FOAM-UP: Advancing Biofoam Production from Bacterial Nanocellulose

Publieke samenvatting / Public summary

Aanleiding

Yearly, the world produces polystyrene equal to the volume of Manhattan and this global production is expected to rise to 17.5 million metric tons by 2030. This fossil-based material is difficult to recycle and takes over 500 years to decompose. Foamlab B.V. produces bacterial nanocellulose (BNC) through fermentation and functionalizes it into high-quality foams for insulation purposes that can replace fossil-fuel-based plastics like polystyrene. However, current production methods rely on pure sugar as the primary feedstock. This not only limits the circularity of the final product but also constrains yield optimization. Transitioning to industrial waste streams as feedstocks offers a promising path to both increase yield and enhance sustainability. However, BNC-producing bacterial strains are typically not adapted to the complexity and variability of industrial side streams, which needs to be addressed. Additionally, the BNC production process and yield can be further optimized via genetic engineering to increase competitiveness. Finally, the circularity of the process still needs to be proven: BNC-based foams are biodegradable, but how can they be reutilized is still unexplored.

Doelstelling

The objective of this project is to develop a high-performance, biobased, and fully compostable BNC foam from industrial side streams—offering a circular and functionally superior alternative to polystyrene. The subgoals of this project include: finding (a) suitable industrial side stream(s) for the

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Algemene informatie / General information

Penvoerder / Secretariat
Foamlab B.V.

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cultivation of BNC-producing bacteria; obtaining genetic information and a genetic toolbox for non-model BNC-producing bacteria; increasing the yield of BNC-based foam using different methodologies; obtaining a robust and high-performance fermentation process from industrial side streams; obtaining high-quality foams from the new production process; proving the circularity of the process by enzymatically degrading the foams back to monosugars and reusing them; and upscaling the process to ~100L scale as proof-of-concept. By valorizing waste streams and maximizing yield, the project aligns closely with the goals of this subsidy program—namely, reducing the use of fossil-based plastics through innovative bio-based solutions. Additionally, the objective is to obtain a circular value chain rather than a linear one, further supporting recycling and reusing of valuable feedstocks.

Korte omschrijving

First, the industrial side streams need to be categorized for their cost and characteristics (e.g. sugar type) by Foamlab B.V. and Looop B.V. Once the feedstocks have been selected, the genome of the BNC-producing bacteria will be analyzed to define strategies for the optimization of the process. The fermentation process will include the tailoring of the fermentation conditions to ensure robust BNC production on side streams. In parallel, the bacterial strains will be genetically modified to increase the production yield. HAN BioCentre will apply targeted genetic modifications to improve microbial performance on these non-traditional substrates, while Foamlab B.V. will explore non-GMO methods to optimize strain behavior. Once the process has been optimized, it will be tested and scaled to ensure the feasibility of the new process. From the obtained BNC, foam will be made to ensure reliability of the end product. Finally, cellulolytic enzymes will be produced and tested on the foam. The sugars obtained can be reused for foam production to test for circularity, or tested in soil samples to ensure lack of toxicity. The economic feasibility of the whole will also be assessed.

Resultaat

The products to be obtained from this project are: a robust process for the production of BNC foam from industrial side streams with a yield of at least 1g BNC/L/day; an expected reduction in feedstock costs of 30%; improved production of the BNC aiming to 2g BNC/L/day by optimizing the fermentation process and (genetic) modification the BNC-producing strains; new knowledge on the degradability of the BNC foam by cellulolytic enzymes; a partnership between a provider of biobased building blocks with contacts in the beginning of the value chain (Looop B.V.) and an end-user for the production of biobased functionalized foams from said building blocks (Foamlab B.V.) with contacts in the manufacturing industry, setting the stage for larger, deeper impact; and finally, by developing technological advances that aid the circularity and sustainability of our society, this project contributes to the pool of knowledge from the Centre of Expertise HAN BioCentre. This will make it possible for them to positively impact many other present and future partners and students, facilitating the training of the committed professionals of tomorrow and advancing the circularity of the Dutch industry.

De data in deze applicatie is afkomstig van de Rijksdienst voor Ondernemend Nederland (RVO) en wordt in samenwerking met de Topsector Energie ontsloten.
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