Data-Driven Enzyme Immobilization

Empowering Industrial Biocatalysis Through Data-Driven Development of Immobilized Enzymes

Inseit was founded in 2022 in Bern with the mission of developing biocatalysts that can be applied directly into industrial setups. Through enzyme immobilization and with its unique approach through biocomputation and advanced simulation technologies, the company is addressing key challenges in biotechnology and sustainability. Inseit was recently selected as part of the cohort of Venture Leaders Biotech 2024 by Venturelab, and was awarded in 2023 two prizes from the renown Nucleate accelerator.

CHEManager International: What inspired your innovative idea, and what problem does it aim to solve?

David Roura Padrosa: The idea for Inseit stemmed from recognizing the inefficiencies of the trial-and-error approaches in enzyme immobilization for biocatalyst development. Enzyme immobilization is a key technique, creating more stable and reusable biocatalysts, but it is still underused due to this. Other biotechnological fields also have the same combinatorial problem, for example enzyme engineering, and they have 'solved' it with data-driven approaches. So, we saw an opportunity to leverage computational tools and simulations to make enzyme immobilization faster and more predictable. Our innovation addresses critical bottlenecks in biocatalyst development, as development time and reliability are two of the main bottlenecks limiting the implementation of biocatalysis in industrial processes.

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Can you describe the key features and benefits of your innovation?

D. Roura Padrosa: Our core innovation lies in both *in silico* and in vitro innovations. First, before going to the lab we apply our *in silico* design workflows and simulations to understand what guides the immobilization of the protein and what are the best strategies to try. After this *in silico* screening, we go to the wet-lab screening. Here, we have been developing for the last two years a semi-high throughput screening platform that allows us to test multiple immobilizations at once. In combination, both aspects allow us to be rational, faster and more effective in our development.

On the other hand, we have also been working on expanding the off-the-shelve offer of immobilized enzymes. Currently, you can find almost exclusively only hydrolytic enzymes, but, biocatalysis goes way beyond this. We offer a wide range of optimized immobilized enzymes: transaminases, imine-reductases, alcohol dehydrogenases, ketoreductases and more. And we are constantly expanding this catalogue because we want to speed up the application of biocatalysis in R&D and production as much as possible.

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What challenges did you face during the development of your innovation, and how did you overcome them?

D. Roura Padrosa: One challenge is from a technical aspect and the other is based on industry. From the technical perspective, one of our main challenges was creating accurate models to simulate immobilization, including protein-material interactions, as this is quite a new approach and very little has been done in this sense. We are getting better at this almost every week, with the new data created and refining our models and assumptions. On the other side, one thing that we had to consider since the beginning was scalability. We are, ourselves, an R&D company but we know our solutions have to be applied at scale to have the impact we want. This is why, since the beginning, we have been looking for partnerships to ensure that what we can produce at the gram scale ourselves, could also be produced, in a fast manner, at the kilogram or ton scale.

> *"Unlike traditional methods that rely on extensive lab experiments, our technology significantly reduces the trial-and-error process."*

How do you plan to bring your innovation to market, and what is your target audience?

D. Roura Padrosa: Our go-to-market strategy focuses on positioning Inseit as a trusted technology partner offering customized solutions for enzyme immobilization. Our initial target audience includes R&D teams in large biotech firms, pharma companies and even CDMOs who are looking to implement biocatalytic steps in their synthesis. We offer both CRO services, to develop customized solutions for our clients and direct sales of the products from our catalogue. Also, it's important to say that we don't stop there and part of our offering is also the application in continuous flow of the desired biocatalysts — a tailored solution or screening the ones we have in our catalogue.

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David Roura Padrosa, Inseit

Personal Profile

David Roura Padrosa is the CEO and co-founder of Inseit, a spin-off from the University of Bern. David earned his PhD at the University of Nottingham (UK), focused on the discovery, characterization and application of novel enzymes for the synthesis of key intermediates in continuous flow. Since 2022, with Inseit, he combines his expertise in biocatalysis and bioinformatics for the development of novel tools that can advance the implementation of biomanufacturing strategies at scale.

What makes your innovation unique compared to existing solutions in the market?

D. Roura Padrosa: Inseit stands out because of its data-driven development. Time is crucial in development stages, and the fact that we can offer *in silico* planning of enzyme immobilization makes a difference for our clients. Unlike traditional methods that rely on extensive lab experiments, our technology significantly reduces the trial-and-error process. Our focus on tailored immobilizations and the wide offer in our catalogue is also unique, and it enables seamless integration of enzymes in multi-step synthesis.

Business Idea

Next-Gen Immobilized Enzymes

Enzymes are powerful catalysts for the synthesis of key chemical intermediates, drugs, food ingredients, and biofuels. But on an industrial scale, they often suffer from rapid inactivation due to harsh reaction conditions, requiring careful evaluation of their cost-efficiency. Moreover, while enzymes excel in certain reactions, they must normally be integrated with up or downstream chemical processes, and in their free form, they can be difficult to incorporate effectively. This limits their widespread adoption despite their demonstrated potential for greener manufacturing, but industries worldwide need stable, reusable enzyme systems to make their production processes both environmentally friendly and economically viable.

Inseit has developed developed a smart platform for enzyme immobilization to address these challenges. Its approach combines computer-based screening (*in silico*) with targeted lab testing (*in vitro*) to quickly identify optimal ways to immobilize enzymes in their most favorable conformation. This enhances enzyme performance, longevity, and reusability while making them more compatible with industrial processing requirements.

The company's tailored bioinformatic workflow sets it apart from conventional methods. It leverages data analytics, machine learning, and advanced simulations to predict optimal immobilization strategies before extensive laboratory testing, saving resources and accelerating time-to-market.

Inseit offers two commercial pathways: custom immobilization development services tailored to specific reaction requirements, and a growing catalog of ready-to-use immobilized enzymes designed for efficiency and versatility. Its products can be seamlessly integrated into existing production lines with minimal process adjustments.

Looking ahead, the company will expand its catalog and refine its technology to help industries adopt sustainable practices. Inseit's vision is to make enzymatic processes the preferred choice for green chemistry applications.

- Inseit, Bern, Switzerland
  www.inseit.ch

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BIOCATALYST IMMOBILIZATION

Elevator Pitch

Towards the Integration of Industrial Biocatalysis

Recognizing the limitations of traditional approaches, the Inseit team developed a Data-driven method for enzyme immobilization. Since 2022, they have developed the *in silico* screening platform, secured key customers, and released the early catalogue of readily available immobilized enzymes. Looking ahead, Inseit is raising a second round of investment to scale its operations, expand the catalog and secure strategic partnerships with CDMOs for pilot projects

Milestones:

2021
- Inseit was selected to participate in the international accelerator organized by Johnson Matthey and The Bakery (UK) and build upon the first open-source tools made available in 2022.

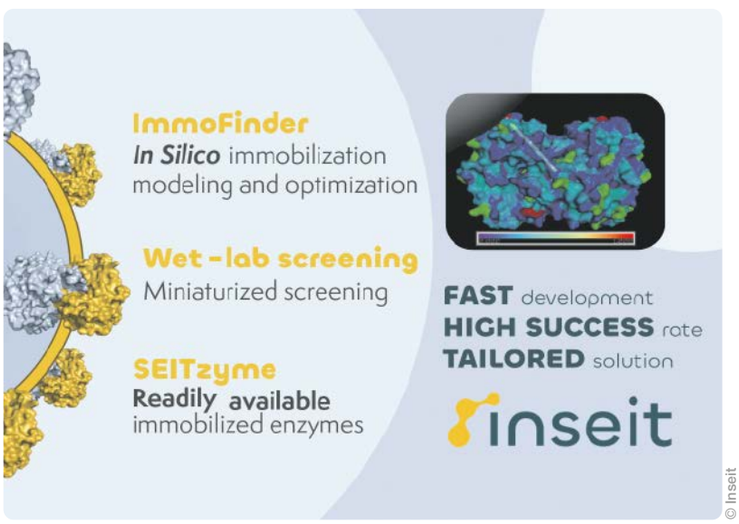
2022
- Awarded a Bridge Proof of Concept grant from Innosuisse and Swiss National Science Foundation
- Incorporation of Inseit in Bern, Switzerland after being awarded a Bridge Proof of Concept grant from Inosuisse and Swiss National Science Foundation.

2023
- Inseit attracted the first round of angel investment after securing the first customer projects.
- Awarded two prizes—Scientific Excellence and Novel Idea Award from the Nucleate Activator

2024
- Inseit was selected as part of the Venture Leaders Biotech 2024, connecting with VCs, partners, and clients from the Boston ecosystem.
- Release of the first iteration of the catalogue of immobilized enzymes, focusing on cofactor recycling and auxiliary enzymes.

Roadmap

Inseit is seeking to establish new collaborations and proof of concept projects with leading CDMOs and fine chemical companies. Further to that, it is looking for strategic investment to ramp up its R&D capacity to both further develop the predictive capacity of our *in silico* screening tools and expand its catalogue of readily available immobilized enzymes.



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Overview of Inseit data-driven technologies, allowing for a fast and reliable development of immobilized enzymes.

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The Inseit team (from left to right, Gordon Honeyman, Cristina Lia Fernández Regueiro and David Roura Padrosa).