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Tools for Efficient Microwave Chemistry: optimised applied electric field and accurate power control

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PURPOSE OF THE ABSTRACT

The EU strategy for the bioeconomy is making a profound change to how the energy is produced and how the materials are used. The policymakers and business leaders predict a significant increase in biomass reliance to reduce the dependence on non-renewable, unsustainable sources.

The biomass can be transformed into fuels and/or chemicals. The production of fuels (charcoal) from wood was developed thousands of years ago, while the secondary tar was successfully used in preserving wooden sailing vessels against rot. Tar (bio-oil) represents a complex mixture of oxygenated-organic blocks, which are ready to be used in the industry without a pre-functionalization step.

There are two routes for biomass valorisation: biochemical and chemical. Alternatively to the biochemical technology, the chemical technologies (thermochemical) are rapid but less selective towards valuable chemicals.

Sustainable thermochemical technology for biomass valorisation should be controllable and selective to maximize the value of biomass resources. Microwave heating is an alternative to the traditional conventional processes. However, it possesses improved control and higher selectivity due to a dipolar polarisation heating mechanism. In such a way, the major constituents of biomass (hemicellulose, cellulose and lignin) react differently during microwave conditions.

SAIREM has been developing microwave and radiofrequency technology for over 40 years to deliver innovative systems to the market. We are permanently working on the improvement of our sustainable solutions for homogenous and controllable heating.

Here we report a unique microwave system (MicroChem) with a possibility for an optimisation of the applied electric field, which substantially increases the number of samples suitable for homogeneous microwave heating. The integrated solid-state microwave generator has superior advantages over the magnetron-based technology such as operating from 1 W to the maximal power with 1 W step accuracy and choice of the suitable frequency from 2400 MHz to 2500 MHz.

The determination of the energy efficiency of the microwave-assisted reaction is important for the development of sustainable technology. The power balance is provided by SAIREM equipment due to real-time monitoring and control of the forwarded, reflected and transmitted power.

A combination of precise power control and power balance opens an opportunity to determine thermodynamic and the kinetic constants of the process, monitoring the phase-transition reactions in real-time.

Overall, the advanced features of MicroChem are very well adapted for biomass processing because of the improved repeatability and reliability of the processes, including extraction and pyrolysis. The available functions to study thermodynamics and kinetics open an avenue to improve the understanding of biomass processing mechanisms, making a step further toward a sustainable biorefinery of the future.

FIGURES

FIGURE 1

FIGURE 2

KEYWORDS
microwave | biomass | sustainable

BIBLIOGRAPHY