

NanoPAT Newsletter

November 2021

Online real-time characterisation solutions for nanoparticle production processes



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Welcome

Dear reader,

NanoPAT project is glad to present our third project newsletter with the main aim of sharing with you our latest technical achievements, introducing our innovative partners and sharing with the community inputs and curiosities related to nanotechnology and process monitoring.

In this third issue you will find an update of the project status. Furthermore, two of NanoPAT's project partners will be presenting themselves. Additionally, some achievements of the last months will be highlighted!

Already in the second year of the project, some preliminary results have been obtained. Thus we will have the opportunity to present them in the public by participating in upcoming fairs and workshops. On behalf of the NanoPAT project I would like to thank you all for being interested in innovation and technology asking you to stay tuned during the next 2.5 years! 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 <u>nanopat_co-</u> <u>ordination@iris.cat</u> and subscribe to our newsletter to receive further information and explore possible collaborations.

Best regards and enjoy the read,



Ioannis Kakogiannos, Coordinator of NanoPAT

NEWSLETTER #03



Project status

The project is currently running its second year with very promising results so far. The three monitoring technologies to be developed and validated within the project are getting more and more matured. Over the last months IRIS, PDWA and BRAVE (PAT technology providers) developed their prototypes and at the current stage, a lab scale validation is taking place at UP, ZHAW and UPV (three of the RTO pilots). The nanoparticles to be monitored by them are silica particles, zeolite and polymers, respectively.

Once we have a successful validation in lab scale, then we are going to move into a pilot scale validation. EVONIK, DSM/COVESTRO, ARKE-MA, FLUIDINOVA and CNANO are already preparing their pilot lines for hosting the prototypes. At the same time, a lot of activities are being organized by BNN and TEMASOL towards collaboration with other EU funded projects with similar or supplementary activity. Since the beginning of the NanoPAT project, we appreciate the valuable exchange of ideas with professionals of the industry and, thus, are eager to integrate tools that can help us fulfill the common goal.

Over the next period, BNN is also organizing very interesting events for the dissemination of our results. Several workshops are planned to happen, so stay tuned for more information on this aspect.



Overview of roles of the partners in NanoPAT



Partner presentations

In this issue we are happy to present our partners MUG and UPV.



About Medical University Graz (MUG)

The <u>Medical University of Graz (MUG)</u> with about 2500 employees and approx. 4300 students comprises 3 pre-clinical Research Centers, 4 pre-clinical Institutes, 19 Clinical Departments, 1 Clinical Institute and a purpose-built Center for Medical Research equipped with highly specialized core facilities as well as modern lab and office space for research projects.

Within the NanoPAT project, MUG provides an adequate lab environment for the validation of the innovative OF2i® technology, which is well established and tested at the MUG on a lab level. The transfer into an industrial environment of OF2i® technology is currently an ongoing project as a SpinOff **BRAVE Analytics GmbH** from the Medical University of Graz.

Further, as partner of the Particle Characterization Lab Graz (**PaLab-Graz**, link only available in German) and the **BioTechMed Graz initiative** it also offers additional infrastructure by the Omics Center Graz and the NIKON Center Graz for offline validation processes of the OF2i technology within the NanoPAT project. Possible process evaluations/optimization, RTO validation and inter-technology comparisons through stateof-the-art stationary reference characterization methodologies DLS, NTA, SAXS, TEM, SEM are objectives within the project.

The University has been participating in numerous EU-funded projects (FP5, 6, 7 and Horizon 2020) and nationally funded projects (Austrian Science Fund, Austrian Research Promotion Agency, Anniversary fund of the Austrian National Bank) and acts as coordinator of various large research initiatives. MUG in general offers cutting-edge technology in the center for medical research (ZMF) with its core facilities in Molecular Biology, Mass Spectroscopy, Microscopy, Flow Cytometry, Ultrastructure Analysis.



About Universidad del País Vasco/ Euskal Herriko Unibertsitatea -

POLYMAT (UPV/EHU - POLYMAT)

The University of the Basque Country (UPV/ EHU) is a teaching and research institution officially founded in 1985. The University of the Basque Country is at the helm of Research. Development and Innovation in the region of the Basque Country. POLYMAT is an internationally reputed research centre in Polymer Science in Donostia-San Sebastián, Spain. POLYMAT includes 34 Assistant, Associate and Full Professors and almost 130 PhD students and postdoctoral fellows. It is a multidisciplinary research center, which includes a wide variety of research teams working in the fields of polymer synthesis, polymerization reaction engineering, membranes, polymers for electronic, energy storage and biomedical applications, rheology and polymer processing.

Within POLYMAT-UPV/EHU, the activities related to this project will be conducted by the Polymerization Processes group that is composed of 6 academic staff, 4 postdocs, and 25 PhD students plus two lab technicians (MALDI-TOF and liquid chromatographic analysis). This is an international and multicultural research team that in the last years has hosted PhD students and postdocs from 20 countries. The Polymerization Process Group of POLYMAT-UPV/EHU is focused on the fundamental understanding of industrially relevant polymerization processes with special emphasis on polymerizations in dispersed media. Polymer dispersions are product-byprocess materials whose microstructure, and hence their final properties, are mostly determined in the reactor. Therefore, the understanding of the processes occurring in the reactor is crucial to achieve an efficient, consistent safe and environmentally-friendly production of polymer materials with improved performance.

The group has over 600 m² of laboratories equipped with state-of-the-art computer controlled reactors to perform polymerization reactions. Techniques for the full characterization of the polymers are available, such as: TEM, AFM, SEM, MALDI-TOF Mass Spectrometer 1H and 13C NMRs, DSC, FTIR, DLS, Disc Centrifuge, CHDF, GPCs (SEC/MALS/RI and AF4/MALS/RI), ultracentrifuge, surface tensiometers, contact angle measurement, etc.

UPV/EHU will lead WP1 defining the requirements and the state-of-the-art of the nano-monitoring technologies that will be used within the project. Moreover, UPV/EHU will have an active role in WP2, WP4, WP5 and WP6. For instance, laboratory testing of samples, synthesis of polymeric dispersions with the use of PDWA and TUS, and comparison of the results obtained by conventional methods as well as, definition of up-scaling specifications will be performed. In WP2 and WP4 UPV/EHU, will be in charge of implementing PDWA and TUS technologies in the monitoring of the production of polymeric dispersions. The role in WP5 and WP6 will be to contribute and give assistance to the partners involved in simulating the process (WP5) and synthesizing polymeric dispersions at large scales (WP6).



Highlights

Presentation of new partner in the project, BRAVE Analytics GmbH

A BRAVE new way of nanoparticle characterization

The principle of the OptoFluidic Force Induction OF2i[®] technology is based on a completely new approach - a targeted (de)acceleration of nano-particles by optical and fluidic force fields. With this technology, statistically relevant particle properties such as size, number-based size distribution and concentrations can be measured continuously online and in real time. The result of this patented OF2i[®] approach is a much deeper and more representative live insight compared to current reference measurement methods, making it a process analytical technology of choice for industrial applications.

BRAVE, as a spin-off of the Institute of Biophysics - Medical University of Graz (MUG), it is still connected and closely working together with MUG for the further development of the OF2i[®] technology. Within the framework of nanoPAT, research in the area of technology validation (MUG) must be advanced on the one hand, but also in the area of hardware, software and application, which is the focus of the BRAVE team. Therefore, BRAVE joined NanoPAT, as a new beneficiary, in September 2020.

The main goal of BRAVE Analytics is to translate the patented OF2i[®] technology into sen-

sor platforms that enable automated, real-time and 24/7 nanoparticle characterization that can be directly integrated into the manufacturing process. Together with the NanoPAT industry partners Fluidinova and Creative Nano, BRAVE is working on increasing TRL levels, gathering feedback from industry and further developing the BRAVE B1 sensor platform to be ready for industrial use soon.

Within the last months, the optical stability, mechanical and fluidic components have been optimized for continuous measurement of nano-hydroxyapatite (Fluidinova) and ceramic composite coatings (Cnano). The OF2i software suite H.A.N.S. 2.1 was equipped with Nano-PAT-specific software packages, real-time data processing was implemented and the graphical user interface was further updated. The underlying OF2i-specific theoretical models were adapted and application-specific particle libraries are under development. Two NanoPAT-specific OF2i sensor station prototypes were built as industry-ready 19" rack stations and delivered to the MUG, which is currently running the small reactors of both use cases for the TRL5 validation phase. BRAVE is excited to contribute to the goals of NanoPAT consortium and looks forward to the challenges, tasks and, of course, rewarding results to come.



News from WP5

The work package 5 "Monitoring Technologies integration, Data Analysis and Simulation software", led by the project partner ANALISIS-**DSC**, started last May 2021. This WP deals with the development of a PAT software platform that will centralize the data stream coming from the different nano-characterization technologies (PDW, OFi2, TUS) and data-driven tools to boost process efficiency in real-time. Specifically, the numerical tool to be used within this WP is a Computational Fluid Dynamic (CFD) tool; these CFD tools analyze different phenomena related to fluids. NanoPAT takes advantage of these tools with the addition of particle behaviour to predict how the flow and particles will interact with each other for the different case studies where the different measuring devices

developed at NanoPAT will be more effective.

Until now, WP5 partners have focused on 2 tasks: a) Initial CFD analysis of some of the case studies to simulate each industrial application to optimise the integration of nano-monitoring systems and other instrumentation in production processes to obtain a high degree of fidelity of the measurements. And b) Initial discussions on the protocols required for the information exchange between the measurement devices of the technology providers (PDWA, BRAVE and IRIS) and the PAT platform and how to display this information to the end users (DSM, Evonik, Fluidinova, Arkema, Cnano) of the different case studies (polymers, silica, hydroxyapatite, zeolite and ceramic, respectively).



Overview of NanoPAT case studies



NanoPAT News

During the summer months of 2021, NanoPAT was very active. Several visits were performed between partners with the main objective of networking and internal knowledge transfer activities to ease the developments within the projects in the upcoming months:

- → Visit of IRIS to POLYMAT (TUS training), 14th 18th June 2021, San Sebastián, Spain
- → Visit of POLYMAT to UP (PDW training) (31st May 2nd July 2021)
- → Visit of ZHAW to UP (PDW training), 28th June 2nd July 2021, Potsdam, Germany
- → Visit of TEMASOL at UPV/POLYMAT (SbD assessment), 15th July 2021, San Sebastián, Spain
- → Online PDW training from UP to UPV/POLYMAT, Covestro/DSM, ARKEMA, ZHAW (PDW training), 9th July 2021

Furthermore, in July 2021, the PAT devices, developed by the technology providers BRAVE, PDWA and IRIS, were handed over to the RTO pilots and are already installed for beginning with the measurements after an optimization of their configurations:

- ➔ PDW spectrometer from PDWA to UPV/POLYMAT (The PDW spectrometers were already installed in the past months at ZHAW and UP/innoFSPEC).
- → OF2i device from BRAVE to MUG.
- → TUS device from IRIS to UPV/POLYMAT, MUG and UP/innoFSPEC.





Zeolite synthesis by Despina Emmanouilidou in the Lab of Industrial Chemistry at ZHAW in Wädenswil

TUS systems delivered and installed





BRAVE & MUG teams uncovering the brand-new BRAVE B1 prototypes



First PDW measurements at POLYMAT



TUS equipment



PDW training at UP

NanoPAT Retrospect

The last 6 months we have been very active! Here you can read about latest activities:

Events with an active role of NanoPAT:

- > NanoPAT @ Advanced Materials 3rd Thematic Conference, 24th June 2021, online
- → NanoPAT @ NanoTEXnology 2021, 3rd 10th July 2021, online
- → NanoPAT @ Nanoinnovation2021, 21st 24th September 2021, online
- → NanoPAT @ EuroPACT, 15th 17th November 2021, online



External Trainings & Knowledge Transfer activities of NanoPAT:

- → Course on Emulsion Polymerization Processes, Sept-Oct 2021, online
- → Interactive PAT workshop @ EuroPACT 2021, 15th November 2021, online

Upcoming Events

- National congress on nanomaterials, science and technology, 29th 30th November 2021, Bilbao (Spain) (Materialen Zientzia eta Teknologia V. kongresua)
- → <u>1st NanoMECommons Workshop</u> on "Materials characterization challenges to support the industry transition in the digital era", 10th December 2021, online
- → 11th Nano Training School 2022 Exact dates to be decided (end of May/beginning of June 2022, Venice, Italy), stay tuned!

→ SAVE THE DATE: NanoWeek 2022, 20th - 24th June 2022, Limassol, Cyprus





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