



*A purification/regeneration
process of spent plating baths based on
functionalized magnetic nanoparticles*

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The PureNano project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No. 821431



3 Years



12 Partners



6 Countries



4,2M Budget

300.000 TONS/YR OF HAZARDOUS WASTE IS PRODUCED
BY SURFACE FINISHING IN PLATING INDUSTRY

EUROPE GOES PURE_{ly}

PURENANO aims to develop a purification process of plating baths from contaminants & undesirable chemical species hindering the operation of the bath using functionalized magnetic nanoparticles MNPs.



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The concept and the content



Why we need PureNano?

Surface finishing treatment bears a significant process applied in many industrial sectors with the view to extend the life of metallic components providing surface properties and functionalities via the application of coatings using electro and electroless plating baths.

However, this continuous replenishment of chemical compounds leads to accumulation of by-products and decomposition product that burden the bath from its proper operation.

Every year a total amount of **300.000 tons** of hazardous waste is produced (an average of 16 tons per installation).

How PureNano works?

PureNano proposes an **innovative**, low cost, **sustainable method** for purification of plating baths which will lead to a significant extension of their life having, as a result, the **decrease of operation expenditures** of plating shops, the **decrease of environmental risks** from the transportation of spent baths and the increase of process efficiency and products quality.

It is based on the timely treatment of plating baths with **functionalized magnetic nanoparticles (MNPs)**, that can absorb in their surface the contaminants and chemical species that are accumulated.



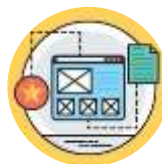
PRODUCTION OF HYBRID MNPs

By one-step precipitation process appropriate surface functionalization.



DEVELOP A PURIFICATION METHOD

By designing a separation for the MNPs that will be integrated in the plating bath lines.



SET UP A DEMONSTRATOR

By designing the PureNano process in an electroless and electrolytic lines.



IPR PROTECTION

By organizing an IPR strategy describing the IPR handling procedures.



MARKET IDENTIFICATION

By identifying the most promising exploitable results

PureNano Concept

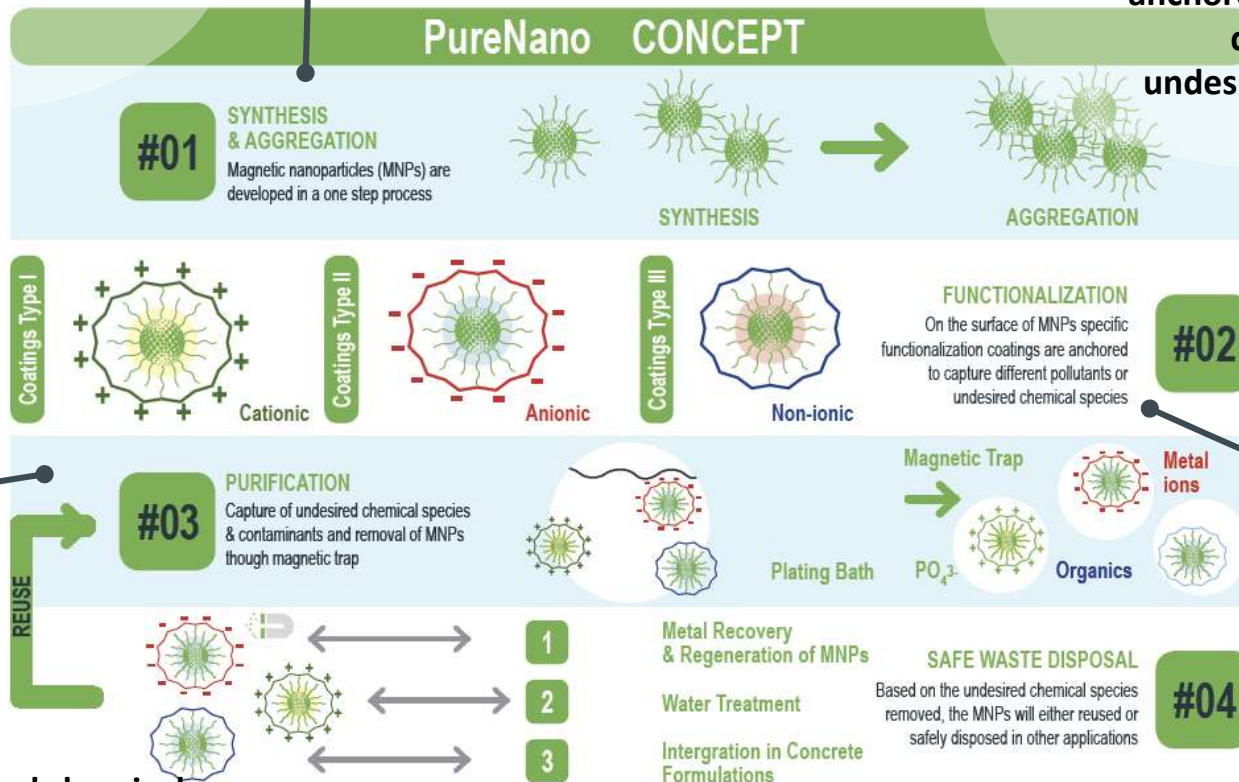


SYNTHESIS & AGGREGATION

Magnetic nanoparticles (MNPs) are developed in a one step process.

FUNCTIONALIZATION

On the surface of MNPs specific functionalization coatings are anchored in order to capture different pollutants or undesired chemical species.



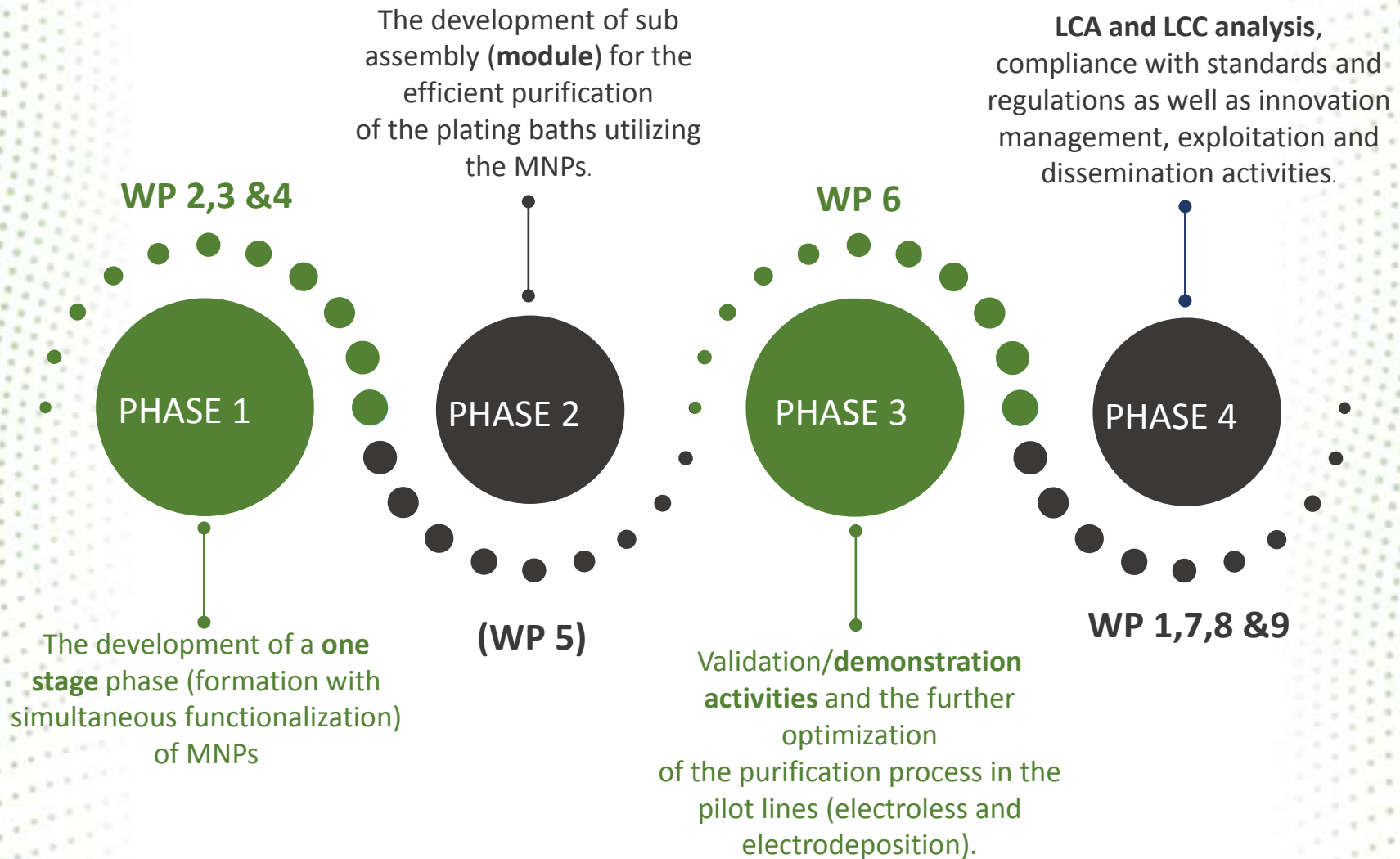
PURIFICATION

Capture of undesired chemical species & contaminants and removal of MNPs through magnetic trap.

SAFE WASTE DISPOSAL

Based on the undesired chemical species removed the MNPs will either be reused or safely disposed of in other applications.





Project Start

Project End



PHASE #1



Development of a **one-stage phase** (a formation with simultaneous functionalization) of MNPs that will provide **low-cost** materials. The PureNano project aims to deliver appropriate **MNPs or MNP aggregates** of adequate specific surface area and proper functionalization targeting the capturing of **specific contaminants** based on the type of the bath.

PHASE #2



Development of sub-assembly (module) for the efficient purification of the plating baths utilizing the MNPs. The **model** of formulated magnetic NPs will be used as a base for optimizing time, efficiency, and cost of the process. This information will set the basis for the development of the **engineering documentation** (conceptual, basic, detailed engineering) as well as the further construction of the module and its integration with the separation of magnetic particles system.

PHASE #3



Demonstrate the **upscaling feasibility** of the production process and the purification system in the real condition in **electroless and electrolytic baths**. The developed systems will be integrated to validate and further optimize the purification process of different electroless and electrolytic formulations.

PHASE #4



This phase will run in parallel to the other three phases and will cover all aspects related to the fast adoption of PureNano results from the market. These concerns **LCA and LCC analysis**, compliance with standards and regulations as well as innovation management, **exploitation** and **dissemination** activities.

WP₁

Management & Coordination

Generation of
Specifications &
Requirements

WP₂

WP₃

Magnetic NPs
development

WP₄

Functionalization of
MNPs

Integration of
purification system
and safe disposal of
MNPs

WP₅

Demonstration
activities

WP₆

Industrial
implementation
issues

WP₇

WP₁₀

Ethics
requirements

LCA/LCC

WP₈

Dissemination &
Exploitation

WP₉

1

Synthesis of Magnetic NPs

Development of MNPs with anchor functionalization by chemical precipitation in a controlled chemical and hydro-dynamical environment. A reactor with adequate mixing nozzle and pumping system can be used to achieve mixing of the precursor solutions providing control on the size and shape of the NPs as well as of their dispersion and the final functionalization.

Functionalization of nanoparticles

Development of surface modification of NPs. The PureNano solution is based on two characteristics of the MNPs, amphiphilic character and extremely high surface area. These make the particles usable for the capture, removal and recovery of contaminants from electrolytes in a single step. Surface modification of MNPs with a suitable stabilizer allows to disperse them conveniently in aqueous solution.

2

3

Design, development and optimization of a purification process

Recycling & Purification process and multiscale modelling.

The functionalized MNPs will be utilized to remove contaminants from plating baths. The process will take place in situ and will consist of two steps. The first step concerns the treatment of the bath with the suitable functionalized MNPs in the plating tank and second the removal/separation of the particles from the plating solution.

Safe disposal of MNPs

Recovery of metals and MNPs reuse

The recovery of metals such as Au, Pt, Ni, Cu, directly from the MNPs can be achieved through electrolytic processes.

Water purification

MNPs can be a cheap and easy solution for non-potable water decontamination by removing heavy metals

Integration in concrete formulations

The addition of used MNPs to self-compacting concrete can lead to enhancement of its compressive strength.

4

The consortium

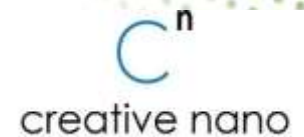


PureNano Partners

PureNano project involves **partners from different domain** (7 industrial partners-SMEs, 4 RTDs, 1 Association) expertise that work together building on their complementarity covering all the necessary competences to implement the overall approach.



POLITECNICO
DI MILANO

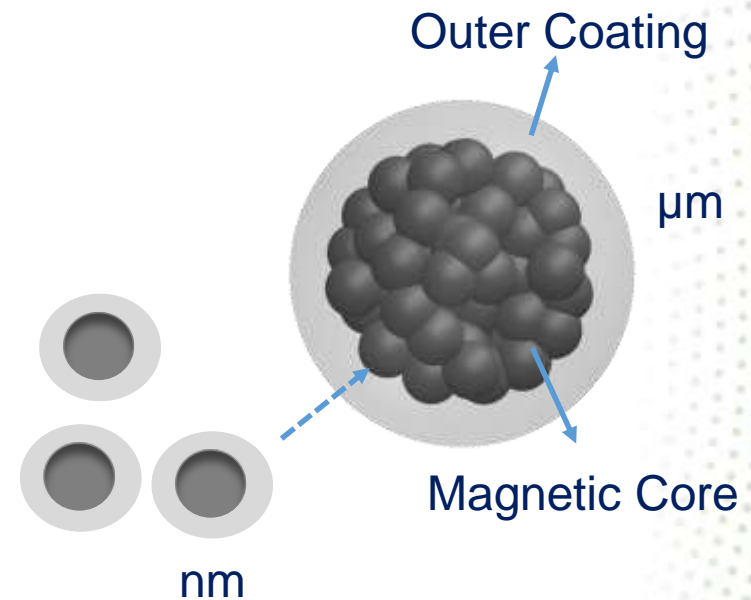


National
Technical
University of
Athens



Pilot Lines





Production Capacity

5 Kg/day

- Pre-treatment tank: alkaline degreasing & U/S
 - Rinsing Tank: clean, tap water (x3)
- Pre-treatment tank: Anodic electro-cleaning
 - Rinsing Tank: clean, tap water (x3)
- Pre-treatment tank: Pickling in acidic solution
 - Rinsing Tank: clean, tap water (x3)
 - Pretreatment Tank: Nickel strike plating
 - Main plating composite Tank I
 - Main plating composite Tank II
- Rinsing Tank: clean, deionized water & U/S
 - Rinsing Tank: clean, deionized water
- Rinsing Tank: clean, deionized warm water
- PILOT SCALE Synthesis and formulation of nano-enabled products





- Use MNPs to remove from the bath:
 - Orthophosphates
 - Chelates
- Install magnetic separation sub-assembly to one of GASER's lines (800L & 10000L for electroless Ni-P)
- Treat stored baths with known concentration of contaminants
- Evaluate deposition rate of recovered baths & quality/mechanical properties of produced coatings

Electroless Nickel



Anodization of aluminum



Zinc plating



Dissemination



Dissemination Material



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