Science of the Total Environment 832 (2022) 154868

Contents lists available at ScienceDirect

Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Review

Immobilized enzyme/microorganism complexes for degradation of microplastics: A review of recent advances, feasibility and future prospects

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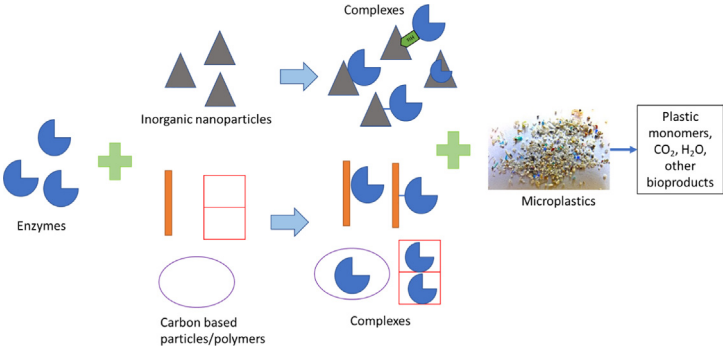
HIGHLIGHTS

- Immobilized enzyme complexes are novel in microplastics degradation.
- Metal nanoparticles-enzyme complexes aid microplastics oxidation and hydrolysis.
- Antimicrobial metal nanoparticles might retard microplastics biodegradation.
- Carbon particle-enzyme complexes entrap, encapsulate, bond and adsorb enzymes.
- New complexes include enzymes-hydrophobins and novel nanoparticles.

GRAPHICAL ABSTRACT



ARTICLE INFO

Editor: Jose Julio Ortega-Calvo

Keywords:
Enzymes
Microplastics
Nanoparticles
Immobilization
Complexes
Synthesis

ABSTRACT

Environmental prevalence of microplastics has prompted the development of novel methods for their removal, one of which involves immobilization of microplastics-degrading enzymes. Various materials including nanomaterials have been studied for this purpose but there is currently a lack of review to present these studies in an organized manner to highlight the advances and feasibility. This article reviewed more than 100 peer-reviewed scholarly papers to elucidate the latest advances in the novel application of immobilized enzyme/microorganism complexes for microplastics degradation, its feasibility and future prospects. This review shows that metal nanoparticle-enzyme complexes improve biodegradation of microplastics in most studies through creating photogenerated radicals to facilitate polymer oxidation, accelerating growth of bacterial consortia for biodegradation, anchoring enzymes and improving their stability, and absorbing water for hydrolysis. In a study, the antimicrobial property of nanoparticles retarded the growth of microorganisms, hence biodegradation. Carbon particle-enzyme complexes enable enzymes to be immobilized on carbon-based support or matrix through covalent bonding, adsorption, entrapment, encapsulation, and a combination of the mechanisms, facilitated by formation of cross-links between enzymes. These complexes were shown to improve microplastics-degrading efficiency and recyclability of enzymes. Other emerging nanoparticles and/or enzymatic technologies are fusion of enzymes with hydrophobins, polymer binding module, peptide and novel nanoparticles.

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http://dx.doi.org/10.1016/j.scitotenv.2022.154868
Received 20 December 2021; Received in revised form 23 March 2022; Accepted 23 March 2022
Available online 28 March 2022