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- MePlat →

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Prof. Lars M. Blank, Coordinator

P4SB

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Top EU Biotech

Microbial bio-engineering can upgrade plastic waste

P4SB: Fighting the plastic crisis with synthetic biology tools and circular recycling

The P4SB project has successfully tested a technology for the biotransformation of plastic waste into value-added materials. Under the EU-funded project, synthetic biology tools were developed to engineer the bacterium Pseudomonas putida so it becomes a whole-cell biocatalyst. In a two-step process...

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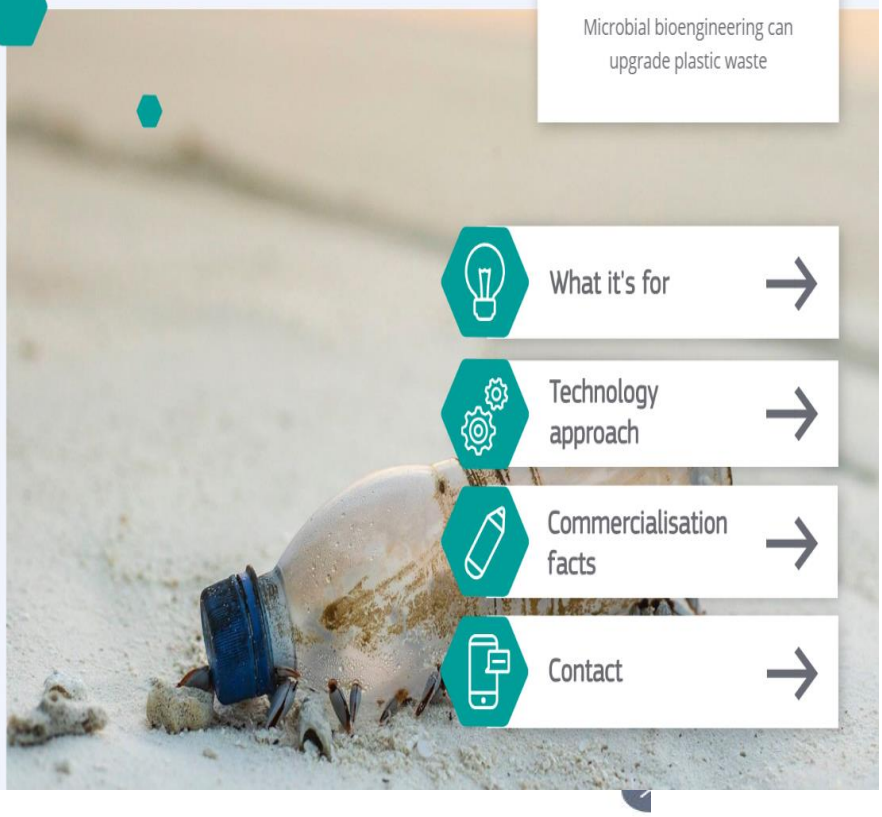
P4SB
From Plastic waste to Plastic value using Pseudomonas putida Synthetic Biology

Microbial bioengineering can upgrade plastic waste



What it's for

Technology approach

Commercialisation facts

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...enzymes are used to decompose petrol-based polymers into monomers, and trained microbes re-compose the monomers back into their fully biodegradable counterparts. Polyethylene terephthalate (PET) and ester bonds containing polyurethane (PU) can be depolymerised by the engineered enzymes. The P. putida cell-factory can also be customised to synthesise new environmentally friendly materials, such as biodegradable bioplastics (polyhydroxyalkanoates [PHAs]), from the decomposed plastics. After finishing P4SB, the consortia partners have been continuing the next level of research with the EU H2020 project MIX-UP.

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Top EU Biotech

"Let's develop a biotech route for upcycling mixed plastics"

Prof. Lars M. Blank, Chair of Applied Microbiology, RWTH Aachen University

Interview with Prof. Lars M. Blank, Chair of Applied Microbiology, RWTH Aachen University

+ INTERVIEW

Synthetic biology is striving to find solutions for the plastic crisis. What are the priorities?

Lars M. Blank: The tremendous increase in fossil plastic production, and the associated pollution needs to be stopped at various levels. Banning landfills for household waste and setting up effective waste logistics are key to reducing the pollution. Increasing the cost of virgin plastic would be very effective, e.g. a substantial CO_2 pricing system would make the re-use of plastic products attractive. More immediately we will see a technological upgrade of plastic recycling, with a shift from energetic recycling (incineration) to mechanical recycling, and also to chemical recycling or to microbial upcycling where enzymatically degraded monomers can be synthesized using bacteria to create new, valuable products. Finally, all new plastic has to be biobased or CO_2-based as part of a circular plastic economy.

The new research project MIX-UP has followed on from the P4SB bio recycling project. Please describe the main goals.

Lars M. Blank: In our EU-funded projects we aim at circular recycling using synthetic biology technologies, which will even allow blends of different plastic waste to be converted into new products for medical use or into goods and compounds for the food and agriculture industry.

Will the upcycling innovations ever compete with petrol products, which are at historical low prices?

Lars M. Blank: At USD 40 for a barrel crude oil, the bio-plastic recycling industry will hardly find a competitive high-value solution. Here, industry must be the driver by investing in new technologies. Political regulations are needed alongside investments. Europe can't steer the oil prices, but it can influence markets via CO_2 prices and regulation.

What applications have been developed using the microbial conversion technology in P4SB?

Lars M. Blank: With our bio-reactor lines we have been following three application routes. One is a biopolyester (PHA) that is directly produced by the microbes and developed by our partner Bioplastech to make a biodegradeable hot-melt glue and a Post-it glue. The second line is a glyco detergent with alternative molecules that can replace the fossil oil- and palm oil-based fat removers of dishwasher liquids, at competitive prices by the way.

And the third product route?

Lars M. Blank: This follows a specialised enzymatic decoration technology applicable in many different fields. Our partner CSIC in Madrid is elaborating PHA-micro and nano-particles that can be decorated with functionalities that are applicable in the dairy and food industry, or for textile and paper degradation. Biomedical applications in the field of wound healing are also being investigated.

Did industry stakeholders show an interest in the synbio applications?

Lars M. Blank: Five different business plans were established under P4SB. For three of them we have received a request from Innovation Radar [*An EU Commission service to identify and highlight high potential innovations].* One consists of a novel platform molecule that might become a hot candidate for a cosmetic emulsifier that there is some industry interest in. The other one is a PHA polyester where our partners in Dublin are working hard to progress the pilot to a demo. For the enzymes degrading PET and PU material, our partners also got requests.

Where do you see the main bottlenecks for a faster exploitation of your research results?

Lars M. Blank: There are still significant technical hurdles that hinder the commercialisation of the enzyme activity for plastic degradation. It is still not feasible to enzymatically address carbon-carbon bonds. Regarding the PUs, finding the chemical Swiss Army knife is unthinkable, however P4SB partners from Strasbourg delivered interesting progress on single chemical bonds.

Are there economic barriers?

Lars M. Blank: We will not see breakthroughs in bioplastics without new laws. On top of this, there are financial barriers for small companies that can provide 10 kg of a demo chemical, but not half a tonne for free. Starved of demonstration opportunities, many developed technologies find themselves in the valley of death.

The successor of P4SB is the MIX-UP project. What's the new approach?

Lars M. Blank: Chinese research entities are collaborating to find solutions that will have a huge impact, as Europe and China cover 50% of the world's plastic production. Our next approach is to use mixed bacteria with mixed enzymes for mixed plastics. This solution can avoid some of the difficulties involved with sorting. We apply a single work flow: put the mix of plastic materials into an enzyme reactor, feed it to microbes, use their metabolic funnel to create a product of value with the leftovers going to chemical recycling or into incineration.

What could be your star products in these new value chains?

Lars M. Blank: The Chinese partners are heading for a microbial polymer that is applicable as a degradabable agri-mulch foil. For Europe we're thinking about a lighthouse upcycling product, perhaps a fashionable fabric that once was a plastic bottle but has been bio-redesigned by our hard working bacteria.

Thank you very much for this interview!