

## The SIMPLI-DEMO project

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### Aim

SIMPLI-DEMO – *Demonstration of Sonication and Microwave Processing of essential chemicals* – project aims at strengthening the chemical process industry and in particular the specialty chemicals and pharmaceuticals industries in its capacity to produce materials and chemicals in a sustainable and competitive way.

This contribution is made by moving from batch to continuous and modular production with flexibility being ensured by the application of alternative energy forms. Currently, the conventional technologies in the specialty and pharma sector tend to be batch-type. These technologies are combined with mechanical mixing and conduction-based heat transfer, inherently leading to poor process control. SIMPLI-DEMO's vision is that of intensified processes, where alternative energy sources enable flexible continuous technologies to achieve localized ultrasound and microwave actuation of multiphase, flow reactors powered by electricity from renewable sources for the purpose of high-value product synthesis.

SIMPLI-DEMO focuses on the synthesis of specialty polymers and particles for use in a wide variety of every-day-use products, e.g. insulation, paints and coatings, plastics, catalysts, as well as health applications, which are important domains in the chemical industry today and into the future. In this context the project follows an integrated approach along the targeted technology readiness level (TRL). SIMPLI-DEMO advances the TRL of modular flow technology for multiphase streams involving suspensions or viscous products from TRL5 (validation in relevant environment) to TRL7 (industrial system demonstration).



### Concept

SIMPLI-DEMO's ambition is to present the first pilot-scale system prototype demonstration for the long-term uninterrupted modular flow operation of solids-laden and viscous-phase containing liquid process streams allowing for decentralized production. At the core of the project are four case-studies, serving as representatives for process classes of high importance in the chemical industry. The research relies on prior art up to at least TRL 4 (Experimental setup in the laboratory) to bring TRL from 5 (technology validated in relevant environment) at the start of the project to a level of 7 (industrial system prototype demonstration) at the end of the four-year project. The industrial demonstration stage will show uninterrupted production for several days to weeks, with an annual production rate of 10 to 100 ton/y.

Each of these case studies is of interest to one industrial end-user in the research consortium. The project will divide the research into two fields of application. Both in the reactive extrusion application field and in the reactive crystallization application field, the project will conduct two-case studies with a different TRL. The case studies are supported by generic and applied research on process modularity and process control & automation, including Process Analytical Technologies (PATs). In addition to the process technology oriented activities, the sustainability and techno-economic improvement is investigated that can be reached by transitioning from a batch process to a modular continuous process.

### Innovation and technical progress in SIMPLI-DEMO

As an integral part of SIMPLI-DEMO's overall view of scale-up, this project uses the Modular Type Package (MTP) concept to take an innovative

modular approach to automation. MTP describes the module interfaces and functions needed for process control and for the digital integration of encapsulated equipment modules in higher-level control systems. A controller and the basic automation functionality of a modular equipment can be easily integrated into a heterogenous, vendor-independent system environment.

Within the automation engineering, the basic automation of a module can be implemented as a black box but offering service-oriented interfaces to higher-level control systems. The higher-level control systems orchestrate the modular plant units by coordinating and invoking the services provided by each module. Overall, the MTP concept paves the way of future-oriented open and flexible service-based system architectures for process control.

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#### For further reading

<https://simpli-demo.eu/>

#### About the author



**Georgios Stefanidis** is Professor at the National Technical University of Athens (NTUA). He holds a Diploma in Chemical Engineering from NTUA and a PhD degree in the same field from the University of Gent. He has co-authored over 100 peer review publications in the broad field of Process Intensification, mostly focusing on alternative energy forms and transfer mechanisms (mainly microwaves and plasma). He is currently one of the Editors of the Chemical Engineering and Processing: Process Intensification Journal (Elsevier), Vice-Chair of the EFCE Working Party on Process Intensification and serves on the scientific committee of the Association of Microwave Power in Europe for Research and Education (AMPERE).

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## *The LEANFA company*

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LEANFA is an Italian company founded in 2014, specialized in design and manufacturing of solid-state microwave and radiofrequency amplifiers and generators, that has recently joined the renowned MUEGGE Group. LEANFA's technology has already been widely validated by several universities and research centres worldwide, and its OEM microwave generators have progressively been adopted by demanding customers involved with projects in the industrial, scientific and medical fields. LEANFA's strong point is essentially its ability to work with a small and efficient team and to count on the great skills flexibility of its young engineering team.

LEANFA's work is constantly focused on grabbing the best of the great advantages of the innovative solid-state microwave technology, especially by means of suitable software platforms that are co-designed with the microwave generators, opening the doors to a virtually infinite series of easily customizable applications which are at the same time very user-friendly and allowing processing accuracies so far unimaginable.

LEANFA's OEM generators are compact, lightweight and highly reliable, perfect to be quickly integrated in equipment for applications in many ISM fields (e.g., solid-state cooking, microwave chemistry, plasma generation, organic tissue ablation, automotive ignition and many others), fully