

Biodegradable Polymers in the Circular Plastics Economy

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Edited by Michiel Dusselier and Jean-Paul Lange

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Preface

Since the start of the mass production of plastics in the 1950s, synthetic polymers have profoundly improved human comfort through their pallet of properties, their ease of shaping, and their low cost. Yet, these plastics are affecting more than just humans.

The presence of plastic litter in the environment and its impact on wildlife has hit all forms of media since the past five years. Due to their very slow – practically nonexistent – degradation they are accumulating everywhere, even in the remotest of places, in an unsustainable manner. For a large part, this problem stems from irresponsible human behavior and should be tackled at that level by public authorities, e.g. through public sensibilization and effective waste collection infrastructure. Once collected, the plastic waste becomes a valuable resource for recycling to polymers, monomers, or feedstock. Hence, much effort in academia and industry is devoted to developing and deploying the necessary technologies. But

- Will recycling fully solve the litter problem?
- Should humanity replace “persistent” products for non-persistent/degradable ones?
- Should we keep some persistent materials for specific applications?
- Do we foresee value for degradation beyond the litter challenge?
- Do we understand the degradation mechanisms? And can we steer or trigger them?
- What do we really mean by (bio)degradable, compostable, bio-, or biobased plastics?
- Will there be a need to compromise in properties for allowing non-persistence?
- How can we introduce new polymers, non-persistent ones, without jeopardizing the sorting and recycling of the whole polymer mix?

In summary, how can we balance non-persistence with durable, functional, reusable, and/or recyclable while designing plastics?

This book tries to offer the groundwork to enable a balanced discussion toward answering these questions. Short of answering all *key questions* posed above, it will hopefully offer an insight into the wonderful chemistry and engineering of degradable and biobased plastics that have come to the fore through a comprehensive approach. It starts by setting the scene and clarifying the terminology. It

then discusses the mechanisms of biodegradation and the environmental impact of persistent polymers. A second section provides a short tutorial on polymers and then covers, in depth, the various families of degradable/hydrolysable polymers, namely polyesters, polysaccharides, and lignin as well as covalent adaptable polymer networks (also known as vitrimers). Finally, a third section places (bio)degradation in the bigger context of plastic waste and recycling, analyzes the life cycle of plastics, and introduces the commercialization barriers that industry (and society) needs to pass to deploy a truly circular plastic economy.

The world needs a lot of different scientific angles to design the new plastics of tomorrow. This book thus hopes to inspire chemists, engineers, and biologists, but also lawmakers and consumers (as we all are). We hope you'll enjoy this book and its chapters, and appreciate the nuanced vision on a new plastics economy we tried to convey.

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