

# Advancing Microfiber Research: A Call for Chemical Transparency and Coordination between Science and Industry

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## ■ INTRODUCTION

Microfibers (anthropogenic fibers < 5 mm, synthetic, semi-synthetic, and natural) are widespread across air, water, and sediment, with growing evidence of human exposure. Recent post-mortem analyses report diverse polymer and modified-cellulose fibers in multiple human organs (e.g., thyroid, kidney, and brain),<sup>1</sup> demonstrating the ability of microfibers to penetrate biological barriers and highlighting the need for toxicology and risk assessment. However, the chemical dimension of microfiber hazards largely remains uncharacterized: textiles contain dyes, pigments, coatings, finishing agents, and unintentionally added chemicals. Some of these chemicals may be toxic, persistent, or bioaccumulative.<sup>2</sup> While serving design, performance, or regulatory functions, fiber chemistries are rarely disclosed. Intellectual property protections and fragmented supply chains are barriers to disclosing what chemicals are present in textiles. This opacity limits researchers’ ability to draw conclusions about microfiber toxicity (i.e., which physical and chemical properties drive effects), hinders reproducibility in studies, and delays collective progress toward safer design.

In addition to chemical transparency, a limitation in microfiber research is the inconsistency in study reporting. Experimental studies vary widely in fiber types, additives, weathering conditions, and exposure routes. A lack of consistency hinders cross-study comparisons and may stem from a reluctance to test niche formulations with unknown compositions. Moreover, the physical properties of the microfibers may not be reported, but are critical for understanding the fate, transport, and risk to organisms. Without harmonized reporting of chemical and physical parameters, it is difficult to develop a coherent picture of microfiber exposure and risk.

Recent policy discussions—such as the United Nations (UN) Global Plastics Treaty—underscore the urgency of addressing chemical additives and the need for traceability across the supply chain.<sup>3,4</sup> However, textiles, a major source of chemicals and macro- and microplastic pollution, have not been consistently included. There is now an opportunity for greater transparency to extend into the textile sector. This

should include synthetic, semisynthetic, and natural materials, all of which shed and can cause negative effects.<sup>2</sup>

A coordinated approach to understanding the chemical dimension of microfiber pollution is needed. We outline priority areas for increased transparency in future research, including (1) chemical prioritization, (2) study harmonization, and (3) infrastructure for collaboration.

## ■ CHEMICAL PRIORITIZATION

Emerging research shows microfiber effects are physical and chemical.<sup>5</sup> However, to assess chemical effects, we currently lack the prioritization, harmonization, and infrastructure to understand or mitigate contaminants associated with textiles. To improve the scientific relevance for toxicity studies and inform safer design, researchers need guidance. Initiatives like ChemForward<sup>6</sup> offer one starting point with a disaggregated database of thousands of chemicals and their use cases across supply chains. This resource can flag priority chemicals and prioritize them based on production volume, hazard, and specific chemical associations with materials or designs. To avoid repeating broad lists, we propose a microfiber-specific prioritization scheme with three tiers. Tier A (high priority) additive classes with frequent use and hazard flags (e.g., disperse dye carriers; formaldehyde-based resins; organophosphorus FRs; PFAS where still present); Tier B (contextual) finishing aids and coatings with moderate hazard or widespread use (e.g., silicones for softening; antistatic polyethylene glycols); Tier C (exploratory): unintentionally added/formed compounds and transformation products identified.

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**Table 1. Collaboration Infrastructure for Microfiber Toxicology: Suggestions, Leads, and Outputs (Authors' Recommendation)**

element	what it is	lead(s)	outputs	metrics
working group	precompetitive consortium (academia, NGOs, industry)	rotating chairs	regular meetings; data-sharing policies	organizations enrolled
reference materials	curated microfiber materials and finishes (virgin, laundered, weathered)	materials group	spec sheets with additives; distribution plan for working with laboratories; storage protocol	microfibers available to participants
method and reporting harmonization	minimal information checklist + test guidance (dose, end points, QA/QC)	methods group	checklist; interlab protocol	laboratories reproduce reference tests; checklist adoption in manuscripts
priority chemicals list	tiered list (A/B/C...) linked to use and hazard; updated annually	chemicals group	list; substitution notes	substitutions piloted
translation to design	guidance for brands on materials, additives, and designs (high- and low-risk)	translation group	design guide	guides used by brands; reported substitutions

## STUDY HARMONIZATION

Harmonizing toxicity study design could improve data quality and comparability. Key recommendations include isolating chemical variables from physical characteristics and aligning test conditions with environmental realism (e.g., using weathered fibers, environmentally relevant concentrations, and mixture-focused testing).<sup>7</sup> While many studies use commercially available textiles, a lack of chemical disclosure limits interpretability. Pairing real-world fibers with known treatments, researchers can better assess effects. A strategy—possibly led by a cross-sector consortium (Table 1)—could define realistic exposures. End points, many of which have already been explored but not codified, could include developmental, endocrine, oxidative stress, systemic biochemical disruption, or behavioral responses under environmentally relevant conditions (e.g., rising temperatures and ocean acidification). Finally, harmonizing microfiber characterization (e.g., size, morphology, polymer type, and chemical profile) is a prerequisite for linking lab results to environmental monitoring and hazard assessment.<sup>8</sup>

## COLLABORATION INFRASTRUCTURE

Information sharing is needed among researchers and industry. Some brands and suppliers are contributing already, by providing access to known fabric samples<sup>9</sup> and disclosing chemistries (e.g., under confidentiality agreements). These collaborations offer mutual value. For researchers, they provide realism and access to otherwise inaccessible chemical data. For industry, the findings can inform material innovation and supply chain management.

Decisions made by industry, coupled with future global regulatory frameworks, will ultimately shape what enters the environment. Without closing the loop between research and design, we risk continuing a cycle of ivory tower studies and industry unable to respond to the latest science. Research should be carried out so it is valuable for decision making. Study findings should be translated into product design guidance, helping brands identify high-risk materials, chemistries, and finishes, and inform lower-impact substitutes. For example, nonfluorinated durable water repellents (silicones and paraffin waxes) as better replacements for PFAS.<sup>10</sup>

The field needs strategic collaboration, not siloed work or duplication. Groups that span academia, NGOs, and industry are well-positioned to lead this effort. The only way to address the complexity of microfiber pollution is through collective action, and this could start with a shared commitment to chemical transparency.

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### Notes

The authors declare no competing financial interest.

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