



## New advances in microwave-assisted green chemical processes at the University of Turin with synthWAVE and flexiWAVE



### Customer

The University of Turin, founded in 1404 by Prince Ludovico of Savoia, is currently one of the three best Italian Universities with Bologna and Padua (ANVUR national ranking 2011-2014). The DSTF is well known for the development of enabling technologies for process intensification in green and sustainable chemistry. The DSTF has active collaboration with big companies (Ferrero SpA, DSM nutritional products, Lavazza SpA, Indena SpA, Bracco Imaging SpA etc) and is partner of several EU H2020 projects.

### Challenge

Chemistry, and in particular organic synthesis, have often been criticized for their propensity to exacerbate both the depletion of natural resources and the rate of ecological impact. In the third millennium, it is now mandatory to harness innovation to forge a sustainable approach to organic synthesis.

### Solution

If we are to achieve innovation in organic synthesis, the two main pillars, besides

the understanding of reaction mechanisms and the design of eco-friendly strategies, must be efficient catalysis and process intensification with suitable enabling technologies and reactors. In this context microwaves play a crucial role.

### Background

The DSTF has 20 years of experience in the application of non-conventional techniques such as ultrasound, hydrodynamic cavitation, ball milling, and microwaves, that can dramatically enhance chemical conversions as well as cutting down reaction times and energy consumption.



# CASE STUDY

## Synthesis | Academia



The DSTF's group of organic chemistry contributed to books, reviews and papers describing the huge advantages of microwave-assisted organic synthesis and microwave-assisted extraction (Springer 2013: Microwave-assisted extraction for bioactive compounds: Theory and practice; De Gruyter 2017: Microwave Chemistry).

### Implementation

The demand for renewable energy sources for organic synthesis has steadily increased over the last two decades. Biomass has been recognized as a major worldwide, renewable source of fixed carbon and one which can be used for the production of fine chemicals, biochemicals, bio-based polymers and biofuels providing immense industrial and economic benefits in chemical production and beyond, thus ensuring the complete embedding of the circular economy's recycling concepts.

### Benefits of the synthWAVE and flexiWAVE

In the last few years the DSTF's researchers could emphasise the fact that efficient, sustainable and scalable synthetic protocols require the last generation of microwave reactors (synthWAVE and flexiWAVE), as irreplaceable tools in modern chemistry for the unique versatility to carry out new experiments in a wide range of operative

conditions. SynthWAVE enable to perform parallel synthesis at high pressure and temperature (up to 200 bar and 300°C) under any gas or gas mixture. FlexiWAVE keep in one equipment all the tools developed in two decades for fast plant extraction, hydrodistillation, biomass conversion, polymerization etc.

### Conclusion

Economic literature has often stated that innovation and evolution feed off the following triad: demand pull, science push and technology push. Thanks to Milestone technology it is now easier to address the research model of E.J. Corey, Nobel Prize in 1990. Besides well-established synthetic methodologies, he highlighted the need of innovative and even speculative approaches.

### About Milestone

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