Global Environmental Science
www.sciltp.com/journals/ges

Perspective

Toward Transferable Descriptors Linking Formation and Environmental Effects of Microplastic-Derived Dissolved Organic Matter

Yunyi Zeng [1], Yangjian Zhou [1], Japhet Cheuk-Fung Law [1], Yanran Huang [1] and Kelvin Sze-Yin Leung [1,2,*]

[1] Department of Chemistry, Hong Kong Baptist University, Kowloon Tong, Hong Kong SAR, China
[2] HKBU Institute for Research and Continuing Education, Shenzhen Virtual University Park, Shenzhen 518000, China
* Correspondence: s9362284@hkbu.edu.hk; Tel.: +886-852-3411-5297; Fax: +886-852-3411-7348

How To Cite: Zeng, Y.; Zhou, Y.; Law, J.C.-F.; et al. Toward Transferable Descriptors Linking Formation and Environmental Effects of Microplastic-Derived Dissolved Organic Matter. *Glob. Environ. Sci.* **2026**, *2*(4), 526–532. https://doi.org/10.53941/ges.2026.100031

Publication History

Received: 7 August 2026
Revised: 23 October 2026
Accepted: 10 November 2026
Published: 18 November 2026

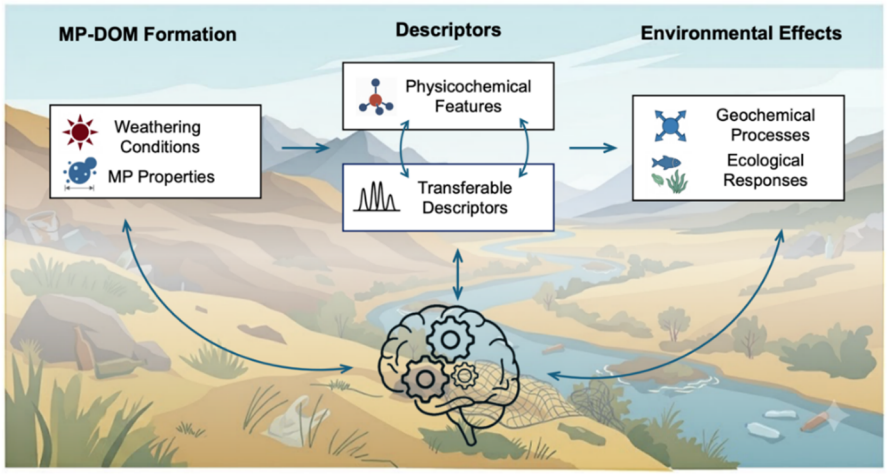
Keywords

microplastic-derived dissolved organic matter;
transferable descriptors;
environmental effect;
descriptor-based framework

Highlights

- A descriptor framework enables cross-study comparison and mechanistic insight.
- E2/E3 links MP-DOM formation with photoreactivity and contaminant transformation.
- Transferable descriptors provide a foundation for future predictive and AI-driven advances in MP-DOM science

Abstract: Microplastic-derived dissolved organic matter (MP-DOM) is increasingly recognized as an active product of plastic weathering; however, its environmental effects remain difficult to compare or predict. A major problem is the absence of variables that can maintain comparable mechanistic meaning across formation and effect studies. To address this gap, we propose a descriptor-based conceptual framework that uses measurable MP-DOM properties as transferable intermediates. Within this framework, using descriptors as a transferable and standardized language, spanning quantity, optical properties, molecular composition, and reactivity, can bridge diverse weathering conditions with downstream environmental effects. Using E2/E3, defined as the absorbance ratio at 250 and 365 nm, as a representative example, we demonstrate how an optical descriptor can connect MP-DOM formation processes with photochemical reactivity and contaminant photodegradation through its relationship with singlet oxygen generation. This framework highlights the need for transferable descriptors as a standardized framework for MP-DOM, providing a foundation for cross-study comparison, mechanistic integration, and predictive assessment of MP-DOM fate and environmental effects.



Copyright: © 2026 by the authors. This is an open access article under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).
Publisher's Note: Scilight stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.

1. Introduction

Microplastic-derived dissolved organic matter (MP-DOM) is a chemically active fraction released during plastic weathering processes, including photoirradiation, mechanical abrasion, chemical oxidation, and biodegradation [1]. Unlike natural organic matter (NOM), which originates from complex biogeochemical transformations, MP-DOM reflects the molecular signatures from the weathering and transformation of plastic materials, including plastic additives, oligomers, and transformation products [2]. Although MP-DOM shares certain lignin-like and tannin-like optical and molecular characteristics also commonly observed with NOM, its distinct molecular features allow MP-DOM to exert multifaceted influences on environmental processes, such as ecological effects, microbial metabolism, contaminant transformation, and carbon cycling [3,4]. However, these heterogeneous environmental effects arise from diverse MP-DOM formation pathways that generate distinct MP-DOM characteristics. This diversity creates a fundamental challenge in establishing predictable relationships between plastic weathering processes and MP-DOM functions. Although many studies have characterized MP-DOM formation and environmental effects, these two aspects have largely developed independently, resulting in a persistent disconnect between the conditions generating MP-DOM and the consequences observed after its release [1,5,6]. This gap currently limits our ability to evaluate the environmental risks and future fate of MP-DOM under different environmental conditions.

A key challenge arises from the complex nature of MP-DOM. Unlike single chemical compounds, MP-DOM is a dynamic mixture whose environmental behavior is influenced by physicochemical properties, including aromaticity, molecular weight, oxidation state, bioavailability, and photochemical reactivity [7]. These properties can potentially serve as intermediate descriptors that link diverse formation conditions to environmentally relevant functions. However, current studies typically treat such descriptors as isolated characterization parameters, preventing their integration across different polymer types, weathering conditions, and environmental matrices [1]. A descriptor-based framework would treat descriptors as transferable variables, enabling integration across parameters, and, in such a way, would translate MP-DOM formation processes into downstream environmental effects.

In this perspective, we propose a descriptor-based framework that establishes specific MP-DOM descriptors as a transferable interaction connecting formation processes with environmental consequences. To demonstrate the utility of this framework, the absorbance ratio at 250 and 365 nm (E2/E3) is selected as a representative descriptor. This case study models how MP-DOM formation affects E2/E3 values and how this descriptor further predicts the singlet oxygen quantum yield ($\Phi_{1_{O_2}}$), and the subsequent photodegradation of aquatic contaminants. We further discuss the current limitations in descriptor development and data integration and highlight future opportunities for combining standardized descriptor datasets with artificial intelligence (AI) approaches. This framework provides a conceptual foundation for moving MP-DOM research from fragmented observations toward a predictive and chemically interpretable science.

2. Descriptors Serve as a Bridge

Descriptors of MP-DOM can help transform MP-DOM from a chemically complex mixture into a set of measurable and interpretable properties, and they can act as essential intermediate variables linking MP-DOM formation directly with environmental effects. For a descriptor to serve as a bridge, it must satisfy several key criteria. It should be experimentally accessible, reported in a standardized manner, mechanistically interpretable, and predictive of at least one environmental endpoint. More importantly, it must be applicable across different polymer types, weathering conditions, and environmental matrices to ensure cross-system comparability. Once these baseline criteria are met, the bridging capacity of a descriptor generally increases with the depth of chemical information it provides. Accordingly, MP-DOM descriptors can be broadly divided into several categories based on their level of information [8].

(1) The first category includes bulk quantity descriptors, namely dissolved organic carbon concentration (DOC) and mass-normalized carbon release. These parameters describe how much MP-DOM is generated, but they provide limited information about its chemical heterogeneity. For example, a longer irradiation time may increase MP-DOM release, but the resulting environmental effect depends not only on the amount of MP-DOM produced, but also on whether irradiation generates chromophores, oxidized fragments, aromatic structures, or redox-active components [9]. Therefore, DOC concentration alone may be insufficient to predict MP-DOM reactivity.

(2) The second category includes optical descriptors derived from UV-vis absorbance and fluorescence spectroscopy, such as E2/E3, SUVA254, spectral slope, fluorescence index (FI), humification index (HIX), biological index (BIX), and PARAFAC-derived fluorescent components. These descriptors can provide information on chromophore composition, aromaticity, apparent molecular size, and source-related characteristics [10]. Optical surrogates such as SUVA254 and E2/E3 are widely used in DOM studies, although their interpretation requires

caution because they represent indirect proxies rather than direct molecular-level information.

(3) In the third category are molecular-level descriptors obtained from chromatography, high-resolution mass spectrometry, or other advanced analytical techniques, which include molecular weight, H/C ratio, O/C ratio, double bond equivalent, modified aromaticity index, nominal oxidation state of carbon, heteroatom class distribution, and relative abundance of formula groups. These descriptors provide more detailed information on molecular composition and underlying chemical processes [11].

(4) The fourth category includes reactivity descriptors, such as reactive oxygen species (ROS) quantum yields, electron-donating capacity (EDC), electron-accepting capacity (EAC), steady-state concentration of ROS, and bioavailability-related parameters [12].

Together, these descriptor categories provide complementary information on the quantity, composition, and functional properties of MP-DOM.

3. Descriptor-Based Framework for MP-DOM Formation and Environmental Effects

We propose a descriptor-based framework that links MP-DOM formation and environmental effects through an intermediate descriptor layer (Figure 1). In this framework, the formation layer consists of intrinsic MP characteristics and environmental weathering conditions. These variables include polymer type, particle size, irradiation wavelength, light intensity, exposure duration, temperature, pH, salinity, microbial abundance and class, and the presence of coexisting constituents such as NOM, minerals and oxidants [13]. Together, these factors determine the quantities and properties of MP-DOM released into the aqueous phase. These resulting characteristics can be captured by descriptors, which translate these diverse formation conditions into measurable MP-DOM properties. The underlying properties represented by descriptors then regulate environmental effects such as contaminant transformation, metal complexation, microbial utilization, toxicity responses and mineralization [2,14–16]. In other words, MP-DOM descriptors serve as the mechanistic middle bridge between formation and environmental function.

To evaluate this concept, we selected E2/E3, an optical descriptor based on UV-vis absorbance, to determine its viability as a proxy connecting the photochemical formation of MP-DOM with its environmental reactivity specifically ROS (e.g., $^1O_2$) production and subsequent contaminant photodegradation. Higher E2/E3 values are commonly associated with lower apparent molecular weights and less condensed aromatic structures of MP-DOM [10]; lower values generally indicate a greater contribution from strongly light-absorbing chromophoric components. Previous studies reported a consistent decrease in E2/E3 with photoaging time across varying salinity and pH conditions, reflecting the influence of environmental factors on polymer aging, oxidation, and compound release during MP-DOM formation (Figure 2a) [17]. Similarly, different polymers (e.g., PBAT and PE) exhibited different E2/E3 in the biological aging processes, further demonstrating that polymer identity and weathering pathways affect this descriptor [18]. These observations collectively suggest that E2/E3 is sensitive to MP-DOM formation processes and can serve as a formation-related descriptor that reflects dynamic changes during weathering.

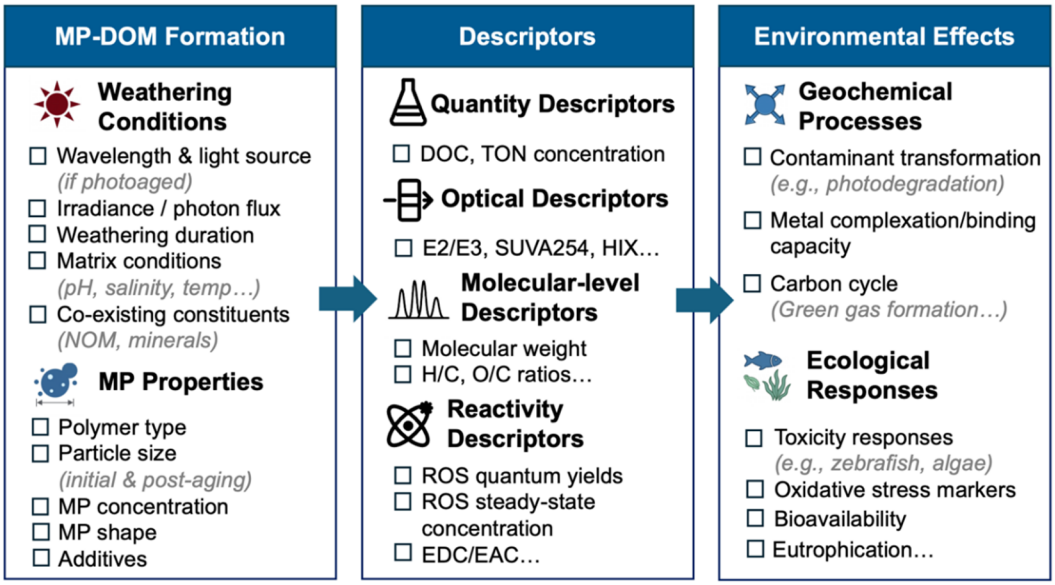


Figure 1. Proposed descriptor-based conceptual framework and reporting checklist for MP-DOM-related research. Abbreviations: TON, total organic nitrogen; SUVA254, specific ultraviolet absorbance at 254 nm; HIX, humification index; H/C, hydrogen-to-carbon ratio; O/C, oxygen-to-carbon ratio; ROS, reactive oxygen species; EDC/EAC, electron-donating capacity/electron-accepting capacity.

 https://doi.org/10.53941/ges.2026.100031

Variations in the chromophoric composition of MP-DOM, as reflected by E2/E3, may modulate light absorption behavior and subsequent excited-state processes that govern ROS generation [19]. We further examined the correlation between E2/E3 and $\Phi_{^1O_2}$, a widely used and standardized descriptor of DOM photoreactivity that integrates light absorption and energy transfer processes [20]. In photochemical processes, chromophores in MP-DOM are excited to singlet states followed by intersystem crossing to form reactive triplet excited states (^{3}MP-DOM*). These ^{3}MP-DOM* can transfer energy to molecular oxygen to produce $^1O_2$ [18,21,22]. As a selective oxidant, $^1O_2$ (E^0 = 0.81 V_{NHE}) has reaction rate constants reaching approximately 10^8 M^{-1} s^{-1} for highly reactive contaminants, including aromatic compounds and pharmaceuticals [23]. A significant positive correlation between E2/E3 and $\Phi_{^1O_2}$ (R^2 = 0.5827, p = 0.0004, Figure 2b) indicates that formation-induced optical changes in MP-DOM are partially reflected in differences in photochemical reactivity. This relationship highlights the potential of E2/E3 to reflect links between chromophoric properties and $\Phi_{^1O_2}$, with implications for contaminant transformation. Thus, E2/E3 may serve as an integrated optical descriptor connecting MP-DOM formation processes with their photochemical functions.

Considering dataset heterogeneity, this cross-study analysis provides a proof-of-concept evaluation of E2/E3 as a transferable descriptor linking MP-DOM formation with photochemical reactivity. Despite variations in polymer types, aging conditions, and environmental matrices, the observed correlation supports its potential as an intermediate descriptor.

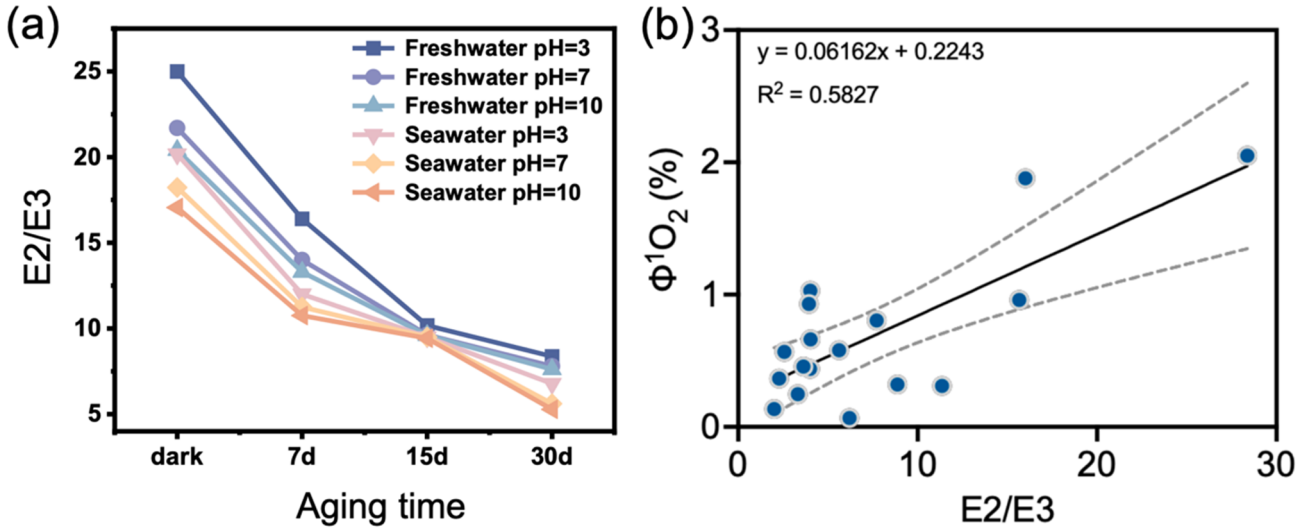


Figure 2. (**a**) E2/E3 of MP-DOM under different pH and salinity conditions as a function of photochemical aging time. Reprinted with permission from ref. [17]. Copyright 2025, Elsevier. (**b**) Relationship between $\Phi_{^1O_2}$ and E2/E3 ratio for MP-DOM. A total of 17 published studies were compiled for this analysis, covering the period from 2022 to 2026 [12,15,16,24–37]. All datasets included both $\Phi_{^1O_2}$ and corresponding E2/E3. The solid line represents the linear regression fit, and dashed lines indicate the confidence interval.

Nevertheless, analogous relationships have been reported in NOM research, where optical descriptors such as E2/E3 have been associated with photosensitized contaminant transformation. The association of these descriptors with $\Phi_{^1O_2}$, reliably predicts the photodegradation efficiencies of diverse organic contaminants (e.g., cimetidine and sulfamethoxazole) [18,38–40]. Because MP-DOM and NOM share partially overlapping chromophoric components, sunlight absorption by both initiates similar photochemical pathways. In conclusion, driven by these fundamentally shared photochemical mechanisms, the E2/E3 ratio functions as a potentially transferable descriptor for evaluating the MP-DOM-sensitized photodegradation of organic contaminants. Notably, the environmental relevance of descriptors may not be identical in the two DOM systems. For NOM, descriptors usually reflect the characteristics of DOM shaped by diverse natural sources and environmental transformation processes, making source attribution challenging [41]. In contrast, MP-DOM originates from plastic polymers and associated additives, and thus such descriptors may retain source-related information regarding MP types [42].

Overall, these examples support the role of E2/E3 as a transferable intermediate descriptor linking MP-DOM formation processes with photochemical reactivity and downstream contaminant transformation, thereby providing a proof of concept for descriptor-driven predictive MP-DOM science.

4. Advantages, Limitations and Future Directions

4.1. Advantages

This framework offers three key advantages in the areas of mechanistic understanding, data integration, and predictive capability.

(1) This framework improves mechanistic interpretability by separating direct correlations from underlying causal processes through the introduction of an intermediate descriptor layer. This approach enables a more systematic understanding of why different MP aging pathways generate distinct environmental effects.

(2) This framework enhances comparability among previously disconnected studies by transforming diverse formation conditions into a unified descriptor space. Existing investigations often vary substantially in polymer type, particle size, irradiation conditions, weathering duration, microbial exposure, and analytical approaches, limiting direct comparison across datasets. By reporting a standardized set of optical, molecular, and reactivity-related descriptors, results generated from different experimental systems can be reinterpreted within a common framework, facilitating cross-study synthesis and knowledge integration.

(3) This framework could enhance the capability to predict environmental effects (e.g., toxicological effects and greenhouse gas formation) by providing a mechanism-informed descriptor space that can be integrated with emerging AI approaches [43]. Specifically, machine learning models could use polymer properties and MP-DOM formation conditions as inputs to predict MP-DOM concentrations, while models combining MP-DOM descriptors with exposure conditions could be trained against measured endpoints to predict environmental effects like toxicological responses. Such integration would enable quantitative prediction across the formation and effect layers, extending the framework beyond the identification of relationships among variables.

4.2. Practical Reality

A unified descriptor-based predictive framework could offer the advantages described; however, current evidence remains insufficient to establish reliable predictions across different MP-DOM systems. Three main limitations constrain its implementation.

First, integrated datasets that simultaneously link MP-DOM formation conditions, MP-DOM descriptors, and environmental effects remain scarce, hindering the establishment of quantitative relationships between formation processes and environmental functions.

Second, inconsistent experimental protocols and reporting practices, such as incomplete descriptions of irradiation parameters and heterogeneous normalization strategies for MP-DOM production and ROS generation, restrict cross-study comparison and data integration.

Third, the relationships between MP-DOM descriptors and environmental effects remain poorly understood, making it difficult to identify suitable descriptors for predicting specific effects.

Predicting different environmental effects requires appropriate descriptors and experimental data. For example, toxicological prediction requires datasets that include measured biological responses, the test organism or cell model, exposure concentration, exposure duration, and assay conditions. Descriptor selection should therefore be tailored to the specific endpoint.

4.3. Future Directions

Addressing these challenges requires the establishment of standardized reporting guidelines for MP-DOM that enable systematic comparison and data integration across studies. A minimum reporting checklist should include four categories of information: (i) MP properties, (ii) weathering conditions, (iii) MP-DOM descriptors, and (iv) environmental effects. Such standardized reporting would enable the construction of machine-readable datasets and facilitate meta-analysis, support descriptor identification, and accelerate the development of predictive models.

Beyond reporting standardization, future efforts should focus on establishing a more comprehensive and transferable descriptor system that integrates optical, molecular, and reactivity-based information. The goal is to consistently report key variables that capture the quantity, composition, and functional properties of MP-DOM, without requiring exhaustive molecular characterization in every study. Standardized datasets will facilitate the identification of informative descriptor combinations. Future studies should move beyond individual parameters toward optimized descriptor sets, using multivariate approaches such as Principal Component Analysis (PCA), Partial Least Squares (PLS), and machine learning to maximize predictive information while reducing redundancy.

By connecting fragmented observations through shared descriptors, the MP-DOM domain can progress from being a collection of isolated case studies toward a predictive and chemically interpretable discipline. The resulting standardized datasets may enable the application of AI approaches to identify complex relationships among formation conditions, molecular characteristics, and environmental reactivity.

Author Contributions

Y.Z. (Yunyi Zeng): investigation, data curation, formal analysis, visualization, writing—original draft preparation, writing—reviewing and editing; Y.Z. (Yangjian Zhou): investigation, visualization, writing—original draft preparation, writing—reviewing and editing; J.C.-F.L.: writing—original draft preparation, writing—reviewing and editing; Y.H.: writing—original draft preparation; K.S.-Y.L.:

 https://doi.org/10.53941/ges.2026.100031

supervision, writing—reviewing and editing. All authors have read and agreed to the published version of the manuscript.

Funding

Kelvin Sze-Yin Leung thanks the Hong Kong Research Grants Council (HKBU 12303524 and 12302125) for their financial support. Yangjian Zhou gratefully acknowledges the support of the National Natural Science Foundation of China (22506221) and the Hong Kong Scholars Program (XJ2024045). Yunyi Zeng is supported by a postgraduate studentship offered by the University Grants Committee.

Institutional Review Board Statement

Not applicable.

Informed Consent Statement

Not applicable.

Data Availability Statement

No new experimental data were generated for this Perspective. The data used in the regression analysis shown in Figure 2b were compiled from the published studies cited in the figure caption.

Conflicts of Interest

The authors declare no conflicts of interest. Given the role as Editorial Board Member of Global Environmental Science, Kelvin Sze-Yin Leung had no involvement in the peer review of this paper and had no access to information regarding its peer-review process. Full responsibility for the editorial process of this paper was delegated to another editor of the journal.

Use of AI and AI-Assisted Technologies

During the preparation of this work, the authors used ChatGPT (OpenAI) to improve language clarity and readability. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

References

1. Liu, X.; Fang, L.; Gardea-Torresdey, J.L.; et al. Microplastic-derived dissolved organic matter: Generation, characterization, and environmental behaviors. *Sci. Total Environ.* **2024**, *948*, 174811.
2. Romera-Castillo, C.; Pinto, M.; Langer, T.M.; et al. Dissolved organic carbon leaching from plastics stimulates microbial activity in the ocean. *Nat. Commun.* **2018**, *9*, 1430.
3. Thompson, R.C.; Courtene-Jones, W.; Boucher, J.; et al. Twenty years of microplastic pollution research—What have we learned? *Science* **2024**, *386*, eadl2746.
4. Zhou, Y.; Zeng, Y.; Law, J.C.F.; et al. Long-Lived Organic Radicals Drive the Photodegradation of Plastic Additives in Microplastic-Derived Dissolved Organic Matter. *Environ. Sci. Technol.* **2026**, *60*, 18835–18843.
5. Lee, Y.K.; Romera-Castillo, C.; Hong, S.; et al. Characteristics of microplastic polymer-derived dissolved organic matter and its potential as a disinfection byproduct precursor. *Water Res.* **2020**, *175*, 115678.
6. Ateia, M.; Kanan, A.; Karanfil, T. Microplastics release precursors of chlorinated and brominated disinfection byproducts in water. *Chemosphere* **2020**, *251*, 126452.
7. Tang, X.; Yuan, X.; Lu, W.; et al. Microplastics in livestock manure and compost: Environmental distribution, degradation behavior, and their impact on antibiotic resistance gene dissemination. *Chem. Eng. J.* **2025**, *513*, 162881.
8. Song, F.; Li, T.; Hur, J.; et al. Molecular-level insights into the heterogeneous variations and dynamic formation mechanism of leached dissolved organic matter during the photoaging of polystyrene microplastics. *Water Res.* **2023**, *242*, 120114.
9. Wang, K.; Ma, S.; Li, Z.; et al. New Insights into the Long-Term Leaching Process of Dissolved Organic Matter from Microplastics: Dynamic Formation and Transformation Mechanism. *Environ. Sci. Technol.* **2025**, *59*, 22180–22191.
10. Lee, Y.K.; Hong, S.; Hur, J. A fluorescence indicator for source discrimination between microplastic-derived dissolved organic matter and aquatic natural organic matter. *Water Res.* **2021**, *207*, 117833.
11. Huang, D.; Ding, L.; Qiu, X.; et al. Molecular-Scale Insights into the Surface Structural Transformation and Light-Driven Production of Reactive Oxygen Species of Goethite Induced by Microplastic-Derived Dissolved Organic Matter. *Environ. Sci. Technol.* **2025**, *59*, 17349–17360.
12. Chen, M.; Xu, J.; Tang, R.; et al. Roles of microplastic-derived dissolved organic matter on the photodegradation of organic micropollutants. *J. Hazard. Mater.* **2022**, *440*, 129784.
13. Zhang, X.; Zhang, T.; Zhang, J.; et al. Review of decisive factors for controlling generation and environmental effect of dissolved organic matter from (micro)plastics. *J. Hazard. Mater.* **2025**, *500*, 140511.
14. Shi, C.; Guo, A.; Pang, S.; et al. Precise characterization of the presence and fate of plastic oligomers in water. *Nat. Water* **2025**, *3*, 461–472.
15. Wang, M.; Zhang, J.; Yang, Y.; et al. Photoreactivity of microplastic-derived dissolved organic matter governed by its oxygen-containing functional groups in hydrophobic/hydrophilic fractions rather than molecular weights. *Water Res.* **2026**, *291*, 125187.
16. Xiao, J.; Zhang, Z.; Liu, P.; et al. Microplastic-Derived Carbon Emissions: From Granular Carbon to Dissolved Organic Carbon and Carbon Dioxide under Ultraviolet Radiation. *Environ. Sci. Technol.* **2025**, *59*, 17310–17321.
17. Yin, Y.; Li, Z.; Li, R.; et al. Effect of pH and salinity on the release of polystyrene microplastics derived dissolved organic matter as revealed by experimental studies and molecular dynamic simulations. *Sci. Total Environ.* **2025**, *975*, 179307.

18. Fan, Z.; Yang, Y.; Wang, P.; et al. Microplastics-driven reconfiguration of organic carbon fractions in lake sediments: Mineralization and stabilization dynamics of biodegradable polymers. *Water Res.* **2026**, *289*, 124852.
19. Helms, J.R.; Stubbins, A.; Ritchie, J.D.; et al. Absorption spectral slopes and slope ratios as indicators of molecular weight, source, and photobleaching of chromophoric dissolved organic matter. *Limnol. Oceanogr.* **2008**, *53*, 955–969.
20. Petersen-Sonn, E.A.; Brigante, M.; Deguillaume, L.; et al. Tropospheric Multiphase Chemistry: Excited Triplet States Compete with OH Radicals and Singlet Molecular Oxygen. *ACS Earth Space Chem.* **2025**, *9*, 533–544.
21. Ossola, R.; Jönsson, O.M.; Moor, K.; et al. Singlet Oxygen Quantum Yields in Environmental Waters. *Chem. Rev.* **2021**, *121*, 4100–4146.
22. McNeill, K.; Canonica, S. Triplet state dissolved organic matter in aquatic photochemistry: Reaction mechanisms, substrate scope, and photophysical properties. *Environ. Sci. Process. Impacts* **2016**, *18*, 1381–1399.
23. Lee, J.; von Gunten, U.; Kim, J.H. Persulfate-Based Advanced Oxidation: Critical Assessment of Opportunities and Roadblocks. *Environ. Sci. Technol.* **2020**, *54*, 3064–3081.
24. Ding, L.; Zhang, H.; Chen, H.; et al. Photochemical transformation of microplastics-derived dissolved organic matter altered the photoaging of microplastics. *J. Hazard. Mater.* **2025**, *500*, 140477.
25. Yang, H.; Gao, B.; Wang, Z.; et al. Phototransformation of microplastic derived dissolved organic matter reduces its adsorption capacity on ferrihydrite: Effects of additive types. *J. Hazard. Mater.* **2026**, *503*, 141147.
26. Ouyang, Z.; Li, S.; Xue, J.; et al. Dissolved organic matter derived from biodegradable microplastic promotes photo-aging of coexisting microplastics and alters microbial metabolism. *J. Hazard. Mater.* **2023**, *445*, 130564.
27. Wang, K.; Xu, S.; Wang, J.; et al. Insights into the photosensitivity and photobleaching of dissolved organic matter from microplastics: Structure-activity relationship and transformation mechanism. *J. Hazard. Mater.* **2024**, *480*, 135931.
28. Huang, D.; Dong, H.; Li, X.; et al. Transformation of dissolved organic matter leached from biodegradable and conventional microplastics under UV/chlorine treatment and the subsequent effect on contaminant removal. *J. Hazard. Mater.* **2024**, *480*, 135994.
29. Wang, Q.; Chen, M.; Min, Y.; et al. Aging of polystyrene microplastics by UV/Sodium percarbonate oxidation: Organic release, mechanism, and disinfection by-product formation. *J. Hazard. Mater.* **2024**, *464*, 132934.
30. Huang, D.; Ding, L.; Qiu, X.; et al. Molecular transformation and photochemical reactivity of microplastic-derived dissolved organic matter on goethite: Implications for persistence and reactive oxygen species dynamics. *Water Res.* **2026**, *288*, 124568.
31. Zhang, J.; Hou, X.; Zhang, K.; et al. Photochemistry of microplastics-derived dissolved organic matter: Reactive species generation and organic pollutant degradation. *Water Res.* **2025**, *269*, 122802.
32. Gu, J.; Chen, K.; Cai, T.; et al. The intermolecular differences in dissolved organic matter derived from microplastics during photo-aging and photo-bio-aging processes. *Environ. Pollut.* **2025**, *381*, 126599.
33. Xu, Y.; Huang, D.; Liu, P.; et al. The characteristics of dissolved organic matter release from UV-aged microplastics and its cytotoxicity on human colonic adenocarcinoma cells. *Sci. Total Environ.* **2022**, *826*, 154177.
34. Zeng, L.; Zhou, Z.; Zhang, J.; et al. Selective degradation of organic pollutants in the aquatic environment by microplastic-derived dissolved organic matter through molecular photoresponse sequence transformation. *Chem. Eng. J.* **2024**, *499*, 156676.
35. Ding, R.; Shan, X.; Ding, L.; et al. Coupled Reactive Regulation by Microplastic-Derived Dissolved Organic Matter Sustains Reactive Oxygen Species Cycling in Laccase-Metal Synergy for Continuous Microplastic Degradation. *Environ. Sci. Technol.* **2026**, *60*, 2101–2111.
36. Yang, Z.; Liu, P.; Wang, J.; et al. Microplastics-derived dissolved organic matters accelerate photodegradation of sulfamethazine in wastewater ultraviolet disinfection process. *Chem. Eng. J.* **2023**, *454*, 140301.
37. Chen, H.; Shan, X.; Qiu, X.; et al. High-Resolution Mass Spectrometry Combined with Reactive Oxygen Species Reveals Differences in Photoreactivity of Dissolved Organic Matter from Microplastic Sources in Aqueous Environments. *Environ. Sci. Technol.* **2024**, *58*, 10334–10346.
38. Wan, D.; Wang, J.; Chen, T.; et al. Effect of disinfection on the photoreactivity of effluent organic matter and photodegradation of organic contaminants. *Water Res.* **2022**, *219*, 118552.
39. Guo, S.; Liu, L.; Wang, L.; et al. Phototransformation and photoreactivity of MPs-DOM in aqueous environment: Key role of MPs structure decoded by optical and molecular signatures. *J. Hazard. Mater.* **2024**, *480*, 136331.
40. Dalrymple, R.M.; Carfagno, A.K.; Sharpless, C.M. Correlations between Dissolved Organic Matter Optical Properties and Quantum Yields of Singlet Oxygen and Hydrogen Peroxide. *Environ. Sci. Technol.* **2010**, *44*, 5824–5829.
41. Li, S.; Harir, M.; Bastviken, D.; et al. Dearomatization drives complexity generation in freshwater organic matter. *Nature* **2024**, *628*, 776–781.
42. Li, Y.; Poisson, K.; McMinn, M.H.; et al. Small Molecules as Markers for Decoding Plastic-Related Information: A Focus on Polymer Composition. *Environ. Sci. Technol. Lett.* **2025**, *12*, 1019–1025.
43. Yang, R.; Duan, J.; Song, J.; et al. Microplastics identification framework: Integration of microplastic-derived dissolved organic matter fingerprints and machine learning. *Water Res.* **2026**, *303*, 126251.