

NanoPAT Newsletter

May 2024

Online real-time characterisation solutions for
nanoparticle production processes



#08

Table of contents

Welcome	2
Project status	3
Partner presentations	6
News & Highlights	9
Knowledge Transfer Activities	15
NanoPAT Retrospect	17
Upcoming Events	19

[Start reading](#)

Welcome

Dear reader,

The NanoPAT project is glad to present our 8th and final newsletter aiming to communicate our latest technical achievements, introduce our innovative partners and share inputs and curiosities related to nanotechnology and process monitoring.

In this 8th issue you will find an update of the project status. Furthermore, two NanoPAT project partners, TEMASOL and EXELISIS, our data, exploitation and innovation managers, introduce themselves and our achievements of the last period are highlighted!

NanoPAT is currently coming to an end. So far we are very satisfied with the progress made by all partners. In a technical aspect, all the three technologies have been successfully validated in the laboratory by our research organisations as well as in the pilot lines of at least one of the five demonstrators participating in the project.

On the other hand, our PAT monitoring system, the PAT platform, is fully implemented and is ready to communicate with all the PAT systems and other devices in the industrial field.

Additionally, the machine learning models embedded in the monitoring software were tested in a pilot line.

In this newsletter you will find all final project outcomes as well as all activities we have been involved in!

If you are interested in the evolution of NanoPAT activities, coming from an academic, industry, or other perspective, and would like to closely follow the progress of the project and its outcomes, do not hesitate to contact us on nopat_coordination@iris-eng.com and continue following us in our social media channels ([LinkedIn](#), [Twitter](#), [YouTube](#)). Curious? Read all about it on the following pages!

Best regards and enjoy the read,



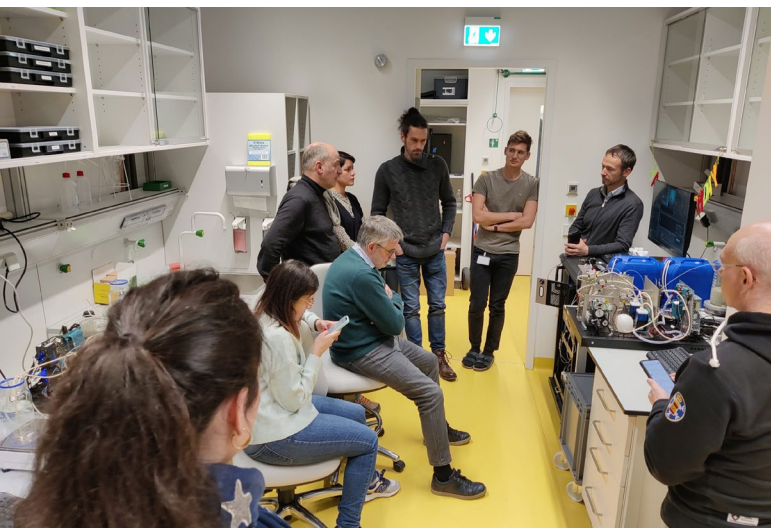
Poojan Timilsina,
Coordinator of NanoPAT



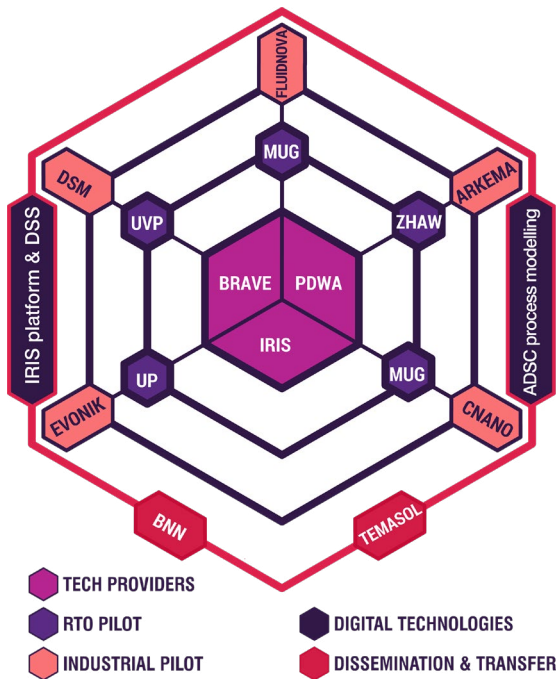
Project status

Since our last newsletter ([issue #7 - Dec 2023](#)), and thanks to a hardworking team, there have been plenty of activities within the NanoPAT project within the last 6 months.

In December 2023 the whole consortium met in Graz (Austria) for our **General Assembly in M43**. at the facilities of our colleagues from MUG & BRAVE. It was a great get-together with lots of very fruitful discussions and getting up-to-date with the developments and achievements during the previous months, which set the basis for these final months. Special thanks to the colleagues of BNN, BRAVE and MUG for organising a fantastic meeting!



With a mixture of feelings, NanoPAT partners met for the last time on 22-23 May 2024 in Barcelona (Spain) for their **Final General Assembly at M48** to give an update of the last six months and for the overview of all activities during the whole project duration! Really exciting four years lie behind us, full of high-impact collaborative work by the entire consortium, delivering successfully demonstrated inline/online real-time process analytical technologies for nanoparticle production reaching till TRL 6/7. Special thanks to our coordinator, IRIS Technology Solutions, for hosting a very successful final meeting and for making us feel at home and bringing us closer to the Catalan cuisine and culture!



Overview of roles of the partners in NanoPAT

During the last months, and after the validation at lab-scale of NanoPAT process analytical technologies (PATs), the installation of the sensors at the pilot plants has been finalised, performing trials of the sensors at the end users' facilities and demonstrating the technologies in real industrial environments.

The **Computational Fluid Dynamics (CFD)** analysis of the 5 Case Studies have been finished successfully. Additionally, ADSC and ZHAW are collaborating in a in-depth CFD analysis of different mixing agitators to understand sedimentation of particles.

The digital platform now contains the Decision Support System. The integration of the different NanoPAT sensors is closed. On the computing

edge software infrastructure (**PAT platform**), capabilities to run machine learning models have been included and were tested during the TUS measurement campaign at Evonik. Further steps towards data standardisation have been performed, by including CHADA metadata information within the raw data that the PAT platform software exports.

Several activities have been pushed and carried out by BNN and TEMASOL towards **collaboration with other EU funded projects** with a similar or supplementary focus. Additionally, activities related to standardisation of the NanoPAT technologies as well as its exploitation have been performed by TEMASOL and BNN.

Moreover, the project partners have been very active with the organisation and/or participation in conferences and other events to promote their research, as well as internal knowledge transfer activities for exchanging ideas within the consortium.

Furthermore, all **public training materials and publications** that have been produced by the project and its partners until now, are available on the project website.

Finally, the project has released three more **peer-reviewed scientific publications** with the results of the research of our colleagues from BRAVE, MUG, UPV/POLYMAT, as well as one **preprint** with contributions from BNN and TEMASOL.

You can find more details about all these activities in the upcoming sections.

PDW

Dilution-free, inline sizing of nano- and micrometer scaled particles at very high concentrations

Applicability in viscous and stirred/flowing systems

Process probe fouling is often no problem for measurement performance

OF2i

Online high-resolution particle size distribution of polydisperse samples

Additional chemical analysis via Raman spectroscopy

Monitors particle concentration, large-particle count and aggregation

TUS

Real time (<100ms) process analysis for low concentrations (<5%SC)

Cost-effective turn-key industrial probe: customisable attachment, hot, acidic/alkaline environment, etc.

Easy to use: no prior knowledge of particle properties needed.

Highlights of NanoPAT Process Analytical Technologies

“

FLUIDINOVA

At FLUIDINOVA, we were very satisfied with the results obtained with the OF2i technology. It gave us additional insights about our process and products, in an easy and intuitive manner. The additional information we obtained from OF2i characterisation can allow us to improve our process, reducing time and costs. With these insights, we will also explore the possibility of increasing our daily production capacity.

Partner presentations

In this issue, we will present the project partners TEMAS Solutions GmbH and EXELISIS PC.



About TEMAS Solutions GmbH (TEMASOL)

TEMASOL is a Swiss-based SME founded in 2020 and whose main goal is to support industry as they ensure that their path to market complies with the Europe aims for a transition towards a sustainable future (e.g. Green Deal and Strategy for Industrial Leadership on Advanced Materials). Our areas of expertise include chemicals, cosmetics, food contact materials and medical devices, where we have successfully implemented the concept of Safe-and-Sustainable-by-Design (SSbD) at prototype and final product level in under-contract projects. This is possible thanks to our multidisciplinary team with experts on LCA, sustainability, toxicology, regulatory affairs, risk assessment, standardisation, business and IT, and through past and ongoing collaborations in key initiatives at national and international level, with several projects on the development and implementation of SSbD and Governance of emerging technologies.

Within NanoPAT, TEMASOL was involved in developing training and capacity building for the knowledge transfer of the NanoPAT technologies to the case studies in the project as well as

to external potential users. TEMASOL is also involved in the implementation of SSbD where the concept was tested at Fluidinova with NanoPAT solution OF2i. TEMASOL worked on maximising NanoPAT impacts by ensuring the future exploitation and sustainability of the Process analytical Technologies (PATs) developed within the project. To this end, TEMASOL had a strong role in the standardisation of the NanoPAT solutions, taking the lead in their presentation at a general meeting of the technical committee of the European committee for Standardisation dedicated to Nanotechnologies (CEN/TC 352) as well as in the development of a SSbD Standard under CEN. TEMASOL also conducted clustering activities with projects dedicated to harmonisation and standardisation in the field of material characterisation. The latter activities led to the creation of a pre-standardised metadata template for materials characterization data (CHADA) supported by a CEN Workshop Agreement (CWA 17815). TEMASOL supported NanoPAT sensor developers to describe their PATs using the published CHADA to manage data genera-

ted by their technology within the project and to improve future exchanges among experts in the entire area of materials characterisation (e.g. industrial end-users, experimentalists, computational modellers), and reduce the barrier utilising advanced materials characterisation.

Contact:

www.temasol.ch



Devendra Joshi

IT & business developer,
project manager



Elise Morel

Standardisation



Blanca Suárez Merino

SSbD implementation &
Standardisation

About EXELISIS IKE (EXEL)

EXEL is an engineering consulting company located in Athens, Greece. The company was founded by a group of engineers and entrepreneurs with extensive experience in business development and innovation. Our key personnel have over 15 years of experience in International Business, Company Formation, Opt Out and Exit Strategy. Our main aim is to cherish our relations with clients and serve them till their balance sheets clearly indicate the value provided by our services. The main core of our services is providing professional assistance and services to our clients that help them to improve their business perception. The company is providing the strategy, the tools and the solutions customised to their clients' needs.

Offering a wide variety of services ranging from Project and Innovation Management to Knowledge Transfer and Communication & Design are some of our competences. Exelisis specialises in providing high-quality research services

developing novel computational tools, conducting various types of engineering studies and offering modern technological solutions as well as implementing them on various applications. Our team consists of a mixture of business analysts, economists and engineers with business development backgrounds. The company's founders have an extensive background participating in many European research projects.

In NanoPAT we are leading activities related to innovation and open-innovation management, facilitating the optimal market uptake of NanoPAT's technologies, supporting transversal knowledge transfer, and ensuring insights gained within NanoPAT are effectively applied in a market-oriented manner. Additionally, we are responsible for IPR management and patent mapping. We are leveraging tools like the „PatSnap“ Patent Search platform to navigate the landscape of intellectual property rights and to elucidate the freedom to operate (FTO). This

ensures not only compliance with existing patents but also positions NanoPAT's innovations for future patent applications, enhancing their competitive edge in the market.



Nikos Tsiantis
Project Manager

Contact:

www.exelisis.gr



EVONIK

We at Evonik tested both the PDW and TUS sensors. During our amorphous silica precipitation, seed particles are generated and we would like to observe their genesis and growth with an in-line method. The PDW and TUS sensors offered the early detection of the particle building mechanisms and growth during the genesis of the nanostructured synthetic amorphous silica. The TUS sensor can provide data up to the gel point in the reaction and the PDW detects from the gel point, making these methods complementary.

News & Highlights

New case study: Polymer analysis with OF2i

NanoPAT's polymer case expert is POLYMAT (University of the Basque Country, UPV/EHU). Within the scope of the project, inline PDW Spectroscopy and online TUS technologies have been tested to monitor the particle size and the particle size distribution of latexes (waterborne polymer dispersions) during their synthesis by emulsion polymerization at laboratory scale. The scale up to industrial application was also started with PDW Spectroscopy technology ([Case Study 1](#) with Covestro as end user).

After learning more about the three NanoPAT technologies and thanks to internal exchange with other project partners, it was identified that the OF2i technology could also be of interest for online particle size monitoring during emulsion polymerisation processes.

For this purpose, Usue Olatz Aspiazu (UPV) carried out an internship at BRAVE Analytics (Graz, Austria), testing the OF2i technology for online and real-time monitoring of emulsion polymerization processes of high industrial value used to produce acrylic latexes used in the manufacture of paints and coatings, among other applications.

These results will be soon presented in the 19th European Student Colloid Conference (24-27 June 2024, Bordeaux (France)) and Materia-len Zientzia eta Teknologia kongresua (3-4 July 2024, Bilbao (Spain)).



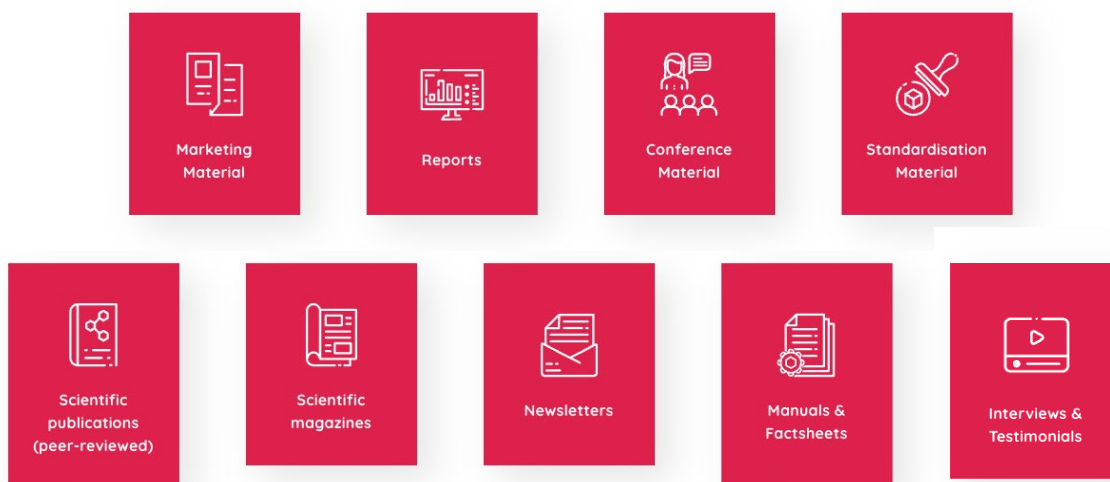
NanoPAT featured at external newsletters / webpages

NanoPATs activities were published and promoted via the BNN QUARTERLIES [04/2023](#) (Dec. 2023) and [01/2024](#) (March 2024) as well as in the NSC Update [#07/2023](#) (Dec. 2023), [#02/2024](#) (Feb.2024), [#04/2024](#) (April 2024), and [#05/2024](#) (May 2024).

Training materials & publications at NanoPAT website

All 91 public training materials and publications that have been produced by the project and its partners until now, are available on the project website, organised in 9 different categories: marketing material (flyers, brochures, videos, presentations, etc.), reports, conference materials (presentations, posters), standardisation material, peer-reviewed publications, articles in scientific magazines, articles in newsletters,

manuals & factsheets, interviews & testimonials. Key information is attached to each material, e.g. title, short description, producer, DOI (if available), date of creation, associated activity (if relevant), reference link, etc.



Recent publications

Our Austrian colleagues of BRAVE Analytics and Medical University Graz published a peer reviewed publication on simulating the imaging of light through a cylindrical capillary under the assumption that the dimensions of the capillary are much larger than the wavelength of light, in the Nanophotonics journal.

Hohenester, U., Neuper, C., Šimić, M., Hill, C. **Imaging the scattered light of a nanoparticle through a cylindrical capillary** (2024). *Nanophotonics*, Vol.13, Issue 4. DOI: [10.1515/nanoph-2023-0773](https://doi.org/10.1515/nanoph-2023-0773)

As a result of the hard work of our Spanish colleagues from UPV/POLYMAT, they got published a peer-reviewed publication on the use of Photon Density Wave spectroscopy to monitor

the particle size in seeded semibatch emulsion copolymerization reactions, in the Chemical Engineering Journal.

U.O.Aspiazu, U.O., Paulis, M., Leiza, J.R.. **Photon Density Wave spectroscopy to monitor the particle size in seeded semibatch emulsion copolymerization reactions** (2024). *Chemical Engineering Journal*, Vol. 483, 149292. DOI: [10.1016/j.cej.2024.149292](https://doi.org/10.1016/j.cej.2024.149292)

Additionally, one of the outcomes of the good collaboration with the EU-NanoSafety Cluster and its projects is the joint publication as preprint in March 2024 (version 5 in May 2024) on the reasons why we do need Safe and Sustainable Design of innovative advanced materials, where BNN and TEMASOL partners were involved.

Cassee, F.R., Bleeker, E.A.J., Durand, C., Exner, T., Falk, A., Hristozov, D., Hofer, S., Hofstätter, N., Friedrichs, S., Heunisch, E., Himly, M., Nymark, P., Pohl, A., Soeteman-Hernández, L. G., Suarez-Merino, B., Valsami-Jones, E., Groenewold, M. **Roadmap Safe and Sustainable Advanced and Innovative Materials 2024-2030** (2024). Zenodo. DOI: [10.5281/zenodo.11191095](https://doi.org/10.5281/zenodo.11191095)

Christian Neuper, C., Šimić, M., Lockwood, T.E., Gonzalez de Vega, R., Hohenester, U., Fitzek, H., Schlatt, L., Hill, C., Clases, D. **Optofluidic Force Induction Meets Raman Spectroscopy and Inductively Coupled Plasma-Mass Spectrometry: A New Hyphenated Technique for Comprehensive and Complementary Characterizations of Single Particles** (2024). Analytical Chemistry, Article 96, 21, 8291–8299. DOI: [10.1021/acs.analchem.3c04657](https://doi.org/10.1021/acs.analchem.3c04657)

Some days ago, the latest publication of our colleagues from BRAVE Analytics and Medical University of Graz, on a new technique for the characterizations of single particles, combining OF2i, Raman Spectroscopy and Inductively Coupled Plasma-Mass Spectrometry, was published in the Analytical Chemistry Journal.

Project Factsheets

For an easier understanding of what NanoPAT has been doing, we have created factsheets of the three **PATs** (PDW, OF2i and TUS) highlighting their most representative features, technical information, benefits and applications of each technology, as well as a comparison with reference methods. Additionally, a factsheet of the **PAT platform**, developed by IRIS, has been created, explaining its aim, structure, technical information, as well as benefits and applications. Have a look at the factsheets [here](#).



Interviews with NanoPAT’s RTO’s and End Users: Evaluation of PATs’ performance

Within NanoPAT, three novel complementary real-time particle size characterisation technologies (Process Analytical Technologies (PAT)) have been not just further developed, but tested, validated and demonstrated in five industrial case-studies, demonstrating the viability of the proposed PAT solutions for the industrial nanoparticle production of polymers, silica, hydroxyapatite, zeolites and ceramic nanoparticles.

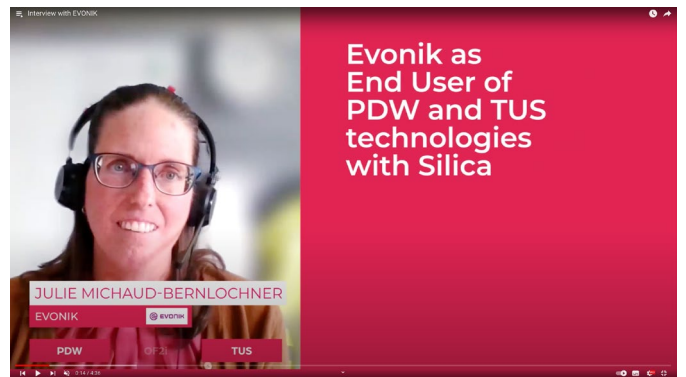
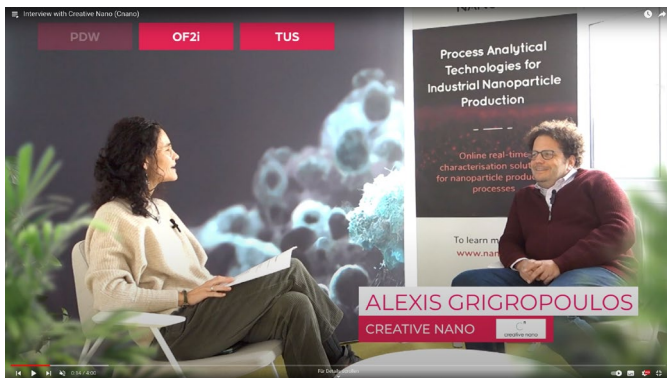
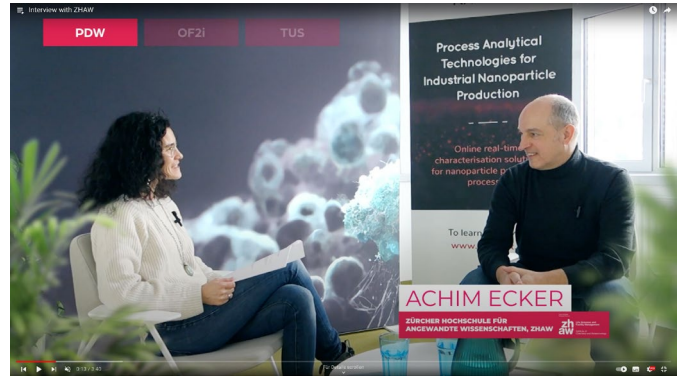
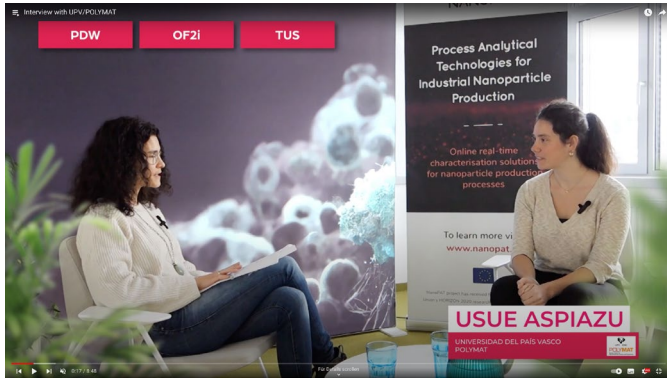
The three PATs developed within the project are Photon Density Wave Spectroscopy (PDW), OptoFluidic Force Induction (OF2i) and Turbidity Spectrometry (TUS). Three of the case studies (CS1, CS2 and CS4) were hosted by large companies (ARKEMA, Covestro, EVONIK) and

the other two (CS3 and CS5) by SMEs (Cnano, FLUIDINOVA). A Research and Technology Organization (RTO) was assigned to support each case study in order to pre-validate the PAT (selected, based on the existing TRL4 results) in a downscaled process (TRL5) before moving to a semi-industrial process (TRL6). Our RTOs are University of Basque Country (UPV/POLYMAT), University of Potsdam (UP), as well as Medical University of Graz (MUG) and Zurich University of Applied Sciences (ZHAW).

We have asked our end users and RTOs to share their experiences with the PATs, highlighting the benefits, advantages, as well as the possibilities observed when installing and using these technologies. Additionally, they discuss the challenges and limitations encountered.

Case Study	End User	Tested Technologies	Nano-material	RTO involved
1	Covestro	PDW, TUS	Polymeric dispersions	UPV
2	EVONIK	PDW, TUS	Silica	UP
3	FLUIDINOVA	OF2i	Hydroxyapatite	MUG
4	ARKEMA	PDW	Zeolite	ZHAW
5	Cnano	OF2i, TUS	Ceramic	MUG

Watch the interviews below to get more insight!





In the following video you can get the impressions of some of NanoPAT partners: Usue Aspiazu (University of Basque Country/POLYMAT), Juan Enriquez (Analisis DSC), Alex Grigoropoulos (Creative Nano), Roland Hass (PDW Analysis GmbH), Blanca Suárez Merino and Deven Joshi (TEMAS Solutions GmbH) and Christian Hill (BRAVE Analytics GmbH).

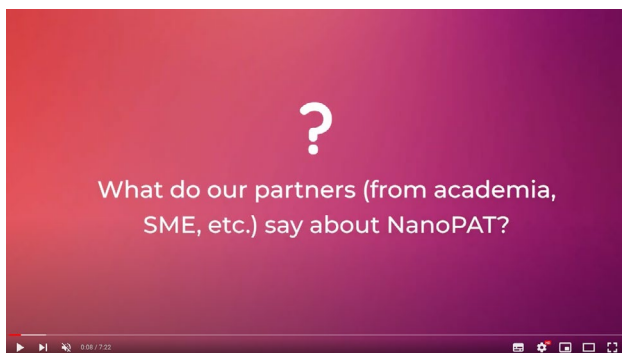
Interview with BNN on (nano)safety and Safe-by-Design

We interviewed Susanne Resch, health & safety expert at BNN, on the relevance of (nano)safety assessments, nano-specific regulatory requirements and the implementation of the Safe-by-Design concept – and how this interlinks with the Process Analytical technologies developed within NanoPAT. Watch the interview to get more insight!



TV report on Austrian Local TV

NanoPAT had the great opportunity to participate in a short report on local TV in Styria (Austria). The three Styrian partners, MUG, BRAVE and BNN seized the moment and made a valuable contribution, among others, highlighting the impact of NanoPAT on society and beyond as well as commenting on the contribution of the 3 Styrian organisations involved in the project: MUG, BRAVE and BNN. The report was shown on an Austrian local TV (ORF2 Steiermark); hence the language is German. Watch the TV report [here](#).



Partners' testimonials on NanoPAT's impact

As the project is coming to an end, we have asked the project partners about their perspectives on the project's impact and what the project has done for them.



Knowledge Transfer Activities

Several visits between NanoPAT partners were performed during the last six months, with the main objective of networking and internal knowledge transfer activities to ease the developments within the project over these last few months:

- In November 2023, colleagues of UP, PDWA and ZHAW visited Arkema (France) for a first measuring campaign of the PDW technology in their zeolite pilot plant. Read more about it [here](#).
- The IRIS team visited in January 2024 Evonik's facilities in Germany to validate the TUS technology in their nanostructures silica pilot environment. Read more about it [here](#).
- In March 2024, IRIS again visited Evonik for a 2nd measuring campaign of the TUS technology in the pilot plant environment. Read more about it [here](#).
- End of April 2024, colleagues of UP, PDWA and ZHAW again visited Arkema for a second measuring campaign of the PDW technology in their zeolite pilot plant in Lacq, France. Read more about it [here](#).
- Also in April, and triggered by BNN, NanoPAT had a very lively internal brainstorming session about further NanoPAT exploitation and next steps.
- In May 2024, the Safe-by-Design (SbD) expert in the project, BNN, supported by TEMASOL, presented NanoPAT's SbD concept to the whole consortium.
- Also in May 2024, colleagues of PDWA visited Arkema's facilities for a third measuring campaign of the PDW technology in their zeolite pilot plant in Lacq, France. Read more about it [here](#).

Some impressions



Visit of UP, PDWA and ZHAW at ARKEMA



2nd measuring campaign at Arkema



Additionally, NanoPAT has made some more steps toward the standardisation of its novel PAT technologies. Within the framework of a Meeting of the CEN/TC 352 “Nanotechnologies” group, representatives of BRAVE and UP/PDWA presented the characterisation techniques OF2i and PDW, highlighting their properties for the

unique determination of specific parameters of nanomaterials (e.g. particle size, etc). As these technologies have not just been tested at laboratory scale, but in real life and industrial scale in different applications/scenarios, they have a high potential for standardisation.



ARKEMA

At Arkema we tested the PDW Spectroscopy technology. PDW gives a good indication of the onset and end of the crystallisation step and can be used during the development of new synthesis routes. In our specific case, it allowed a significant shortening of the crystallisation time. For particle sizing and probe-head stability further development is still needed.

NanoPAT Retrospect

During the last six months, NanoPAT was very active participating in different **conferences and events**, sharing the developments of our project and our know-how:

- ➔ In January 2024, TEMASOL participated in the NMBP-35 exploitation workshop, jointly organised by the H2020 Projects CHARISMA, NanoMECommons, and EASI-STRESS, for identifying synergies and potential collaboration points between the projects.
- ➔ In February 2024, NanoPAT's coordinator Poojan Timilsina (IRIS), attended the Joint Workshop Advanced Materials Characterisation and Modelling Projects organised by HaDEA, presenting NanoPAT's key aspects.
- ➔ In March 2024, colleagues from Cnano, TEMASOL and BNN participated in ANTHOS'24. In addition to the overall networking activity in the tremendous event organised by BNN, Alex Grigoriopoulos (Cnano) gave an oral presentation on 5 March on "Promoting photocatalytic activity of S-doped TiO₂ NPs by applying a SbD modification", promoting mainly the research carried out in the SbD4Nano project, but highlighting the collaboration between projects, the impact of EU funded projects, as well as the role of NanoPAT in their developments. Read more about it [here](#).
- ➔ In March 2024, Roland Hass from PDWA presented NanoPAT and the PDW technology at the Bio-PAT Partnering Event for Bioprocessing & Process Analytics.
- ➔ Also in March 2024, BNN attended the EIC Summit, the ETP SusChem Board and the EU R&I Week '24 in Brussels with the aim of promoting NanoPAT process analytical technologies to the stakeholder groups at these events. Read more about it [here](#).

Some impressions



NanoPAT at ANTHOS'24

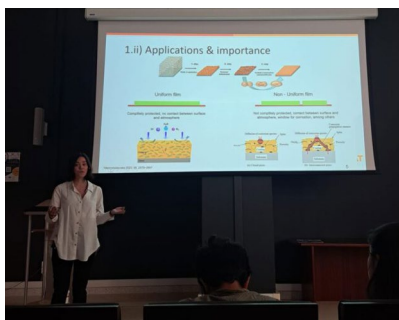


BNN at EU R&I Week '24

- ➔ In April 2024, BRAVE participated in Analytica 2024 in Munich, promoting the project and their OF2i technology in their booth. Additionally they had a poster presentation. Read more about it [here](#).
- ➔ On April 19, Usue Aspiazu from UPV/POLYMAT attended the PhD Day of the Faculty of Chemistry in San Sebastian (Spain) to highlight the importance and usefulness of particle size monitoring techniques in the field of emulsion polymerization, due to the effect that particle size and particle size distribution has on the final latex applications. Read more about it [here](#).
- ➔ On May 24, colleagues from TEMASOL participated in the Kick-off meeting of CEN/WS “Review the contents of CWA 17815:2021 “Materials characterisation - Terminology, metadata and classification”, for bringing forward the standardisation activities related to the PAT technologies developed in NanoPAT.
- ➔ On May 24, BNN and BRAVE participated again in the “Lange Nacht the Forschung“ (the long night of science) in Graz, Austria, for bringing science closer to the general public: BNN explained on their hands-on station the importance of nanomaterials and nanotechnology, and how to discover them in everyday life, through interactive activities, such as quizzes and memory games. BRAVE organised a guided tour through their laser laboratory explaining the use of their OF2i technology in e.g. medicine. Read more about it [here](#).



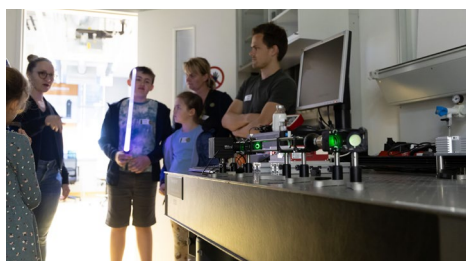
BRAVE at Analytica 2024



PhD Day at UPV/EHU Chemistry Faculty



BNN at „Lange Nacht der Forschung“



BRAVE at „Lange Nacht der Forschung“



Upcoming Events

Before the project ends, some highlights of the events where NanoPAT will be present in the upcoming months. Don't miss us at:

- [Polymers 2024](#), 28-31 May 2024, Athens (Greece)
- [Industrial Technologies 2024](#), 03-05 June 2024, Namur (Belgium)
- [Achema 2024](#), 10-14 June 2024, Frankfurt am Main (Germany)
- [19th European Student Colloid Conference](#), 24-27 June 2024, Bordeaux (France)
- [Materials Science and Technology Congress](#)
(Materialen Zientzia eta Teknologia kongresua), 3-4, July 2024, Bilbao (Spain)

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CNANO

At Cnano we tested the OF2i and TUS process analytical technologies. By participating in the NanoPAT project, we have learned a lot about how ceramic nanoparticles “behave” when dispersed in plating baths.



Thanks for *everything*

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