

### The PHA toolbox

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For the sake of energy storage, the majority of organisms produce polymers from high-energy monomers and recycle them during starvation conditions. Starch as a prominent example has been utilized already by the ancient Greek in the classical antiquity and remains an important component in today's industrial products (e.g. thickener and stabilizer in food industry, internal sizing and surface sizing in papermaking, corrugated board adhesives, clothing starch for laundry).

Polyhydroxyalkanoates (PHAs) comprise a large class of polyesters synthesized by many bacteria as storage polymers. Depending on the specific bacteria strain as well as the substrate feed, the properties of the isotactic polyesters range from highly crystalline to completely amorphous dictated by the type and composition of side chains of the monomeric units. Thus, a wide range of mechanical properties is available when it comes to choosing the right polymer for a given application. Apart from their mechanical properties and the fact that PHA synthesis is independent from fossil resources, these polyesters offer a class of sustainable material revealing further interesting properties such as biodegradability and biocompatibility.

A large number of scientists make effort on the optimization of the fermentation procedures and down-stream processing to increase the productivity as well as the number of different available polymers within the two subclasses of polyhydroxyalkanoates, namely short- and medium-chain-length PHAs (e.g. different monomeric composition, molecular weight and molecular weight distribution). On the other hand, researchers use chemical modifications of available polymers to tailor the material properties of the polyhydroxyalkanoates produced by the bacteria. (e.g. changing the solubility by the introduction of functional groups in the side-chains).

In the Institute of Life Technologies at the University of Applied Sciences in Valais, Switzerland, we bring together fermentation expertise with the molecular design of the biogenic polymers by chemical modification, creating an integrated approach to provide advanced materials to a variety of highly demanding applications (e.g. medical devices and implants, drug carriers and coatings, metal injection molding). This synergy provides a fast and complete continuous feedback loop with less risk of design failure due to mismatched processes between fermentation optimization and chemical modification, lowering the barrier to create new tailor-made materials for highly demanding applications.