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Towards circularity of plastics: A materials informatics perspective

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ABSTRACT

Plastic pollution and the associated adversities have been intensively researched recently, providing ample solutions with diverse possibilities and yielding a considerable corpus of literature in plastic waste management (PWM). Regardless of the vast range of techniques formulated, such as mechanical recycling and chemical depolymerization, many of these approaches have limitations including significant costs, ecological threats, and inefficiencies in handling diverse plastic types. Manual analysis of these challenges and the reported solutions from the vast collection of interdisciplinary research papers is extremely laborious. Herein, using tools of data science to create a network of ~350,000 papers and subsequent clustering to identify various protocols for PWM and determining the main paths of their knowledge evolution, we review their progress. The broad objective of this analysis is to provide a comprehensive understanding of different PWM techniques, with a focus on the importance of integrated, technologically advanced, and environmentally conscious approaches to solve plastic pollution. We identify four major categories of PWM (physical, chemical, physio-chemical, and biological) and analyze their mechanistic details. Our study highlights the critical need for the establishment of more sustainable PWM methodologies, supporting the integration of artificial intelligence to refine process optimization and cultivate interdisciplinary collaboration focused on advancing a circular economy and reducing plastic waste. Together with a deep discussion on the gaps between the set goals and the current achievements identified, these analyses could be a useful tool to confront the PW crisis.

Abbreviations

Short Form	Full Form
ABS	acrylonitrile butadiene styrene
ALD	atomic layer deposition
BPA	bisphenol A
BPC	black polycarbonate
CAN	citation network analysis
CCD	central composite design
CO2-eq	carbon dioxide equivalent
DCM	dichloromethane
DFT	Density functional theory
EG	ethylene glycol
EPVC	Expanded Polyvinyl Chloride
FCC	fluidized catalytic cracking
FRC	fibre-reinforced concrete
FTIR	Fourier Transform Infrared Spectroscopy
HDPE	high-density polyethylene
HNT	halloysite nanotube
HPL	high-pressure laminate
HSF	hazelnut shell flour
LA	lactic acid
LCA	Life Cycle Analysis
LDPE	low-density polyethylene

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