanostructured materials for Sintering
4. **IMPACT INNOVATIONS GmbH – Germany**
   Validate nanostructured materials for CGS
5. **INOP – Poland**
   Validate nanostructured materials for SPS
6. **Matres – Italy**
   Technical coordinator
7. **+90 – Turkey**
   Evaluate nanostructured materials for SLS
8. **Manudirect Srl – Italy**
   Adapt nanostructured materials for DLS machines
9. **Putzier – Germany**
   Validate nanostructured materials for HVAF
10. **IMDEA Materials Institute – Spain**
    Develop nanostructured materials via Hot Pressing

Technology Applications

Sintering for Abrasive Tools

Free Sintering

Diam-Edil has developed hot pressing and free sintering processes for diamond cutting applications. Diam-Edil targeted two key market applications to test and validate the advance material combinations:

- Diamond cutting sectors for disc
- Diamond bead for wires

Key Innovative Features

- Improved cutting performance and tool life
- The development of these new materials with nanostructured multi-phases allow the reduction of manufacturing steps into a single process step due to the self- brazing behaviour of the material and consequent reducing the overall cost

Spark Plasma Sintering – (SPS)

INOP has developed Spark Plasma Sintering (SPS) of diamond composites for Tungsten Carbide plate cutting. INOP targeted two key market applications to test and validate the advance material combinations:

- Copper-based welding electrodes
- High temperature bearings

Key Innovative Features

The key advantage of the Copper-based welding tips is their high durability.

- High electrical conductivity compared to that of pure Cu
- High mechanical properties
- High resistance to recrystallization due to decoration of grain boundaries with Al2O3 nanoparticles

The key advantage of the High temperature bearings is their high durability.

- Low friction coefficient at the high (> 600 °C) temperatures
- High wear resistance at the high (>600 °C) temperatures
- Weight reduction of components is very important for the aircraft industry

Coatings by Thermal Spaying

Cold Gas Spraying – (CGS)

IMPACT INNOVATIONS GmbH has developed Cold Gas Spraying (CGS) equipment targeting three key wear resistant market applications, to evaluate and validate the machine and nanostructured powder combinations:

- Rolls (e.g. support rolls, driving rolls, printing rolls, guide rolls)
- Oil & Gas/Heavy Industry Parts (e.g. pumps, pistons, rings, shafts)
- Automotive Cylinder Blocks

Key Innovative Features

- Improved cutting performance and tool life
- High thickness wear resistant coatings
- Light weight hard coatings
- Better surface aspect after laser heat treatment - possibility of deposition also in sensitive substrate due to low thermal impact of CGS technique
- No temperature effect to the substrate compared to other thermal spray coatings
- Increase of the life of the components with subsequent lower cost for maintenance
- Expected lower component consumption

High Velocity Air Fuel – (HVAF)

Putzier developed a high velocity air fuel (HVAF) spraying process to build up dense and very hard coatings for improved erosion and abrasion resistance. Putzier targeted two key market applications to test and validate the advance material combinations:

- Blades for distributing fertilizers
- Rods for hydraulic cylinders in marine environments

Key Innovative Features

- High hardness
- High erosion resistance
- Very low porosity

Additive Manufacturing

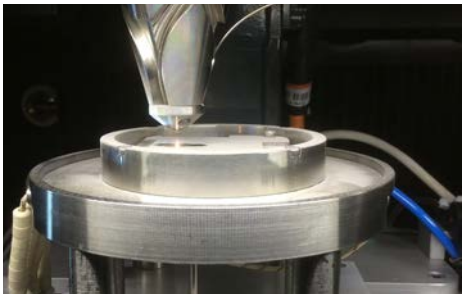
Direct Metal Laser Sintering – (DLS)

Manudirect developed its direct metal laser machine that applies metallic coatings to parts and components with precision and defined material properties. Manudirect targeted three key market applications to test and validate the advance material combinations:

- Tools for reverse drawing of metal sheet in the auto market
- 3D Saw teeth
- 3D Micro-fluidics injection moulding

Key Innovative Features

- Increased range of advance materials which can be processed by the machine



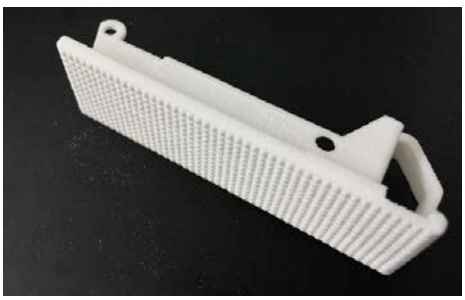
Selective Laser Sintering – (SLS)

+90 developed selective laser sintering (SLS) processing to use powder based PP-like raw material to accelerate the development and potential use in 3D printing. +90 targeted two key market applications to test and validate the advance material combinations:

- Vacuum casting equipment
- Cap part for automotive

Key Innovative Features

- PP material helps manufacture flexible and customised prototypes with higher strength.
- PP like materials cost less compared to PA12
- First manufacturer to use PP material to produce components by SLS technology



info@pilotmanu.eu
www.pilotmanu.eu

PilotManu is funded by the EU FP7 programme
for research, technological development and
demonstration under grant agreement no 604344