
Session **#Keynote lecture**

## Accelerating sustainability through the use of enzymes

**Jens Erik NIELSEN** Novozymes

Modern biotechnology holds the potential to introduce novel, more sustainable alternatives in many industrial, house-hold and agricultural processes. However, the robustness of chemical and fossil fuel based solutions and the pervasive subsidies for fossil fuel poses a great challenge to the introduction of biotechnology on a larger scale. Stability, safety and cost in use are parameters that are of vital importance, and it is important that the biotech industry jointly take responsibility for making biotech solutions as viable as possible on these parameters to compete in the modern economy. In the present talk I will discuss strategies and initiatives to promote the use of biotechnology – and enzymes in particular – as sustainable alternatives, and highlight some of the most important characteristics and use cases.


Session **#1**

## Tailored-made enzymes for industrial applications: screening from diversity to enzyme engineering

**Olivier VIDALIN** Protéus by Seqens

Abstract not received


Session **#1**

## Microfluidic methods for enzyme engineering

**Jean-Christophe BARET** University Bordeaux, CNRS UMR5031

Microfluidics provides means to miniaturize, automatize biological assays in microcompartments. By downsizing the size of microcompartments to tens of microns, single cells can be screened at a ultrahighthroughput based on their ability to catalyse chemical transformations. Over the past years, microfluidic methods have been used for directed evolution of enzymes making use of the capability of the technology to reliably analyse and screen large libraries of variants.

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Session **#1**

## AI-powered computational design for enzyme engineering

**Sophie BARBE** TBI (Toulouse Biotechnoloogy Institute), Biocatalysis department

The field of computational protein design (CPD) is currently experiencing an unprecedented phase of development, significantly impacting biotechnology. Our advanced CPD technologies leverage a unique combination of automated reasoning and machine/deep learning algorithms, along with molecular modeling and simulation methods, to enable the rational design of tailor-made proteins. The original automated reasoning capacities provide accuracy and computational efficiency while offering the ability to integrate design requirements together with physics-based models and/or learning-based models from various sources of protein data (including, sequence, structure, biochemical/biophysical data). This comprehensive approach provides effective means to efficiently address design challenges and pursue complex design objectives, which can be indirectly learned through machine/deep learning. The synergy between these AI algorithms and molecular simulations empowers us to consider multiple molecular and conformational states crucial for protein function, especially in the context of enzyme catalysis. These new computational protein design methods offer transformative solutions for accelerating and reduction the cost of developing tailor-made proteins, meeting the growing demand for sustainable processes in diverse industrial sectors. In this presentation, I will focus on our latest advances in CPD, highlighting their capabilities, with an emphasis on their application in the field of enzyme engineering.


Session **#1**

## EziG® – An advanced technology for enzyme immobilisation

**Sebastian GERGEL** EnginZyme (Sweden)

Immobilised enzymes have emerged as an indispensable tool in industrial biocatalysis, providing a range of benefits such as biocatalyst reusability, streamlined downstream processing, and foremost improved enzyme stability. The optimal choice of immobilisation support materials, however, is often a time-consuming and expensive process. This presentation introduces our advanced EziG® technology – a universal immobilisation matrix that offers a simple and cost-effective solution for a wide range of biocatalytic applications. EziG® is designed to achieve superior enzyme loadings, high activities, and stabilities with a wide range of enzymes, making it an efficient solution for immobilised enzyme-based processes, helping to meet the growing demand for sustainable industrial processes. At EnginZyme, we have successfully used EziG® to develop new process solutions for the production of in-demand chemicals ranging from pharmaceutical intermediates to food and cosmetic ingredients. This presentation will showcase the versatility, efficiency, and reliability of EziG®-based biocatalytic processes, highlighting their optimisation and scale-up with a case study as an example.

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Session **#1**

## Exploiting microbial cell factories to secure the future of industrial enzymatic biocatalysis

**Rita CRUZ** Ingenza Ltd (Scotland)

Establishing bioprocesses to manufacture valuable industrial enzymes in microrganisms requires the design, construction and optimisation of strain productivity and stability, fermentation and efficient DSP. Often, a diverse range of microbial cell factories, beyond the ordinary off-the-shelf Escherichia coli-based expression systems, must be explored to ensure scalable and economically-viable biomanufacturing of biocatalysts with broad genetic origins and associated challenges. This presentation will exemplify Ingenza's inGeniusTM platform of enabling technologies, offering enzyme manufacturers unique solutions to streamline and accelerate their industrial biotechnology and engineering biology processes. This platform combines Ingenza's gene design algortihm (codABLE®), a library of genetic parts, genome editing tools, FACS-assisted optimization of protein expression and tailored fermentation protocols for a wide range of organisms aimed at rapidly demonstrating bioprocess feasibility to meet future manufacturing requirements. Case studies will focus on how Ingenza has collaborated with its customers and academic partners to develop and tech-transfer new, efficient approaches for the production of industrially-relevant enzymes to manufacturing sites around the world. Our bioengineering technologies are bringing increased predictability to overcome persistent limitations associated with strain improvement, enabling rapid progression to process optimization and scale-up for applications.

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Session **#1**

## Challenges in scaling up industrial enzyme production

**Nico SNOECK** BBEU Ghent Belgium

The scale-up and production of new industrial enzymes is not straightforward and many consideration are required during development.

Bio Base Europe Pilot Plant will present the development and production of an HMF oxidase used during the production of FDCA, the building block of PET alternative PEF, from its EU project “SMARTBOX”.


Session **#1**

## Fast, easy, robust disruptive solution for enzyme quantification

**Philippe PEBAY** Zymoptiq France

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Session **#2**

## Enzymes, key processing aids and additives, essential for enhancing the performance and sustainability of food and feed

**Jacky VANDEPUTTE** Expert innovation

Enzymes are fundamental processing aids and additives that play a pivotal role in enhancing the performance and sustainability of the food and feed industries. They contribute to various critical aspects, including the improvement of organoleptic and nutritional quality in food products, the efficient utilization of waste materials such as meat by-products, the reduction of energy costs, and the potential for substituting or reducing preservatives and additives. Enzyme formulations not only provide solutions to energy and wheat-related challenges but also address consumers' growing demand for clean food labels.

Despite the century-long history of enzyme utilization in the food industry, there remains ongoing optimization of enzyme blend activity across the entire spectrum of food processing, encompassing areas like bread production, brewing, fruit juice extraction, and starch processing. Moreover, biocatalysis has long been employed within the food industry to generate both raw materials and finished products. Historically, the predominant focus of biocatalysis has been on hydrolytic reactions, particularly for debranching purposes.

However, recent patent analyses have brought to light innovative methods for molecule synthesis through biocatalysis. These breakthroughs have paved the way for the creation of diverse food ingredients, including prebiotics, low-calorie sweeteners, antioxidants, and pH regulators. Notable examples include hesperetin dihydrochalcone, rebaudioside, phosphatidylserine, gluconate, and gallate de propyle.

In this presentation, we will delve deeper into the multifaceted role of enzymes and biocatalysis in the food and feed industries, exploring their impact on performance, sustainability, and innovation.


Session **#2**

## How enzymes help you to be more sustainable in food ingredient processing

**Maureen DE WISPELAERE** DSM

Abstract not received


Session **#2**

## Enzymes for Feed

**Jlali MAAMER** Adisseo

Abstract not received

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Session **#2**

## Biocatalysis for Commodity & Speciality Chemistry

**Jean-Christophe LEC** Arkema

Chemical companies are optimizing their current processes for keeping global warming in line with the Paris Agreement. Especially, Arkema want to further reduce the environmental footprint of the Group's activities.

In this context, Arkema is developing a new R&D activity centered on biotechnologies for addressing tomorrow challenges. This conference will depict i) Arkema's expectations concerning biocatalysis technologies and ii) main key performance indicators fixed on feedstock, reaction, and downstream processing parts.

Then, these indicators will be illustrated through an industrial success-story: The hybrid process for Biomethionine production.


Session **#3**

## Enzymatic carbon capture

**Sonja SALMON** North Carolina State University (USA)

Global climate change is caused by high and ever-increasing demand for the electricity and heat generated by fossil fuel combustion that emits huge amounts of carbon dioxide ($CO_2$) into the atmosphere. Reactive absorption of $CO_2$ into alkaline liquids is known to be the most effective type of carbon capture method for emissions at atmospheric pressure, but the costs of broad deployment have been too high. The enzyme carbonic anhydrase (CA) catalyzes the reaction of $CO_2$ with water ($CO_2 + H_2O \leftrightarrow HCO_3^- + H^+$) when alkaline pH provides a driving force. This reaction is highly selective for $CO_2$ in gas mixtures and the fast reaction rate in otherwise kinetically limited solvents offers the potential to make more efficient and sustainable $CO_2$ capture systems. Biocatalytic wet filters made from textiles with CA immobilized at the surface dramatically enhance the rate of $CO_2$ reactive absorption in benign low-energy solutions to improve $CO_2$ capture efficiency. Description of the technology and results from prototype testing will be presented. These versatile easily customizable textile filters could be made to optimize effectiveness across a broad range of applications, including point source emissions, direct air capture and integration with $CO_2$ utilization or storage.

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Session **#3**

## Enzymatic plastic recycling

**Alain MARTY** Carbios

Abstract not received


Session **#3**

## EnZync: addressing difficult-to-recycle plastics with enzymes

**Alexander SANDAHL** Danish Technological Institute

Enzymatic deconstruction of plastics represents a recycling paradigm shift urgently needed in the transition to a sustainable future. Although enzymatic activity onto plastic thermosets has been reported, the fundamental understanding of the interactions and underlying mechanisms is needed if enzymes are to be applied in thermoset recycling.

The hypothesis of the EnZync project is that by discovering and developing enzymes and optimizing polymer substrate interactions, specific deconstruction of thermosets into their original building blocks will be within reach. To meet this scientific challenge EnZync has assembled key competences within the microbiology, molecular biology, biophysical- and organic chemistry as well as material- and computational science.

Thermosets like polyurethane and epoxy are targeted, as these are high performance and irreplaceable materials but suffers from low recycling globally. Characteristic to thermosets is a high content of perceivably enzymatically labile chemical bonds, however build-in crosslinking renders them insoluble and inaccessible to enzymes. EnZync will accelerate the needed structural- and functional characterization of both thermoset materials and enzymes, in addition to enzyme compatible process conditions.

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Session **#3**

## Optimized enzymes for controlling phytopathogens

**David DAUDÉ** **Gene&GreenTK, Proxis development group**

Gene&GreenTK (GGTK) is a deep-tech start-up that has emerged from the academic excellence of Aix-Marseille University. Founded in 2013, the biotech company specialises in the discovery, development and maturation of innovative molecules, in particular recombinant enzymes.

GGTK has developed VesuBACT, an enzyme technology derived from an extremophilic micro-organism capable of inhibiting bacterial virulence without generating resistance mechanisms. Thanks to its original mode of action - disruption of Quorum Sensing - this biocatalyst limits bacterial infection without killing the bacteria. VesuBACT's high stability means it can be used in a wide range of strategic sectors (food, human and animal health, water treatment and agriculture).

VesuBACT is therefore a sustainable response to major public health and environmental challenges in a global context of increasing antibiotic resistance. GGTK's priority is to develop a sustainable approach to combating phytopathogenic bacteria using its innovative enzymes. Proofs of concept in planta have already been obtained, showing efficacy comparable to conventional phytopharmaceutical products such as copper or streptomycin.

GGTK has developed a production process for its enzymes on a pilot scale and now wishes to industrialise production in order to begin the regulatory stages and go to market.

In addition to VesuBACT, GGTK is using its expertise to develop new disruptive enzymes and has already identified promising antifungal candidates.


Session **#4**

## Applications of prebiotic gluco oligosaccharide, ceramide analogs and laccases from Botrytis cinerea

**Florent YVERGNAUX** Solabia

Regardless of plant extracts, nature is an inexhaustible source of inspiration for the production of active skin ingredients. Thus, in many cases by observing nature and mimicking the molecules it produces or the mechanisms it brings into play, it leads to ingredients with great interest. But many times also the quantity of these molecules are very poor in nature. Over the last 40 years, biotechnologies and, in particular enzymology, have also become increasingly important in the research and development of compounds for cosmetic applications. So, the enzymatic strategy to mimick natural molecules is therefore an efficient and environmentally friendly way forward. The use of enzymes at industrial scale confers a large number of advantages to these development strategies. (One can for example quote, the nonpolluting productions, energetic gains, very strong limitation in obtaining secondary molecules ...).

Some illustrative ideas of active ingredients related to industrial use of enzymes (glucosyl transferase, lipase and laccase) will be described during this presentation.


Session **#4**

## How enzymes can bring stability and efficiency for cosmetics applications

**Alexis RANNOU** Givaudan Active Beauty

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