



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

1st ISSUE

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1. What does MOZART EU Project present?



Hard Chromium (HC) coatings have dominated the surface finishing industry for almost 100 years due to their excellent hardness, as well as wear and corrosion resistance, making them extremely attractive for a series of applications in automotive, aerospace, and other industries. However, the process of acquiring these types of coatings presents significant environmental and occupational health issues as it is based in the use of Chromium Trioxide (CrO_3) also known as hexavalent chromium (Cr^{6+}), a recognized toxic, carcinogenic, and mutagenic compound. For these reasons, chromium trioxide is already listed in Annex XIV to REACH (European Regulation No 1907/2006). In 2019, the European Commission (EC) approved a proposal that obliges companies that use HC to implement strict risk management procedures for various uses of the substance in the automotive, aerospace, and other sectors. The decision also gives these companies a maximum of seven years to reassess the availability of safer alternatives or substitute the substance as soon as possible.

In this context, MOZART is a Horizon Europe project which has the ambitious purpose of assisting in the fulfillment of REACH requirements to eliminate HC, offering an environmentally less harmful and less toxic alternative to the painting and coating industry. It proposes Safe and Sustainable by Design (SSbD) coating solutions in specific applications based on Nickel (Ni) matrix nano-composite electroplating processes.





1. What does MOZART EU Project present?

Nano-composite coatings containing nanoparticles (NPs) and nano-enabled materials as reinforcing means are potential candidates as durable protective coatings in applications where high wear and corrosion resistance are needed. Their significant advantage compared to other alternative solutions to HC is that they can be produced from the existing infrastructure of plating shops by applying low-cost modification in the lines for the safe integration of NPs, keeping thus the investment level low.

In MOZART, two families of Ni composite coatings will be developed and tested in 3 test cases: in manufacturing, machinery, and automotive industry. In addition, the development of a web-based Decision Support Tool (DST) and the implementation of AI models and simulation will support the integration of SSbD approaches and the advancement of the new technologies into the industry.

Overall, the MOZART project provides scientific, technological, economic, and societal impact by delivering a SSbD methodology for applying high-quality durable Ni-matrix nanocomposite coatings as a replacement for HC plating, aligned with the green digital transformation of the EC.



2. Insights



15 Partners



42 Months Duration

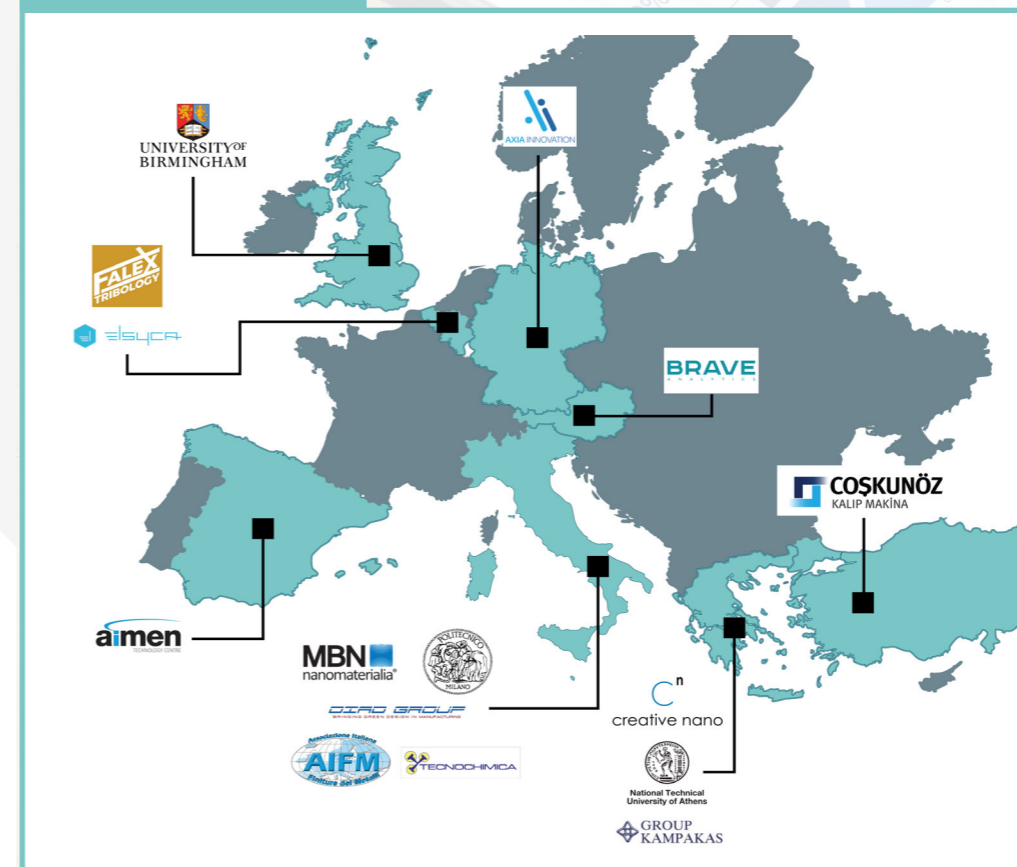


8 Countries



4.7M EU Contribution

PARTNERS



3 INDUSTRIAL APPLICATIONS



AUTOMOTIVE



MANUFACTURING



MACHINING



3. Why MOZART?

IMPACTS

MOZART project deals with a real industrial need that seeks an urgent solution. Thus, the long-term impact of MOZART is expected to affect a major part of the electroplating industry and, more specifically, part of hard chromium plating. But its impacts do not limit only to technological solutions to the industry; it is much wider and will benefit society as a whole.

SCIENTIFIC

- o Fabrication of new types of advanced nanocomposite coatings
- o Development of AI models & simulations allowing a faster deployment of the new coatings
- o Better understanding of the dispersions /electrolytes & mechanisms of electroplating process

ECONOMIC

- o Double the productivity of plating shops due to the significantly higher current efficiency of Ni composite plating (98%) compared to HC (25%)
- o Opening of a new technological niche in the surface finishing market
- o Increasing EC competitiveness in the sector by offering advanced & greener composite coatings as replacement to HC

TECHNOLOGICAL

- o 2 new families of more durable & protective coatings as replacement to HC
- o 3 real industrial applications: automotive, manufacturing & machining industry
- o Development of a Decision Support Tool for SSbD application on novel coatings

SOCIETAL

- o Elimination of HC providing a safer occupational environment in plating shops
- o Removal of pollution in the neighboring areas to plants
- o 80% reduction of occupational cancer incidents & deaths, in the long-term



3. Why MOZART?

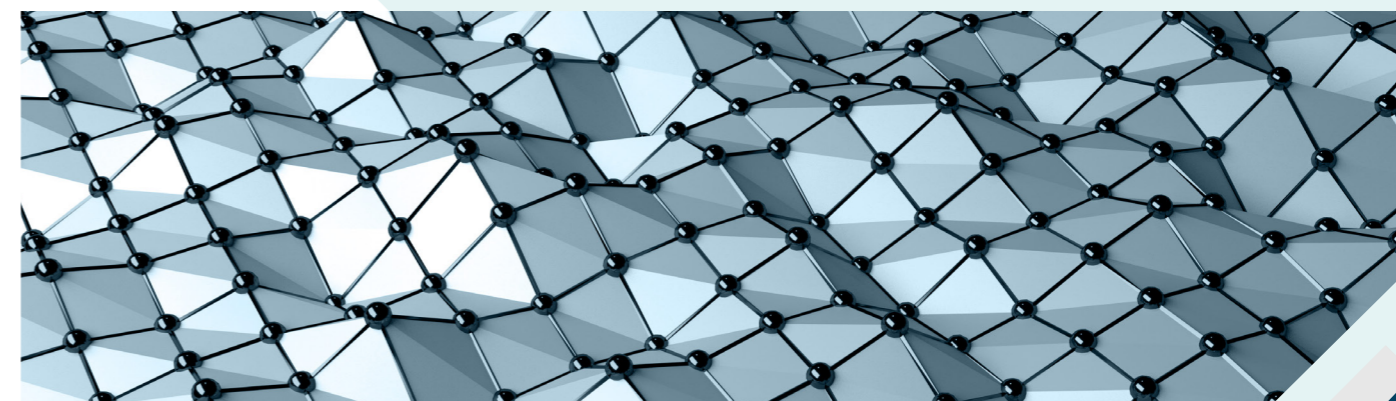
BENEFITS OF NANOCOATINGS

MOZART provides coating solutions that will allow the safe and sustainable replacement of hard chromium coatings in a range of applications. Nano-composite coatings are potential candidates as durable protective coatings in applications where high wear and corrosion resistance are needed. In the MOZART project two families of Ni composite coatings will be developed: one reinforced by ceramic nanoparticles, for hard coatings with wear and corrosion resistance; and a second one reinforced by 2D materials with the additional feature of self-lubrication.

These types of coating provide important benefits like:

- Safety and Sustainability since they are environmentally less harmful and less toxic
- Corrosion prevention due to their enhanced durability (it can last up to 25 years)
- Increased hardness and wear resistance, making them useful in a broad range of applications
- No need for regular maintenance as they are waterproof and resistant to temperature change
- Maintain the item's natural appearance for they are colorless and invisible

Although several benefits are to be expected from nanotechnology-based coatings, to ensure their safety, studies should be performed at an early stage of their development to look not only at the environmental and performance benefits but also at the risks posed by nanomaterials and their applications. MOZART will develop and test the novel coatings concerning the potential release of nanomaterials across their entire life cycle, in order to ensure their ecological sustainability and safety to producers' and consumers' health.





4. MOZART Technologies

▪ Reinforcement of composite coatings using nanoparticles (NPs)

The inclusion of ceramic and 2D NPs (e.g., SiC, Al_2O_3 , BC_4 , Graphene – Gr, MoS_2 , WS_2) can lead to composite coatings with excellent properties. Additionally, these properties may be tailored to the end application's needs by the proper selection of NPs. For example, 2D nanomaterials like Graphene nanoplatelets (GNPs) in Ni matrix provide attributes such as self-lubrication, and the addition of silicon carbide (SiC) NPs shows significant reduction (around 50%) in the coefficient of friction under dry lubrication. The mechanisms of NPs incorporation are governed by a series of parameters, like the status of NPs in the plating bath, the chemistry of the bath, and the applied current. In MOZART, accurate control of these parameters will be held during the process to obtain high-quality coatings.

▪ Data-driven model using physical informed neural networks

Artificial neural networks (ANN) are designed to replicate the behavior of neural networks found in the human brain. They are the foundation of Artificial Intelligence (AI) and are behind many of the most complex applications of machine learning, like recommendation systems for customers in products like streaming services, virtual assistance, and speech and facial recognition. The use of ANN gave rise to data-driven models, which are based on empirical observations of the process. This type of modeling is able to describe real conditions of the process, and it requires little knowledge about the system to be modeled.

MOZART will use generative algorithms with physically informed neural networks to deploy a predictive tool to correlate the properties of the bath and the performance of the coatings, considering the SSbD parameters.

▪ Simulation/modelling using Computer Aided Engineering (CAE)

Computer-aided engineering (CAE) is the broad usage of computer software to aid in engineering analysis tasks. CAE tools are used to analyze the robustness and performance of components and assemblies. Its tools encompass simulation, validation, and optimization of products and manufacturing processes. CAE systems aim to be major providers of information to help support design teams in decision-making and have been used in various fields, like automotive, aviation, space, and shipbuilding industries.

MOZART will use CAE strategies for developing tooling systems that enable to plate or electroform parts within thickness specifications, considering the crucial gravitational impact on the NPs content and allowing a deeper analysis of the plating processes with a dispersed NPs load.



4. MOZART Technologies

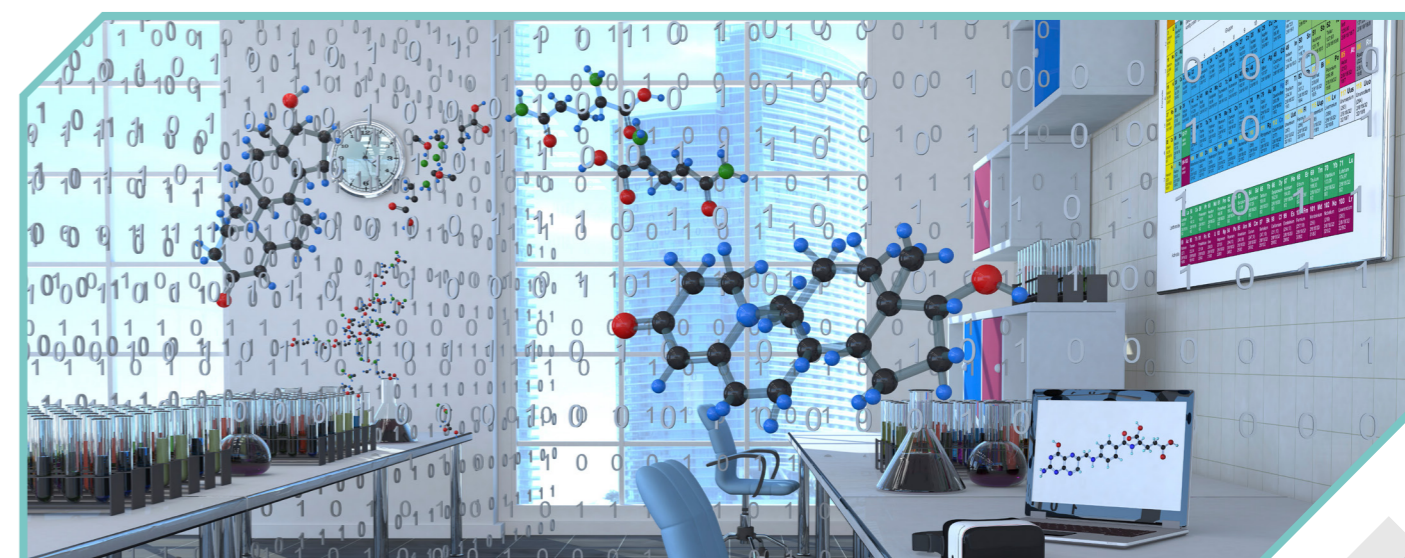
▪ Ultrasonication

The ultrasonication technology involves the application of intense ultrasound waves into liquids and slurries. The acoustic cavitation produced by intense sonication creates energy-dense conditions such as high pressure and temperature differences, as well as high shear forces and turbulence. These forces agitate particles, break droplets, and disrupt cells resulting in homogenization, dispersion, emulsification, and extraction effects. For the electrolytic baths used in Ni-based plating, MOZART will use this technique to homogenize dispersions and to clean surfaces from loosely attached impurities, achieving mono-dispersed composite electrolytes.

▪ Online monitoring using Optofluidic Force Induction (OF2i®)

The Optofluidic Force Induction (OF2i®) is a highly sensitive online and real-time particle characterization method, developed by our partner BRAVE Analytics, that sets particles in motion through actively induced photonic and fluidic forces. The high-speed evaluation of their movements provides statistically relevant process monitoring data (PAT-sensor) such as size, size distribution, and concentration from several microns down to 20nm.

An online monitoring OF2i® sensor station using the MOZART specific models and algorithms will be built, tested at lab-scale colloidal suspensions, and validated through offline standardized characterization methods for subsequent pilot line tests, providing online, continuous, and real-time particle characterization as well as process feedback and quality control.





5. Alignment with EU guidelines

REACH COMPLIANCE

MOZART utilizes REACH compliant electrochemical baths and relevant methods for composite coatings.

But do you know what REACH compliance means?



REACH is the acronym for Registration, Evaluation, Authorisation, and Restriction of Chemicals. It is a standard regulation of the European Union (EC 1907/2006) that establishes policy and procedures for collecting and assessing information on the properties and hazards of chemical substances, addressing the risks associated to them, and promoting the use of alternative safer substances.

REACH compliance applies to all chemical substances imported or produced in the EU and it was created due to the large and unsupervised use of chemicals within Europe that could be harmful to society and the environment.

In 2019, the REACH committee imposed strict regulations regarding the use of hexavalent chromium, obliging companies who use this substance to apply for authorization or find a suitable alternative to substitute it. Thus, MOZART contributes to REACH's ultimate target: protecting human health and the environment from the risks caused by chemicals, while enhancing the competitiveness of the EU chemicals industry.



5. Alignment with EU guidelines

GREEN DIGITAL TRANSFORMATION



The European Union (EU) strives to be sustainable, fair, and competitive.

To keep the planet livable and to seize economic opportunities, the EU is committed to a rapid and inclusive transition to environmentally sustainable ways of living and doing business. The green transition aims to achieve a safer and more sustainable future by tackling climate change and environmental degradation.

At the same time, the growing importance of digital technologies is transforming society and the economy. As part of the digital transition the EU aims to exploit digital technologies for sustainability and prosperity, and provide more opportunities for citizens and businesses. Successfully managing the green and digital "twin" transitions is the keystone for a sustainable, fair, and competitive future. In this sense, MOZART delivers a safe and sustainable by design methodology for applying high quality durable Ni-matrix nanocomposite coatings as a replacement of hard chromium plating, aligned with the twin transformation targets of the EU: #Green – based on the REACH compliance materials that will be utilized, the increased energy efficiency of the process, modifications of plating lines for decreasing wastes and increased occupational safety; and #Digital – based on the utilization of AI models and simulation for the identification of optimum parameters of plating concerning the geometry of the objects that will be plated, leading to savings in raw materials and time.





6. Safety, sustainability and integration

SSbD APPROACH

According to the European Chemical Industry Council, “Safe and Sustainable-by-Design” (SSbD) is seen by the European Union as a process to speed up the market adoption of new and alternative chemical products and technologies that build trust with consumers regarding their safety, environmental and societal benefits, and leverages the shift towards a circular economy and climate-neutral society.

SSbD is an iterative process that guides the innovation and marketing of chemicals, materials, products, processes, and services that: (i) are safe; and (ii) provide environmental, societal, and/or economic value through their applications.

In this sense, the European Commission wants to introduce SSbD as a pre-market strategy to ensure innovation for improved safety and greater product sustainability. Given the enormous diversity of consumer products and services, it is recommended that SSbD assessments are conducted at the product application level, taking into account the intended use.

MOZART’s approach will be to continuously evaluate all aspects of the project for compliance with the most up-to-date SSbD principles. This will take place dynamically as the project runs, evaluating inputs and products using SSbD criteria. Check out below how this is going to be implemented during the project.

DECISION SUPPORT TOOL

MOZART will support the integration of its technologies and advancement into the industry and facilitate the adoption of the SSbD frameworks by developing a web-based Decision Support Tool (DST). The DST will incorporate the principles of optimization-based mathematical modeling and ontology theory, in order to produce guidance for interested industrial end-users on how to identify the optimal selection of the type of coating to be produced, alongside various production parameters, such as the type of current to be considered, its density and the chemistry bath. Overall, the DST will enable end-users to exploit MOZART’s Safe and Sustainable technologies, ensuring the alignment of their products, materials, and processes with the “by-Design” concept.



7. News and Updates

MOZART Kick-off Meeting

On June 30th, 2021, 15 partners from 8 countries (Italy, Spain, Greece, Belgium, Austria, Turkey, Germany, United Kingdom) attended the Kick-off Meeting (KoM) to discuss the mission and the goals of MOZART by presenting their unique role within the project. The KoM took place remotely and focused on the 8 Work Packages, deliverables, and milestones of MOZART, and on the next actions of each partner for the first months of the project.

The MOZART consortium ended the KoM looking forward to the next steps and for joining forces building on their specific scientific know-how and expertise for the successful achievement of the project’s ambition.



MOZART launch announcement in an Italian magazine, by our partner ASFIMET

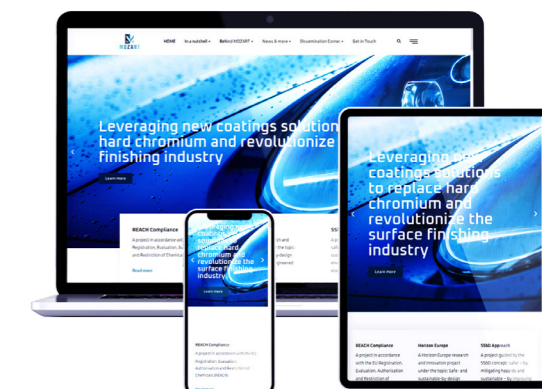
Our partner, ASFIMET SRL, communicated the launch of MOZART project in the first edition of 2022 of the magazine Galvanotecnica e nuove finiture. Founded in 1949 by Prof. Eugenio Bertorelle, the magazine is the reference publication for Italian galvanic companies and the metal finishing market sector. In the article, they talked about the context of the project and how it fits inside the finishing industry, highlighting how MOZART is aligned with the twin transformation targets of the European Commission: Green and Digital.



Social Media and Website

From the very beginning of the project, Dissemination and Communication Activities started with the ultimate target to maximize the project’s contribution and its wider impact. In the first month, social media profiles were created to communicate the results and impacts of the project, reaching out the society as well as specific audiences. Until now, our followers sum up to 400 people!

The official website (www.mozart-project.eu) has just been launched (September 2022) and contains all key information you need to know to dive into the project.



Don’t hesitate to visit it and sign up to receive next issues from our newsletter!

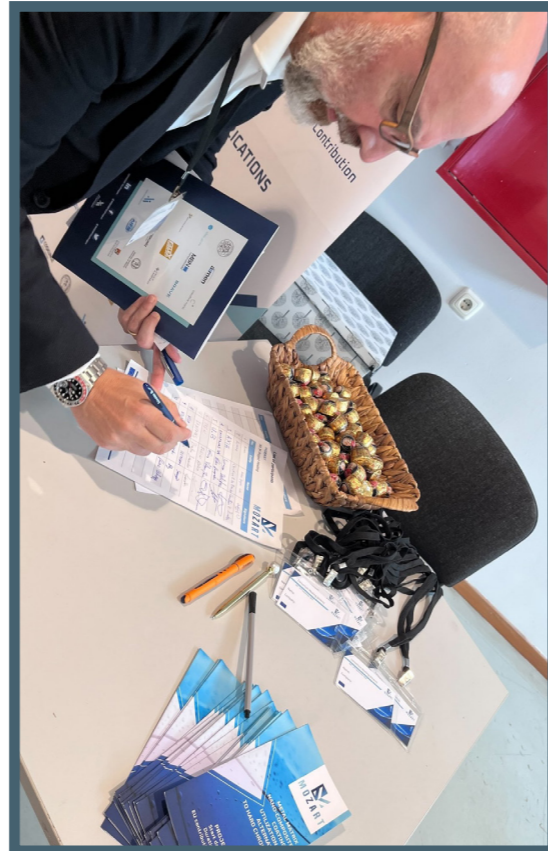


7. News and Updates

Consortium Meeting in Athens

The MOZART consortium got together physically for the first time since the beginning of the project for a meeting in Athens, Greece, co-hosted by our partners National Technical University of Athens (NTUA) and Creative Nano (Cnano). The meeting took place on the 26th and 27th of September and the partners presented their progress until month 4 and the next steps for each work package.

At the meeting, the 15 partners discussed technical aspects of the project related to the next steps towards the challenge of making the plating process a greener and safer process replacing hard chromium using the SSbD approach. The first 3 deliverables of the project are linked with WP2: Specifications & Requirements based on SSbD strategy which submitted the deliverable D2.1 at the end of September and WP8: Dissemination, Exploitation & Communication, which is submitting D8.1 and D8.2 by the end of this month (M6).



7. News and Updates



By the end of the first day, a citizen engagement event was organized by our partner Cnano, where the partners had the opportunity to strengthen their network, socialize and exchange opinions on the project and the challenges of the relevant sectors, over a pleasant dinner, celebrating also the birthday of the project's coordinator.

The Social Science Event was also attended by researchers and industry members outside of the consortium, allowing to disseminate MOZART along with related projects, and also to distribute its flyer to the audience, presenting the project's main concept, impacts, and applications.





7. News and Updates



On the second day of the meeting, all partners visited Cnano facilities to get to know on site the plating lines that will be used to produce the novel nanocoatings and have more productive discussions on how to achieve the project's main goals.

The MOZART consortium ended the meeting looking forward to the next steps of the project!



8. Meet our Partners

MOZART's multidisciplinary approach is guaranteed by the expertise of 15 partners from 8 countries, among universities, research institutes, large enterprises, and SMEs. Check out each one of them and their role in the project.



Politecnico di Milano (PoliMi) – Italy

PoliMi is leading Management & Coordination activities and will also take part in technical activities, including the optimization of electrolyte chemistries in collaboration with other partners.



Asociacion de Investigacion Metalurgica del Noroeste (AIMEN) – Spain

AIMEN is leading the AI models in strong collaboration with the researchers and academic partners of the consortium.



Creative Nano (Cnano) – Greece

Cnano is responsible for the Safe and Sustainable-by-Design (SSbD) strategies and will collaborate in technical activities both with the upstream partners as well as with the end users.



Elsyca (ELS) - Belgium

ELS role in the project will be of crucial importance for successfully achieving the high demanding nanocomposite plating. Strong collaboration with BRAVE, Cnano and PoliMi will take place for the proper simulation of the processes.



MBN Nanomaterialia (MBN) – Italy

MBN will undertake the pre-functionalization of nanoparticles (NPs) enhancing their properties and promoting safer procedures. The team will collaborate with TECNOCHIMICA and PoliMi to define the chemistries for NPs pretreatment.



8. Meet our Partners



Brave Analytics (BRAVE) – Austria

BRAVE will bring significant benefits to the development of the process as they will use their OF2i® technology to enable the characterization the characterization of the status of nanoparticles in the plating tanks during the plating procedure, allowing timely interventions in the process.



TECNOCHIMICA – Italy

TECNOCHIMICA will undertake activities based on their experience to optimize composite formulation in collaboration with MBN, PoliMi, Cnano, and ELS.



Falex Tribology (FALEX) – Belgium

FALEX will be responsible for characterizing friction and wear, properties of crucial importance for the final products.



Kampakas SA (KAMP) – Greece

KAMP has vast expertise in developing lightweight manufacturing and surface finishing solutions, already adopted in their production lines. KAMP has a successful history of collaboration with some of MOZART partners (PoliMi and Cnano) resulting in innovations related to lightweight manufacturing and surface finishing solutions, already adopted in their production lines. During the project, the company will act as an end user for the machining industry application.



DIAD Group (DIAD) – Italy

Besides its role as end user in the automotive industry, DIAD team will also provide their philosophy in eco-design and eco-compatibility processes.



8. Meet our Partners



Coskunoz Kalip Makina (COS) – Turkey

COS is a large enterprise covering a wide field of activities in the automotive, aerospace, and manufacturing sector, where COS is a Tier 1 supplier of major European OEMs. COS participation as an end user will have multiple benefits, especially in guiding the research activities toward real large-scale industrial scenarios.



National Technical
University of Athens

National Technical University of Athens (NTUA) – Greece

During the project, NTUA will take advantage of their experience in the field of environmental sustainability and will undertake the environmental assessment via Life Cycle Assessment and Life Cycle Cost analysis (LCA/LCC).



AXIA Innovation (AXIA) – Germany

AXIA is responsible for the dissemination, communication, and promotion of the project through its website and social media platforms, and exploitation-related activities including the design of dissemination material, IPR protection, business planning, knowledge management, and innovation management. AXIA team also leads the development of the SSbD decision support tool for coatings selection.



ASFIMET SRL – Italy

ASFIMET will lead the training and clustering activities providing a faster acceptance and integration of the project results in the value chain.



UNIVERSITY OF
BIRMINGHAM

University of Birmingham (UoB) – United Kingdom

UoB will be responsible for the design and implementation of SSbD strategies, including release, toxicological tests, and assessment of occupation air quality in collaboration with Cnano and PoliMi. It will also provide its expertise in open science practices.



9. Dissemination Events

MOZART AT RESEARCHERS' NIGHT, IN GREECE

On September 30th, 2022, from 5 pm to 10 pm, the MOZART project was disseminated at the [Researchers' Night](#), held in the Patission Historical Complex of our partner National Technical University of Athens (NTUA). The Researchers' Night is an initiative of the European Commission that happens every year welcoming more than three million visitors in 30 countries and more than 400 European cities, with the aim of familiarizing the public with the wonderful world of Research. This year, the framework of the European program was "MARIE: My awesome research is for everyone!"



The Researchers' Night in Greece under NTUA's coordination focuses on the transmission of research to society with young people being in the front line, the creation of jobs for highly qualified scientific staff, the support of entrepreneurship among young students, as well as promoting start-ups for the real economy. NTUA presented the MOZART concept and distributed its flyer to a large audience of students, researchers, and curious visitors. More than 15,000 people toured the 150 virtual, interactive, and demonstrative laboratories showing the research and innovation developed by all the Universities and Research Centers of Attica, all the Schools of NTUA, and many interdisciplinary organizations, with the help of hundreds of volunteers.

MOZART DISSEMINATED IN 3 ITALIAN EVENTS BY OUR PARTNER ASFIMET

33.BIMU 2022 - October 12th to 15th

Our partner A.I.F.M. - Galvanotecnica e nuove finiture participated in the [33.BIMU](#) as an exhibitor disseminating the MOZART project. 33.BI-MU is the main and most important Italian exhibition dedicated to the industry of metal cutting, metal forming and additive machine tools, robots, digital manufacturing, and automation systems, enabling technologies and subcontracting. The exhibition took place at Fieramilano in Rho, Italy, and brought together leading companies in the various exhibition sectors from more than 10 countries inside and outside Europe.



9. Dissemination Events

ASFIMET participated at the event showcasing a booth, aiming to disseminate the projects they are involved in regarding machine tools and metalworking, including MOZART. Therefore, they had the opportunity to present the project to the visitors and distribute its flyer, which can be downloaded [here](#).



SICAM 2022 - October 18th to 21st

ASFIMET also participated in the [SICAM 2022](#) as an exhibitor disseminating the MOZART project. SICAM is the International Exhibition of Components, Accessories and Semi-finished Products for the Furniture Industry that takes place annually in Pordenone, Italy. The event promotes all the product novelties and market trends for future collections of furniture, kitchens, bathrooms, and interior design, presenting international exhibitors, manufacturers, and suppliers from all over the world. Over the years, SICAM has presented global producers in the most diverse areas, being an interesting meeting to establish new contacts with potential stakeholders for projects like MOZART.

ASFIMET disseminated MOZART alongside other related projects they are involved in, showcasing a booth where visitors could know more about the main concept, technologies, and impacts of the project and also receive the printed version of its [flyer](#).



P&E Coating Days 2022 October 26th to 27th

[P&E Coating Days](#) is an event dedicated to innovation in the field of Surface Treatment, mainly focused on ecoCoating, powder coating, and new surface treatment technologies. The event aims to be a meeting point for the exchange of knowledge to encourage the development of real technological innovations.

This year's event took place in Milan, Italy, and our partner ASFIMET disseminated MOZART with a booth, where they had the opportunity to present the project and distribute its [flyer](#) to the visitors, for them to get to know the project in more detail.



9. Dissemination Events

The surface and coating industry is the main targeted industry for the applications of the MOZART technologies. Therefore, to expose the project in events involving members of this industry is extremely important since it can attract stakeholders, broaden the MOZART community, and expand the scope of the project's impacts.

NEXT EVENT



FASTENER FAIR 2022 - November 30th to December 1st

ASFIMET also plan to attend the Fastener Fair Italy, which is a business trade event covering all aspects of the fastener and fixing industry. This exhibition offers opportunity to make new contacts and build successful business relationships between producers, wholesalers, end users, and the industry. It provides a showcase in Italy for national and international manufacturers and distributors of industrial and construction fasteners and fixings, fastener manufacturing technology, and related products and services. Click here to know more [Fastener Fair Italy 2022](#).

Stay tuned to our next editions of the newsletter to discover more about this and other upcoming events.





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



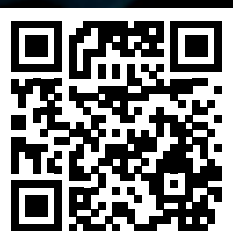
National Technical
University of Athens



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