Biodegradability as end of life option in a circular economy: value and path forward

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Abstract

The concepts for sustainable chemistry in a circular economy have become more and more elaborated. An agreement has been reached that the reduction of the carbon footprint and of negative environmental impacts are key pillars of all concepts. Use of renewable resources, CO_2 as carbon source and inclusion of recycled carbon into the value chains are proposed (Nova Institute, 2023). At the moment, the process of biodegradation is still "standing aside" and is only partly integrated into the overarching concept of sustainable chemistry. The presentation will give an overview of the different areas of biodegradable materials and makes a proposal, how to better integrate nature`s central recycling concept into the overarching concept of sustainable chemistry.

Biodegradable materials can be divided into three major categories: biodegradable small molecules, biodegradable structural polymers (used to make plastic) and biodegradable Water Soluble Polymers (WSP`s)

Biodegradable structural polymers: In the recent years significant progress has been made towards the understanding of biodegradation of structural synthetic biodegradable polymers in different environmental compartments (e.g. soil, freshwater, marine). In addition, new concepts and approaches have been developed:

- The Initiative "Microplastic-free Austria" puts the property of "non generating persistent microplastic" in the center of all considerations with consequences for value in compost and agriculture/forestry.
- HYDRA Marine Sciences considers the aspect of "biodegradation" as a tool to prevent harm to the environment.
- With the dual use concept for paper-structural biodegradable polymer constructs (composting and paper recycling) and enzymatic recycling concepts for e.g. polyesters, the connection to technical recycling can be made.

These concepts open new perspectives on the value of biodegradable structural materials in a circular economy and are going beyond the traditional view of strict separation of either technical recycling or biodegradation.

Biodegradable Water Soluble Polymers (WSP`s): With the initiative of the Royal Society of Chemistry for "Polymers in liquid formulations" this important and broad application field (e.g. home and personal care, applications in agriculture) comes into focus. It is apparent, that these materials cannot be recollected & technically recycled, but need to be fit for "natural recycling" via biodegradation. The presentation will summarize the progress of knowledge on biodegradable polymer biodegradation in recent years and the similarities and differences to the biodegradation of small biodegradable molecules.

For all areas of biodegradable materials, a fundamental understanding is needed as part of a joint approach of industry, academia and other stakeholders. The progress which is made in recent years and the new concepts to validate the value of biodegradability allows the integration into the overarching concept of sustainable chemistry consisting of the use of renewable resources, CO_2 and recycled carbon as feedstock, as well as biodegradation.

Keywords Circular economy · Biodegradability

Literature

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