Removal of Microplastics by Advanced Nanomaterials

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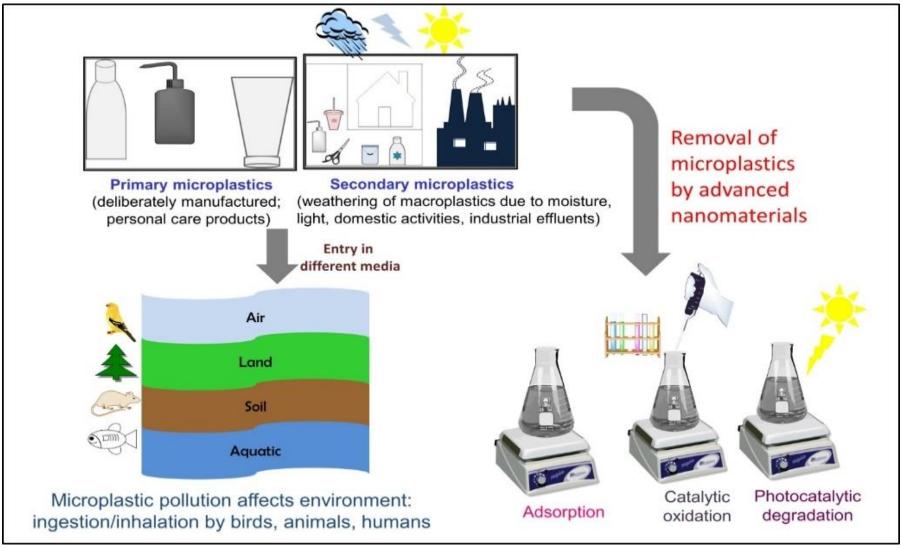
Graphical Abstract



Abstract

Microplastics (MPs) are light-weight plastic particles (size < 5mm), that are ubiquitous in the environment having various compositions, shapes, morphologies, and textures. The adsorption of several deadly contaminants occurs on the surface of MPs because of their hydrophobic nature and large surface area/volume ratio. The ingestion of micron-sized MPs is hazardous to living beings especially marine species, birds, animals, and soil creatures. Human exposure

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to MPs is also unquestionable because of their presence in the air, indoor dust, food items, etc. Understanding the gravity of the situation, it is imperative to take severe steps against the menace of MPs. Removal methods like adsorption, catalytic and photocatalytic degradation are the techniques that utilize advanced nanomaterials for the eradication of MPs. The change (reduction) in polymer weight implies the degradation of the polymer and additionally FTIR and SEM analysis are the characterization techniques, used to identify the changes in the structural and morphological features of MPs after the disintegration. Adsorption technique employing magnetic adsorbent promises to remove ~100% MPs whereas biodegradable catalysts can eliminate ~70-100% of MPs. Catalytic degradation through advanced oxidation facilitated by $SO_4^{\bullet-}$ or $OH^{\bullet}$ radicals (generated by peroxymonosulfate or sodium sulfate) is also an effective system for the elimination of MPs. Photocatalytic degradation using diverse materials like TiO_2 based catalysts like ZnO-based catalysts, nitrogen-doped, carbon-doped TiO_2, Au@Ni@TiO_2, etc., has also been widely reported in the literature. The thorough analyses of removal efficiency, advantages, and disadvantages of the contemporary nanomaterials for the removal of MPs can be beneficial in this regard for fabricating much more efficient materials as well as for advancements in the technologies to achieve complete elimination of MPs. Largely, the reusability and cost factor of nanomaterial to be utilized as adsorbent/catalyst determine the commercial viability. The economical, as well as environmentally benign synthesis approaches, should be targeted to achieve a versatile catalyst. Relentless efforts concerning plastic regulation are crucial to completely clear out this problem from the environment.

Keywords: Microplastics; environment; adsorption; photocatalytic degradation; catalytic oxidation.

Biography

Dr. Soumen Basu was born in West Bengal, India in 1980. He received the B.Sc. degree (Chemistry Hons.) from Vidyasagar University, India in 2001, the M.Sc. degree (Inorganic Chemistry) from the same university in 2003 and the Ph.D degree from Indian Institute of Technology, Kharagpur, India in 2008. He did his first postdoctoral research from University of Alabama, USA (from 2008-2009), and second postdoctoral research from Australian Institute for Bioengineering and Nanotechnology (AIBN), University of Queensland, Australia (from 2009-2011). He is currently working as Associate Professor, Thapar Institute of Engineering and Technology, India in the field of environmental sustainability (water splitting/wastewater treatment/toxic pollutant degradation) by advanced functionalized nanomaterials. He is also actively involved in developing chemical-sensors/nanobiosensors and porous adsorbents for carbon capture and storage (CCS) technology. He has published more than 140 research articles in reputed international journals with an h-index of 37 and citations of 6500.

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