The first green, non-toxic antifouling agent for sealants, coatings and paints to transform the construction and marine industries

Reporting

Project Information

ZABIO

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Project website

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Project closed

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Coordinated by
CYSBIO
Denmark

Periodic Reporting for period 3 - ZABIO (The first green, non-toxic antifouling agent for sealants, coatings and paints to transform the construction and marine industries)

Reporting period: 2022-10-01 to 2023-03-31

Summary of the context and overall objectives of the project

Across many huge industries, like construction, marine and agriculture, toxic biocides are used as antifouling agents to prevent micro- and macro-organism damaging surfaces. However, such antifouling agents pose large environmental and societal burdens as they pollute the environment, harm ecosystems, are produced by fossil-based chemical synthesis or heavy metal extraction, and are hazardous to the health of workers, consumers and the public. Increased regulations and legislations regarding banning and lowering use of toxic antifouling agents is pushing industries to seek for green alternatives. However, no safe, eco-friendly and cost-competitive antifouling agents are currently available that meet the functional requirements to prevent attachment of organisms until now. Cysbio has developed a proprietary cell-based manufacturing system for renewable production of sulfated compounds, of interest is the bio-based antifouling agent zosteric acid (ZA-bio). The team has leveraged advanced metabolic and enzyme engineering to optimize yields of ZA-bio, creating a cell factory system that can be upscaled to meet substantial chemical company demands. Cysbio enables a green and safe antifouling agent that is commercially viable for the first time, as ZA-bio is cost-competitive with existing toxic heavy metal and synthetic chemical alternatives. The ZABIO consortium consists of a non-profit SME, a service provider for process development, scale-up of biobased products and processes (Bio Base Europe Pilot Plant) and large multinational chemical and consumer goods company (Henkel) to fulfil the value chain and accelerate market entry of ZA-bio integrated products into the construction industry within two years (Q3 2022). As a result of this project ZA-bio will be commercially available as a chemical compound (sales by Cysbio) and initial contracts with Henkel will facilitate market growth by introduction of ZA-bio based sanitary sealants and façade coatings. The two year project will address EU health and environmental goals.

Work performed from the beginning of the project to the end of the period covered by the report and main results achieved so far

Cysbio has generated a production strain and fermentation process that exceeds expectations, and which has been transferred to process scale-up and downstream process development at BBEPP. At the current state the production process is antibiotic-free and the upscaling efforts to 15m3 scale are completed both for fermentation and downstream processing. Several batches of different qualities of ZA-bio were provided by BBEPP for application testing at HENKEL and for other commercialization efforts. First application data show a clear antifouling effect against bacterial growth on tiles without an effect on cell viability. As part of the commercialization efforts, the product registration path is identified, and an initial literature review has been performed. Application trials have been conducted for other markets, showing some promising effects, and a patent application has been filed. A roadmap towards reaching registration for different markets is underway, and application data to open markets beyond the end of the project has been initiated. Delay in product samples and product definition has caused delays for application testing and registration and thus the project has been extended by six months.

Since the transfer of the production strain to upscaling within the ZABIO project, further strain

engineering has been performed, focusing on bottlenecks in the production host and on the yield of the process, which ultimately is going to improve the economy of the process in a follow-up scaling campaign.

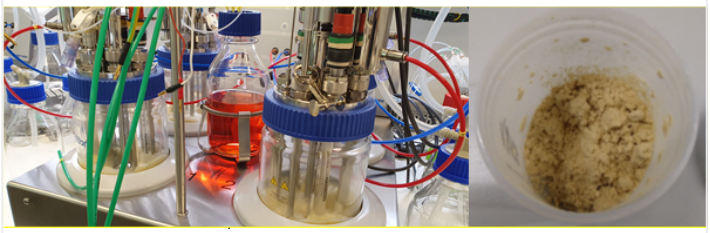
Progress beyond the state of the art and expected potential impact (including the socio-economic impact and the wider societal implications of the project so far)

This consortium advances the state-of-the-art for the first time, with a nature-identical antifouling solution, harnessing zosteric acid. The innovative elements of ZA-bio that advance antifouling products for construction and other industries are supported by unique expertise and Intellectual Property Rights of the ZABIO consortium. Such aspects comprise:
• Innovative sustainable production of ZA-bio: CYSBIO's proprietary Sulfation Technology Platform employs novel recombinant host cells for accelerated natural synthesis in titers and yields that are commercially economic and attractive.

This has been satisfied, while there is still room for improvements in key fermentation parameters, which in turn will benefit the economy and the purification process. The last period of the project made it possible to demonstrate strain performance at the expected yield and titer levels sufficient for economic production, though the upscaling and downstream process work still needs some further work after the project has finalized in order to deliver the fully ready production process. The project team expect a ready production method with acceptable economics to be achievable within one year from end of the project, making it realistic to reach production in 2024 as originally planned.
• Upscaling of ZA-bio manufacturing by fermentation: BBEPP's deep experience and facilities enables 1) de-risked upscaling of fermentation processes to 15 m3 within 2 years, and 2) develop an efficient and solvent free downstream product purification process compatible with large scale production. Such expertise has as expected accelerate ZA-bio to market as the first 100% bio-based effective and economical antifouling agent.

The fermentation process has been upscaled to 15 m3, however, with lower performance and therefore lower end titer than in the smaller scales. Samples have been taken for further analysis and they have contributed to the understanding of the process. The downstream process has an unsatisfying yield, product definition and product color, and the scaling up to commercial scale would require further studies and more process work, which will be initiated after the project ends.
• Testing and modification of ZA-bio for product integration: For HENKEL, this opportune ZABIO collaboration allows first mover advantage for entering the market with first 100% bio-based antifouling agent. HENKEL can leverage state-of-art facilities to test and modify the ZA-bio compound to be compatible with non-water-based silicone and acrylate technologies according to current product specifications, guaranteeing market access. Based on the last testing results this is however not reaching efficacy levels that currently will allow commercialization. Because of these final project results the focus of ZA-bio has shifted to the alternative spin-off markets: antifouling for ship paint, bio-fungicide applications and other uses where the antimicrobial/antifouling efficacy has proven effective and promising.

• Spin-off potential: the unique mechanical antifouling mechanism of action allows safe use of ZA-bio in many industries, particularly agriculture as a bio-alternative to pesticides, in healthcare and food as an antimicrobial agent, and pharmaceuticals and supplements for antioxidant and anti-inflammatory properties. Unique and novel chemical properties of conductivity and heat resistance would allow ZA-bio to be used as monomer for breakthrough polymers with applications in ion-exchange membranes, fuel cells and even battery technology. Together these markets exceed €10 billion in total value, and a realistic long-term business potential for ZA-bio is above €1 billion, even if just 2-3 of these markets open up as expected.



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