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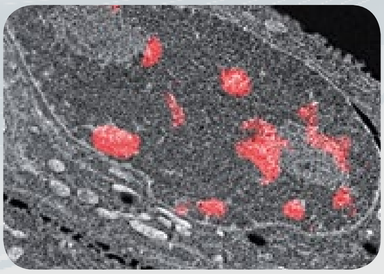
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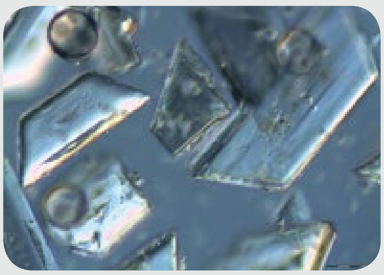
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Content

Waste Conversion Technologies

Bioplastics from Syngas Fermentation

The EU-funded Synpol project ("Biopolymers from syngas fermentation") is developing a sound industrial process for the conversion of different waste streams into the so-called syngas ("synthesis gas") as a contribution to the production of bioplastics and further high value-added products. The produced syngas, mainly composed of CO and H_2, is then used as feedstock for the biotechnological production of polyhydroxyalkanoates, a versatile group of biopolymers for the production of bioplastics.

Too Much Waste around Us

Every day we waste money in transporting municipal solid waste (MSW) miles out of cities or states to be landfilled. Long term environmental and economic problems created by landfilling prove that it is not the solution to the waste problem, and waste conversion technologies are becoming a massive growth industry worldwide. Experts say that over the next decade waste-to-energy and waste-to-bioproducts technologies will undergo a compound annual growth rate of over 11%. There are many waste resources hidden in our communities. For example, MSW, agricultural residues and sewage sludge from water treatment plants contain lots of reusable carbon fractions. An eco-efficient waste conversion process means recovering most of the waste as valuable products in an environmentally friendly manner. In this context, the significance of the Synpol project is remarkable considering the high amount of available relevant waste produced solely in Europe every year (approx. 261 million tons (MT) of MSW including approx. 25 MT of plastics, approx. 120 MT of agricultural residues (e.g., straw) and >10 MT of sewage sludge) [1-4]. The basic idea and work flow scheme of the project is presented in Figure 1.

PHA: an Alternative for Petrol-based Plastics

Polyhydroxyalkanoates (PHA) are a well-known family of polyesters accumulated as cell granules by naturally occurring microorganisms serving as carbon and energy reserve. Figure 2 shows bacterial cells containing PHA granules and some short chain length PHA isolated from bacteria. Many different PHAs of diverse desired properties including biodegradability can be produced from renewable resources by the biosynthetic action of selected prokaryotes. Currently, PHAs are one of the alternatives to petrol-based plastics, elastomers or latexes.

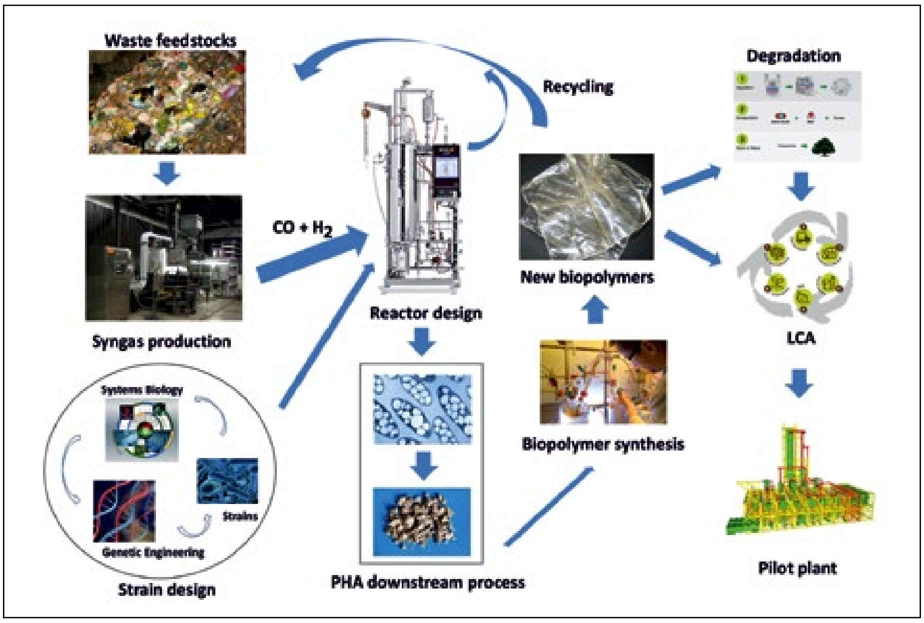


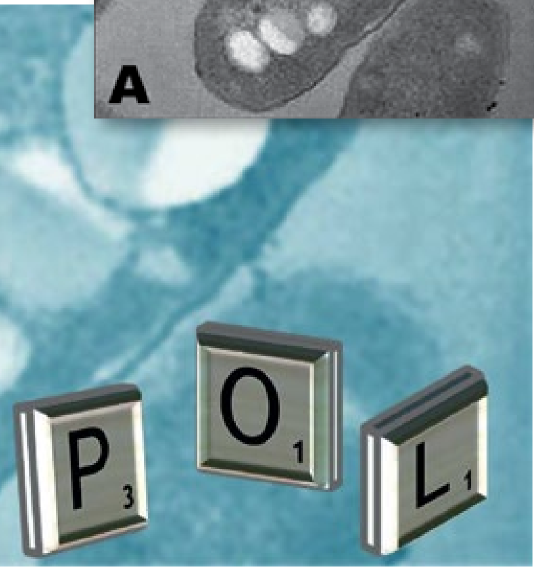
Fig. 1: The Synpol process - From different waste feedstocks to biopolymers

Non-food Competing Feedstock Materials

The need for alternative materials, because of the finite sources of fossil reserves is generally accepted. In order to become a competitive alternative on the market, the price of bioplastics for a certain application must be in the same range as the competing petroleum-based plastic. Hence, the costs of PHAs have to be reduced considerably despite the current unstable price of crude mineral oil. As an alternative solution, diverse waste streams exist which currently constitute severe disposal problems and, at the same time, do not interfere with the nutrition chain. This is especially true for the daily produced household waste that ends up in landfills or the sewage sludge loadings from water treatment plants. The utilization of these waste streams is a viable strategy to overcome a potential ethical conflict. Indeed, it can be considered as the most promising approach in making PHAs economically more competitive.

Philosophy and Roadmap

The Synpol project aims at converting these waste streams via refined gasification processes (pyrolysis supported by innovative microwave technology) into synthesis gas (syngas) that contains high amounts of carbon monoxide (CO) and hydrogen (H_2). These gaseous carbon fractions are biotechnologically converted towards PHA biopolymers by applying bacterial fermen-



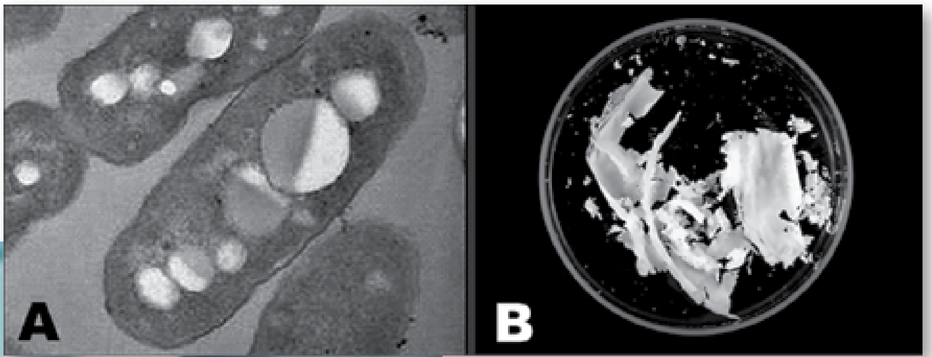


Fig. 2: Photography of a PHA granules-accumulating bacterial strain (A) and short chain length PHA (B) isolated from a bacterial culture.

tation processes using different bacterial strains. The selected bacterial strains are naturally occurring microorganisms that will be optimized for higher PHA production efficiency by genetic and metabolic engineering techniques based on the newest findings from systems biology.

The project brings together public research centers with waste producers from different processing industries (landfilling, agricultural and water treatment industries), gasification industry and polymer processing biotechnological companies. This synergism will benefit all players and will result in new value creations. The project´s time roadmap is illustrated in Figure 3 and summarizes the main working lines of the consortium.

A Project of Great Expectations

From the perspective of the Synpol project, important progress will be achieved in terms of combining the environmental benefit of future-oriented biopolymers with the economic viability of their production. This should finally facilitate the decision of responsible policy-makers from the waste-generating industrial sectors and from the polymer industry to break new ground in sustainable production. In the future, PHA production from different waste streams applying gasification technology should be integrated into existing process lines of biotechnological bioplastic companies, where the feedstock material directly accrues. By taking profit of synergistic effects, this can be considered a viable strategy to minimize production costs. The project therefore offers a timely strategic action that will enable the EU to lead the syngas fermentation technology for waste revalorization and sustainable biopolymer production worldwide.

The 48 month Synpol project has secured almost 7.5 million € in funding under the Food, Agriculture and Fisheries, and Biotechnology theme of the European Union Seventh Framework Program (FP7/2007-2013; grant agreement nº 311815). The project was launched in October 2012 and is coordinated by the Biological Research Center (CIB) in Madrid (Spain) which is part of the Spanish National Research Council (CSIC). Follow the project under www.synpol.org.

The Project Team Players:

From Industry

- Biopolis S. L. (Spain) – Industrial fermentation
- Bioplastech Ltd. (Ireland) – Biopolymer synthesis
- Organic Waste Systems NV (Belgium) – Biodegradation & LCA analysis
- Bionet Servicios Técnicos S. L. (Spain) – Simulations & Pilot plant design
- Infors AG (Switzerland) – Fermentation development & Bioreactor design
- Befesa Gestión de Residuos Industriales S. L. (Spain) – Waste management

From Academia

- Consejo Superior de Investigaciones Científicas (Spain) – Project coordination, Syngas production, Bacterial Research & Downstream processing
- University of Manchester (United Kingdom) – Bacterial Systems Biology
- Universität Ulm (Germany) – Bacterial fermentation & Recombinant strains
- University College Dublin (Ireland) – Proteomics & Molecular biology
- Haute Ecole Spécialisée de Suisse Occidentale (Switzerland) – Fermentation reactor design & Downstream processing
- Kungliga Tekniska Högskolan (Sweden) – Biopolymer synthesis
- Westfälische Wilhelms-Universität Münster (Germany) - Bacterial fermentation & Recombinant strains
- Université de Strasbourg (France) – Biopolymer design

References:

[1] http://bit.ly/12ZOjgs
[2] http://bit.ly/12kWe1y
[3] http://bit.ly/1351OwK
[4] http://bit.ly/12ZOQPy

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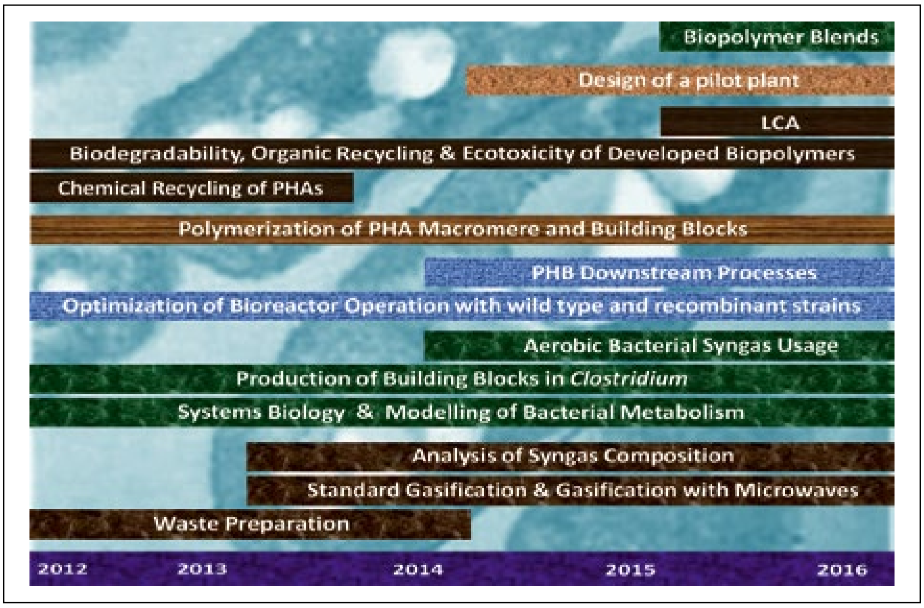

Fig. 3: The Synpol roadmap

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