Thursday 13 March 2025 @ BASF Antwerpen (Antwerpen)

TRENDS IN ENERGY AND CHEMICAL PROCESS APPLICATIONS

Lecture

Green Electricity: from Source to Process

Ir. Frank Vanwynsberghe (BASF Antwerpen)

In the decarbonization of (chemical) processes, green power plays a crucial role. However, this green power comes with a multitude of challenges, such as, but not exclusively, generating sufficient power, researching new technologies, adapting the processes, the need for sufficient (electrical) knowledge, dealing with material bottlenecks as well as adapting the electrical grids. Frank Vanwynsberghe reflects on these challenges and explains how BASF Antwerp deals with them.

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Microwave Heating and Microwave Excited Plasmas - Alternative Technologies for Industrial Process Intensification and Decarbonisation

Dr. Ir. Marilena Radoiu (Microwave Technologies Consulting)

Industrial activity is a major contributor to the world's greenhouse gas emissions, and the immense diversity of the sector means that there is no one-size-fits-all solution to achieving net-zero emissions targets. Given the growing urgency to move away from fossil fuels and the potential role of clean energy in this transition, in many cases this means electrification. In this context, the use of electricity for the industry's transition to a decarbonised economy requires optimisation of the energy transfer to deliver efficient, cost-effective processes. These challenges open up new opportunities for the industry's transition to a resilient, energy-efficient, renewable and climate-neutral economy, ranging from implementing commercially available solutions to experimenting with new technologies.

However, this transition is difficult for many industries that require high temperature processing, high thermal energy rates and short payback periods for investments. For this reason, the use of microwave heating and microwave plasma assisted processing should be given special attention, mainly due to their unique physical properties combined with the possibility of using them as a source of very high temperature processing by opening up a new range of mechanical, chemical and metallurgical processing techniques.

While conventional heating processes by conduction and convection mechanisms are driven by thermal gradients in the material, microwave heating processes are governed by the energy conversion from microwaves as source of thermal energy, which acts directly on the materials through molecular interaction with the electromagnetic field, thus avoiding limitations to heat transfer by conduction. Moreover, if the sample is heterogeneous and contains materials with different response to MW, this can lead to a localized heating in the sample, which may be more effective than the bulk heating achieved by conventional methods.

Many of the industrial applications being built today using microwave power have large power requirements, some installations require over 100 kW, and this implies that the microwave generator must have high grid efficiency to avoid energy wastage. The microwave power generated must be stable to ensure plasma stability and process and equipment reliability. This leads to the choice of the 915 MHz magnetron-based generator as the main industrial choice due to its high-power output, efficiency and relatively low CAPEX compared to other microwave generators such as klystron, gyrotron and even solid-state generators. 915 MHz solid-state generators currently have insufficient microwave output power and grid efficiency to be considered for high power applications, but scale-up to > 100 kW should consider the use of multiple plasma reactors, in series or in parallel, each reactor connected to its own microwave generator.

Here we give examples of industrial applications that have proved that the implantation of the microwave-assisted processing can open opportunities to develop new products and more energy efficient and rapid processes with high potential for the industry, e.g., quality enhancement, better process control, higher yields, smaller footprint, more respectful to the environment.

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Unlocking the Future of Clean Energy: Catalysts for Ammonia Cracking

Ing. Franky De Wilde (Nippon Shokubai)

As renewable energy rapidly becomes more cost-effective than fossil fuels, the global shift towards sustainable energy is accelerating. With ambitious climate goals driving the demand for CO2-neutral solutions, massive investments in solar and wind energy are on the rise. However, these renewable sources are often abundant in locations far from where energy is most needed and are subject to interruptions like calm winds or reduced sunlight. This presents a critical challenge: how do we efficiently store and transport this energy?

One of the most promising solutions is to convert electrical energy into a chemical form. With the low cost of renewable energy, hydrogen production via electrolysis is becoming increasingly viable. However, hydrogen's low volumetric energy density makes it difficult to store and transport economically over long distances. For intercontinental energy transport, ammonia emerges as a powerful alternative, offering a carbon-free, high-density solution for energy storage and transfer.

Recent advancements now allow ammonia to be produced competitively from renewable sources. Its superior volumetric energy density and favourable physical properties make it ideal for long-distance energy transport. But the journey doesn't end there—at its destination, ammonia can be reconverted into hydrogen, unlocking its potential as a clean energy carrier.

In this keynote, I will unveil groundbreaking catalysts developed by Nippon Shokubai that efficiently crack ammonia into hydrogen and nitrogen. We'll dive deep into one of these innovations—a catalyst that enables autothermal cracking, eliminating the need for external energy inputs in this energy-intensive process.

Finally, I'll explore how the cracked gas from this process can be directly used in a Solid Oxide Fuel Cell, bypassing additional purification steps to produce electrical energy with exceptional efficiency. Join us to discover how these cutting-edge technologies are poised to revolutionize the future of clean energy and pave the way for a sustainable, CO_2-neutral world.