MOZART

METAL MATRIX NANO-COMPOSITE COATINGS UTILIZATION AS ALTERNATIVE TO HARD CHROMIUM

3rd ISSUE
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CONTENTS

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1. MOZART project in detail

In this 3rd issue of the MOZART project newsletter, you will find valuable insights into the project's multidisciplinary approach and the innovative techniques utilised to produce the next generation of nanocoatings.
Let's discover the primary areas of focus and their respective roles in the project and delve into the methodology used by the MOZART consortium to produce these innovative nanocoatings.

MOZART Multidisciplinary approach

Replacing hard chromium coatings is not an easy task, especially when you need to coordinate excellent physical and chemical properties, durability, nanotechnology, and sustainability of the process and the new alternative coatings. Thus, developing a quality product with the potential to be accepted by the industry requires a combination of knowledge and expertise from different technical and scientific fields.

Furthermore, the primary focus of the MOZART project revolves around electrodeposition, an inherently multidisciplinary field, particularly when intersecting with nanotechnology. To effectively harness the diverse expertise required to achieve the project's goals, a broad spectrum of specialists from diverse disciplines are brought together to collaborate. Here's a glimpse into the primary disciplines and their roles within the project.

CHEMISTRY
Formulating baths, assessing the compatibility of chemical compounds, and functionalizing nanoparticles (NPs).

PHYSICS
The utilization of ultrasonication to de-agglomerate NPs and the assessment of hydrodynamic conditions in fluids.

MATERIALS SCIENCE
Comprehending the mechanisms of hardening in composite materials based on their structure and composition, evaluating the properties of materials, and establishing correlations between them.

ARTIFICIAL INTELLIGENCE (AI), MODELLING & SIMULATION
Formulating baths, assessing the compatibility of chemical compounds, and functionalizing nanoparticles (NPs).

ENGINEERING
Designing and modifying plating lines and executing electroplating.

TOXICOLOGY
Toxicity screening utilizing in vitro cell-line models and a mini-release accelerator device.

1. MOZART project in detail

Untangling MOZART methodology

The MOZART methodology aims to employ a Safe and Sustainable by Design (SSbD) approach for providing protective coatings that can replace hard chromium in diverse applications. It encompasses various techniques such as electrodeposition, functionalisation of nanoparticles, and optimisation of the electroplating process.

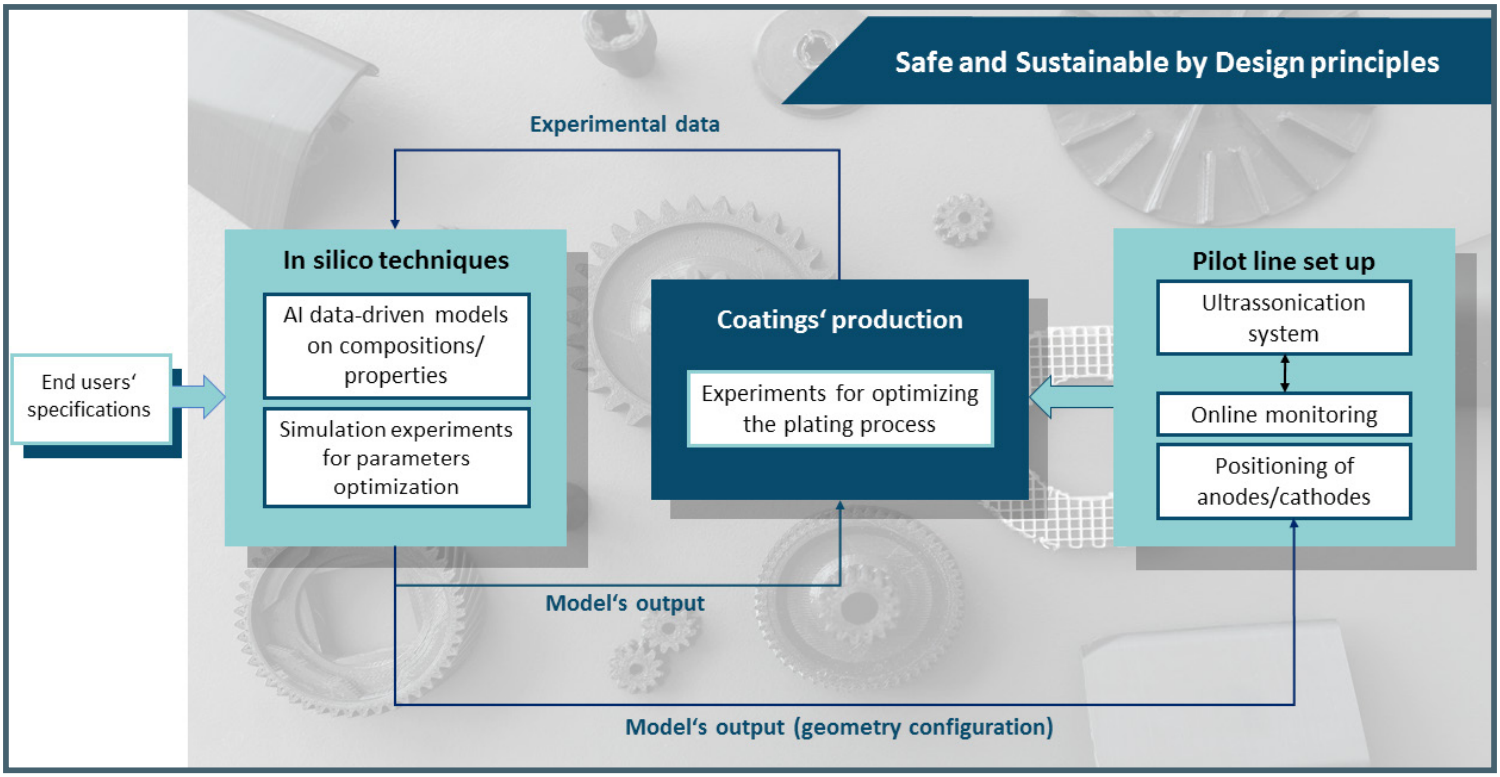
The structure is comprised of the following steps:

STEPS	DESCRIPTION
1	The process commences with an analysis of end-user specifications (including desired values and targets) that are then utilised as input for computer experimentation using in-silico techniques.
2	The in-silico techniques leverage end users' data in two ways: a) **MODELS:** Through the development of hybrid data-driven models using Artificial Intelligence (AI) to predict the correlation between electrolyte composition and coating properties. b) **SIMULATIONS:** By simulating the plating process to generate output for the plating parameters.
3	Both models and simulations are fed with actual experimental data from the technical partners responsible for producing the coatings.
4	Ultimately, by leveraging the SSbD approach in conjunction with the simulation output, the pilot line will be established and adapted to achieve a high level of monodispersed composite electrolytes, and a uniform current density distribution across the surface of objects to be coated, even those with complex geometries.

1. MOZART project in detail

In summary, the MOZART methodology seeks to acquire the essential knowledge, models, and simulations, as well as infrastructure to:

- Deliver coatings with optimal structure and outstanding mechanical and physicochemical properties.
- Promote the use of safe and sustainable processes and novel materials.



Read the full article about SSbD

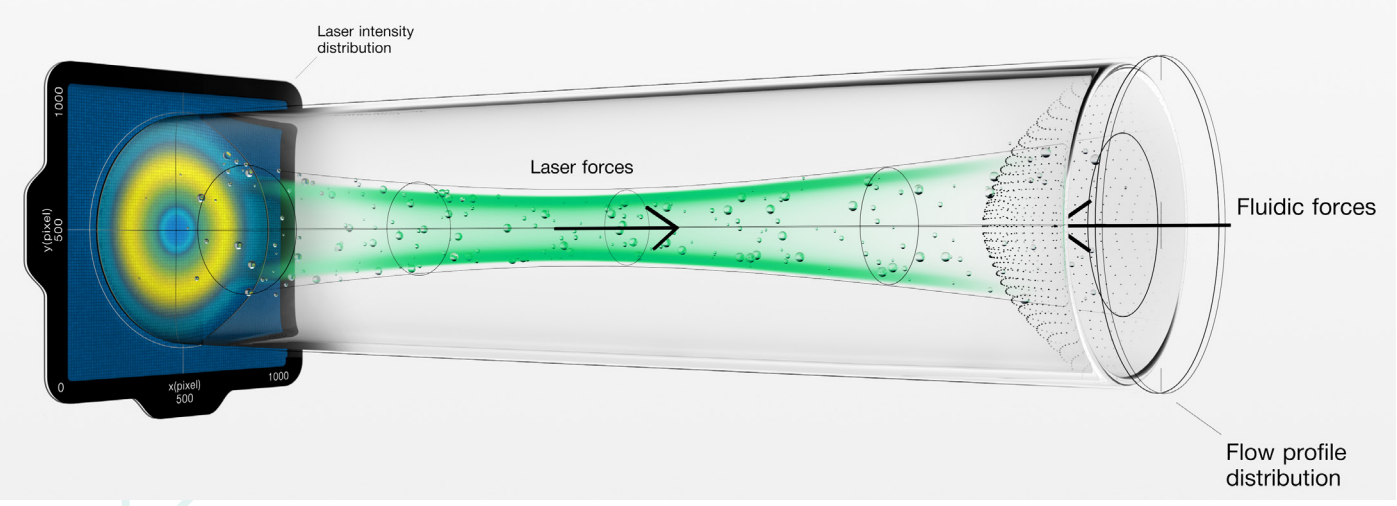
2. Nano-characterisation: Unveiling the mysteries of small-scale science

Nanoparticles are tiny particles that have at least one dimension between 1 and 100 nanometers. Due to their unique size and properties, they have numerous applications in fields such as medicine, electronics, and energy. Particularly, they are widely used in coating applications due to their unique properties, such as high surface area and reactivity.

To ensure the quality and performance of the coatings, it is essential to characterize the nanoparticles before and after the coating process. Characterization methods can provide information on the size, shape, distribution, and surface chemistry of the nanoparticles. This information is crucial for controlling the coating properties, such as adhesion, wetting, and durability. Additionally, understanding the behaviour of nanoparticles in the coating formulation can help optimize the coating process and prevent issues such as settling or agglomeration. Therefore, nanoparticle characterization plays a critical role in the development and optimization of coatings for various applications.

One way of characterising nanoparticles is through the OptoFluidic Force Induction (OF2i). OF2i is a technique that uses both light and liquid forces to manipulate nanoscale objects. It is an extension of the "optical tweezers" principle, pioneered by Physics Nobel-prize winner Arthur Ashkin, where a laser beam traps particles. OF2i focuses a laser through a liquid sample, which pushes the particles forward and allows them to move along their spiral trajectories, minimizing interparticle collisions. This movement is recorded by a microscope, and the velocity change correlates with particle size.

OF2i was originally developed as a process analytical technology (PAT) method for continuous production monitoring of pharmaceuticals. By observing and adjusting the size of particles in pharmaceutical nanoemulsions and nanosuspensions directly during production, it can prevent failed batches and save costs. However, as the development continued, the MOZART partner **BRAVE Analytics** sees OF2i's potential to be useful for in-process quality control, predictive maintenance, and monitoring in a variety of fields such as biotech, biopharma, nanomedicine, nanoplastics, and polymers.



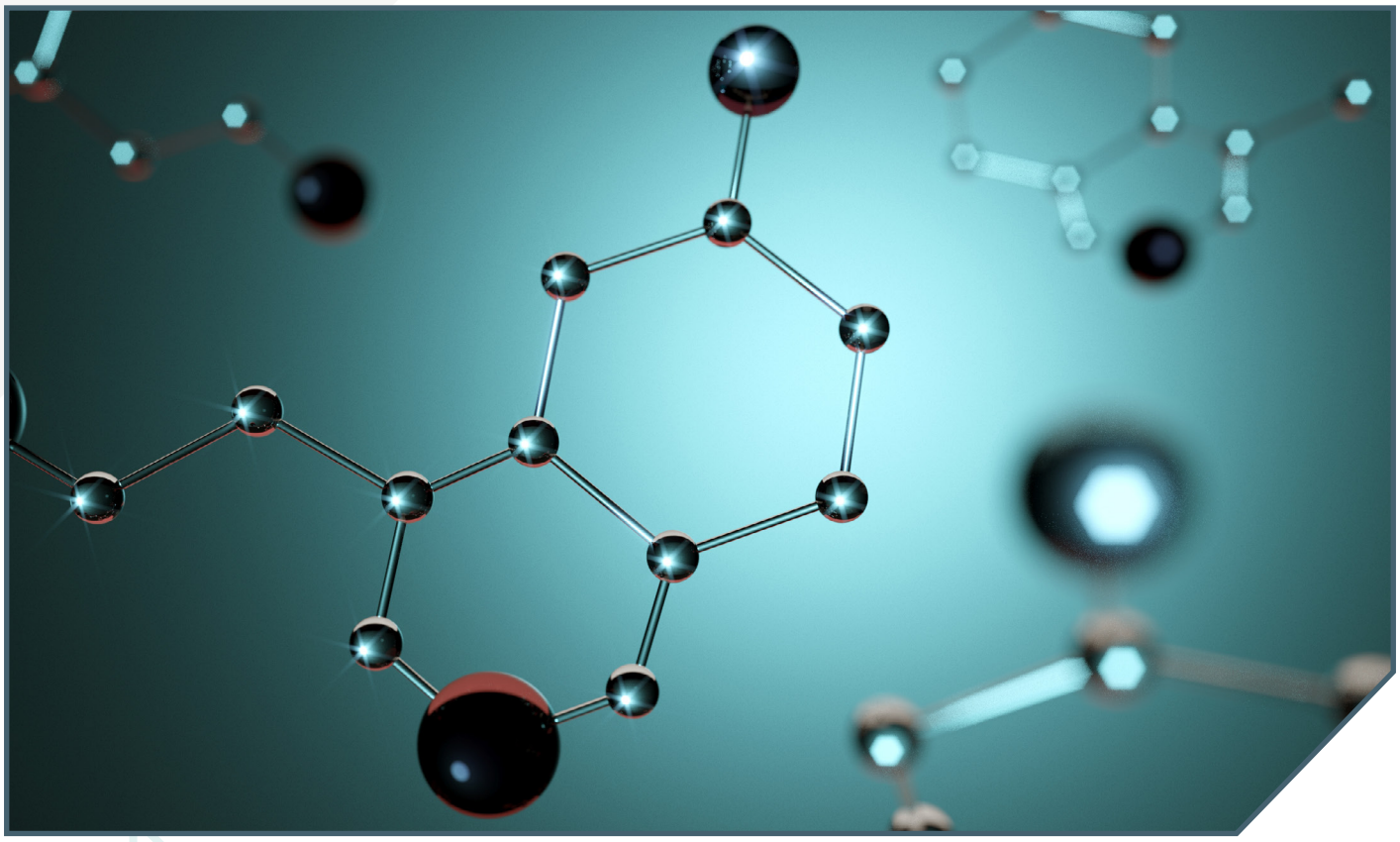
This text was based on the article written by BRAVE Analytics for the MOZART project.

2. Nano-characterisation: Unveiling the mysteries of small-scale science

BRAVE has developed a BRAVE PAT sensor with "OF2i inside" which will be used in the MOZART project to monitor the electrodeposition of nanocomposite pulse plating coatings. Integrated into the process, the sensor will continuously measure the properties of particle ensembles at a high rate of up to 4000 particles per minute. It will track how the particles behave during the process while monitoring their conditions and environment, providing feedback to adjust operational parameters if needed.

BRAVE will bring significant benefit to the development of the nanoparticles as it will make possible the characterization of their status in the plating tanks during the plating procedure, allowing timely interventions in the process.

To know more about the BRAVE new way in online particle characterization, just click here.



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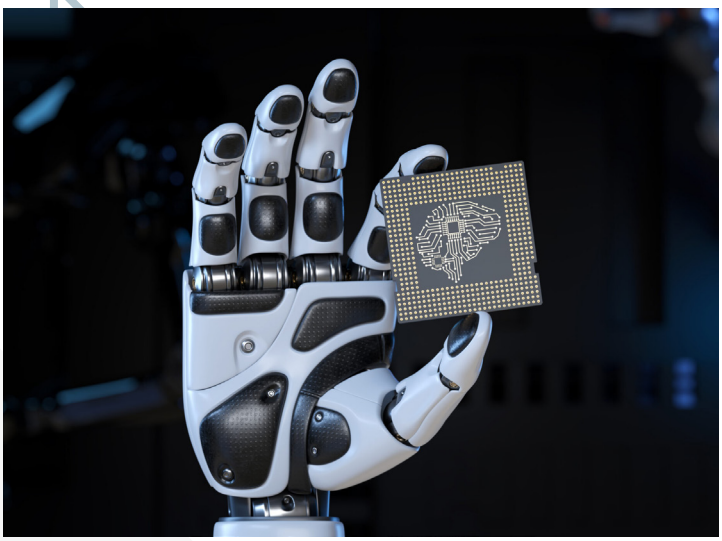
3. Now trending: Artificial Intelligence – how it is used in the coating industry?



Artificial Intelligence (AI) is revolutionizing the way we live and work. Its role in industry and society has become increasingly significant in recent years. AI technologies are being used to develop innovative solutions in various fields such as healthcare, finance, transportation, and entertainment, among others.

More specifically, AI is playing a vital role in the development of new materials and coatings in the industry, revolutionizing the way we produce, test, and optimise them. By leveraging advanced machine learning algorithms, AI is enabling researchers and engineers to identify new materials with desired properties, simulate complex physical and chemical processes, and optimise production parameters to achieve better quality and lower costs.

Moreover, AI is helping to design safer and more sustainable materials, by reducing waste, energy consumption, and toxicity, and promoting the use of renewable resources. With the increasing demand for high-performance and eco-friendly coatings, AI is becoming a key tool for innovation and competitiveness in the coating industry, allowing companies to stay ahead of the curve and provide better solutions to their customers.

One application of artificial intelligence in the coating industry is the use of Generative Adversarial Networks (GANs). GANs are a type of artificial neural network architecture that consists of two models: a generator – that produces synthetic samples similar to the real ones; and a discriminator – that identifies the fake samples generated.

In MOZART, the partners are using Generative Adversarial Networks (GANs) to facilitate the production of new coating designs optimised for specific performance criteria. By training the GAN on a dataset of coating properties and their corresponding materials, the generator can produce novel combinations of materials and properties that may not have been previously considered leading to the development of new and innovative coatings with enhanced properties, such as improved durability, adhesion, or optical performance.

To know more about GANs and how they are used in the MOZART project, read the **blog article by AIMEN** on the **MOZART website**.

This text had the contribution from AIMEN (Christian Precker)

4. Expanding Horizons: Presenting MOZART at international events across Europe

Showcasing MOZART

A spotlight on the project at the Tornitura Show

A.I.F.M. – Galvanotecnica e nuove finiture (**ASFIMET**), a partner of MOZART, promoted the project at the Tornitura Show, which is the first turning and lathe exhibition in Italy, held in Bergamo, Italy, from February 16th to 18th, 2023.
This biennial event is organised by D.F. Edizioni and provides a platform for professionals to stay updated on the latest news, discover solutions, network with customers and suppliers, and engage in business activities related to turning. ASFIMET had a booth at the event, where they showcased MOZART and distributed flyers to potential stakeholders and industrial partners.
For more information about the event, click **here**.

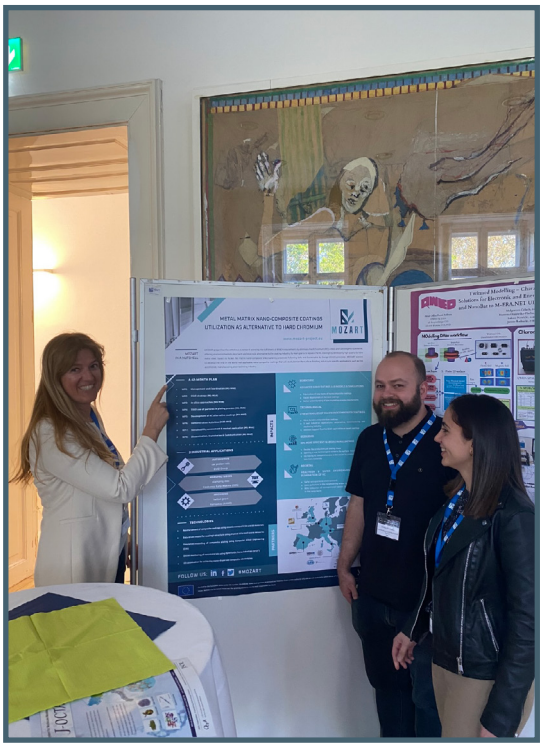
MOZART takes on MECSPE 2023

A sneak peek into the project's participation

From March 29th to 31st, MOZART partners A.I.F.M. – Galvanotecnica e nuove finiture (**ASFIMET**) and Politecnico di Milano (**PoliMi**) showcased the project at the MECSPE, an international fair for the manufacturing industry held in Bologna, Italy. The 2023 edition focused on three thematic areas: training, digitisation, and sustainability, all essential pillars for growth in a 4.0 context.
The event provided visitors and exhibitors with the opportunity to discover the latest technological innovations in the industrial process sector. ASFIMET had a booth at the event featuring the project's dissemination and communication materials, conducting brief presentations about their involvement in the project, and promoting discussions, updates, and new business relationships. **Tecnochimica**, another MOZART partner, also attended the event.
The project coordinator, Luca Magagnin from PoliMi, presented MOZART's impacts and innovations, boosting engagement with potential stakeholders and industrial partners. To learn more about the MECSPE and its future editions, please follow this **link**.

4. Expanding Horizons: Presenting MOZART at international events across Europe

MOZART project showcased at EMMC 2023:
Materials & Digitalisation for the Green Transition



DIAD Group presented the MOZART project at 4th EMMC International Workshop 2023 in Vienna, Austria. This international workshop focused on Materials & Digitalisation for the Green Transition, which is aligned with MOZART project goals. DIAD Group showcased the project's poster, highlighting the progress made so far and the expected outcomes.

As a MOZART consortium member, they play a vital role in achieving shared objectives by validating the coatings through the industrial case of car piston rods. AIMEN, another MOZART partner, also attended the event. Inside the project, they are developing AI models to support the production of novel coatings. We are thrilled about the event and excited to keep working towards a safer and more sustainable future!

5. MOZAR's first publication: Optofluidic Force Induction revealed

We are thrilled to announce that our partner, BRAVE Analytics, has published its first scientific paper as part of the MOZART project. The paper, entitled "Theoretical description of optofluidic force induction," has been published in the prestigious journal Physical Review Applied by the American Physical Society (APS Physics).

This publication represents a remarkable achievement for the MOZART project, as it highlights the cutting-edge research being conducted by our talented team of scientists and engineers. The paper's theoretical description of Optofluidic Force Induction (OF2i) is a critical step towards achieving the project's ultimate goal of developing innovative and efficient nanocoatings as a replacement for hard chromium ones. We look forward to more exciting developments from our consortium members!

Read and Download the paper by clicking **here**.

6. Time flies when we're making progress: MOZART one-year is coming up

By the end of this month (May 2023), the MOZART project will complete one year, and the consortium will meet each other again in person to celebrate the achievements and plan the next steps. The meeting will take place at the facilities of our partner **Asociacion de Investigacion Metalurgica del Noroeste – AIMEN**, in O Porriño, Galicia, Spain. We can't wait for it!

Progress until now and future achievements

Since the last issue of our newsletter, the MOZART project had some important achievements:

- the Intermediate MOZART report (deliverable 1.1) containing the technical progress of the project and draft use of resources, which will be updated at month 27 by PoliMi; and
- the first successful formulation of REACH-compliant Ni/Ceramic NPs electrolyte (milestone 3), by Tecnochimica, PoliMi, and Creative Nano (Cnano)

Soon, other two important steps will be accomplished (milestones 4 and 5):

- the integration of SiC NPs gravitational impact on Elsyca's simulations led by AIMEN; and
- the first successful lab-scale deposition of nanocomposite Ni/SiC coating exhibiting high values of hardness (1000 HV) by PoliMi.

In the next newsletter issues, we will have a summary of the achievements in the first year of the project and many more insights!

Stay tuned to follow up on all MOZART project news!

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Follow the project on social media

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