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Production of non-biodegradable biopolymers: current state and perspectives

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The term 'bioplastic' is defined as either biodegradable plastic materials and/or plastics that are produced from renewable resources. Currently, bioplastics accounts to only about 1 % of the total plastic materials annually produced. Biodegradable polymers have attracted considerable interest by the chemical industry because they have applications in various areas like for example as compostable packaging materials or in medicine and pharmacy as resorbable materials. Polyhydroxyalkanoates (PHA) and polylactic acid (PLA) are fully biodegradable and are fully or partially synthesized by biotechnological processes, respectively. On the other side, persistent polymers, which are not biodegradable, are of course also very important and essential for the manufacturing of long-living goods for example in automobiles and buildings. Biopolymers were ever considered to be biodegradable, and a large number of bacteria and fungi are able to grow at the expense of such polymers and to use them as carbon source for growth and energy. Against the paradigm that any compound, which is synthesized by the living matter, is biodegradable, it is possible to produce also persistent polymers completely or partially by biotechnological processes. Polythioester (PTE) homopolymers are only one example: they are fully persistent and completely synthesized in engineered bacteria expressing a synthetic pathway. Various PTEs can be so far produced from special organic sulphur compounds, which are obtained from the chemical industry, by fermentation of recombinant strains of *Escherichia coli* and other bacteria. Organic sulphur compounds are so far still required for biosynthesis of PTE. The composition of these PTE can be modified by engineering the metabolism of the strains or by using special feeding regimes or by a combination of both. Other examples for persistent 'bioplastics' are polyethylene and polypropylene, for which the building blocks can be synthesized by bacterial fermentation and then converted by chemical processes into intermediates that are chemically polymerized.

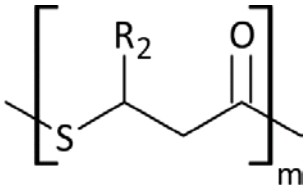

Figure 1. General formula of polythioesters (PTE)

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