



Addressing the
environmental
impact of microfibers
in textiles



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WHITE PAPER

In recent years, the use of microfibers and other synthetic materials in textiles has grown significantly as producers seek new ways to improve the quality and durability of apparel products. This is particularly the case for manufacturers of athletic and outdoor apparel and footwear, in which the use of microfibers can provide increased warmth and resistance to environmental conditions while also reducing the weight of the finished product. Textiles incorporating microfibers can offer producers greater flexibility in product design while also helping to reduce the use of more expensive natural textiles.

But the increased reliance on microfibers and synthetic materials in textiles bring with it a previously hidden cost. Textiles comprised of microfibers shed during the normal laundering processes used in most developed countries. Often too small to be trapped by standard filtering mechanisms, these microfibers are then routed through wastewater streams and end up in lakes, rivers, and oceans. Aside from contributing to plastic pollution, microfibers often retain a residue of chemicals that were used to coat the original textile, leading to chemical contamination.



In this UL white paper, we'll discuss the use of microfibers in textiles and the growing concern regarding their environmental impact. Learn how the U.S. intends to regulate efforts currently underway to address the microfiber issue, as well as scientifically-based test methods under development that can be used to assess the extent of microfiber shedding in textile samples. Lastly, we'll discuss how UL is working with manufacturers to evaluate the textiles used in their apparel and footwear products, and enabling them to provide consumers with objective information critical to the environmental assessment of those products.

What are microfibers?

Microfibers are generally defined as fibers that have a linear mass density of one denier (dtex) or less and a diameter of less than 10 micrometers, making them smaller than a strand of silk, and approximately one-fifth the diameter of a human hair. Microfibers are comprised of a combination of synthetic materials, including polyesters and polyamides like nylon and Kevlar®. Other microfibers may consist of polyesters and polyamides in combination with polypropylene.

First produced on an experimental basis in the 1950s and 1960s, microfibers achieved commercial market success in the late 1980s and early 1990s. Today, the overall demand for microfibers and other synthetic fibers has surpassed that of natural materials such as wool and cotton.¹ Further, global demand for synthetic fibers is projected to grow at more than 7% per year over the next several years, reaching a total market of more than \$144 million (USD) by the year 2023.²



Microfiber-based textiles are used in a variety of clothing, particularly in athletic wear and undergarments, in fashion accessories as a substitute for leather and other natural materials, and in cleaning products such as cloths and mops. Microfibers have even been used as an outer, moisture-absorbing shell for basketballs used in professional sports!³ Specific material combinations used in various types of microfibers can result in textile products that offer diverse performance characteristics, including:

- **Durability**—Microfiber-based textiles are more durable than comparable natural materials. This is important for textiles and fabrics subject to excess wear during normal use.
- **Stain resistance**—A key benefit to using microfibers is their resistance to staining. Stain resistance makes microfiber-based textiles a preferred choice for furniture and upholstery surfaces.
- **Moisture absorption**—Microfibers absorb significantly more moisture than natural fibers and wick away unwanted perspiration from the skin. As such, microfiber-based textiles are frequently used in athletic wear and clothes intended for use in warm climates.
- **Insulation**—Microfibers are an excellent substitute for natural insulating materials such as goose down, and can provide effective insulation in winter garments as well as sleeping bags and outdoor equipment.
- **Weight**—Microfibers are also lighter weight than natural fibers. This allows manufacturers to produce textiles for clothing that offer an outstanding performance profile without added weight.
- **Price**—Microfibers and other synthetic-based fabrics are less expensive to produce, contributing to greater control over product production costs.

The environmental impact of microfibers in textiles

Unfortunately, microfibers in textiles are also having a measurable impact on the environment. Microfiber-based textiles are now known to shed synthetic fibers and microplastics, both during normal use and as a byproduct of conventional laundering processes. Researchers have found that a single garment comprised of microfiber textiles can shed thousands of fibers in a single machine washing.⁴ (Ironically, microfiber-based textiles comprised of recycled materials, such as water bottles made of polyethylene terephthalate (PET) plastics, may actually shed more microfibers, since they may be less strong than microfibers made from virgin plastics.⁵)

Conventional filtering mechanisms and systems used in washing machines and municipal wastewater treatment facilities may be effective at capturing a large percentage of these shed fibers, with some filtration technologies claiming capture rates as high as 99%.⁶ Even with high capture rates, the volume of water being processed means that significant amounts of microfibers and microplastics make their way into nearby rivers, lakes, and oceans potentially impacting aquatic life. Microfibers and microplastics have also been found in the ground where sludge from wastewater treatment facilities has been applied, which can affect agricultural growth and livestock.

The potential environmental impact of microfibers is further compounded by various chemicals used in the production of microfiber-based textiles. Dyes, waterproofing agents or chemicals that reduce potential flammability of a finished textile product can adhere to microfibers that have been shed from the fabric. These chemicals are then released into the environment along with the microfibers, posing additional pollution risks

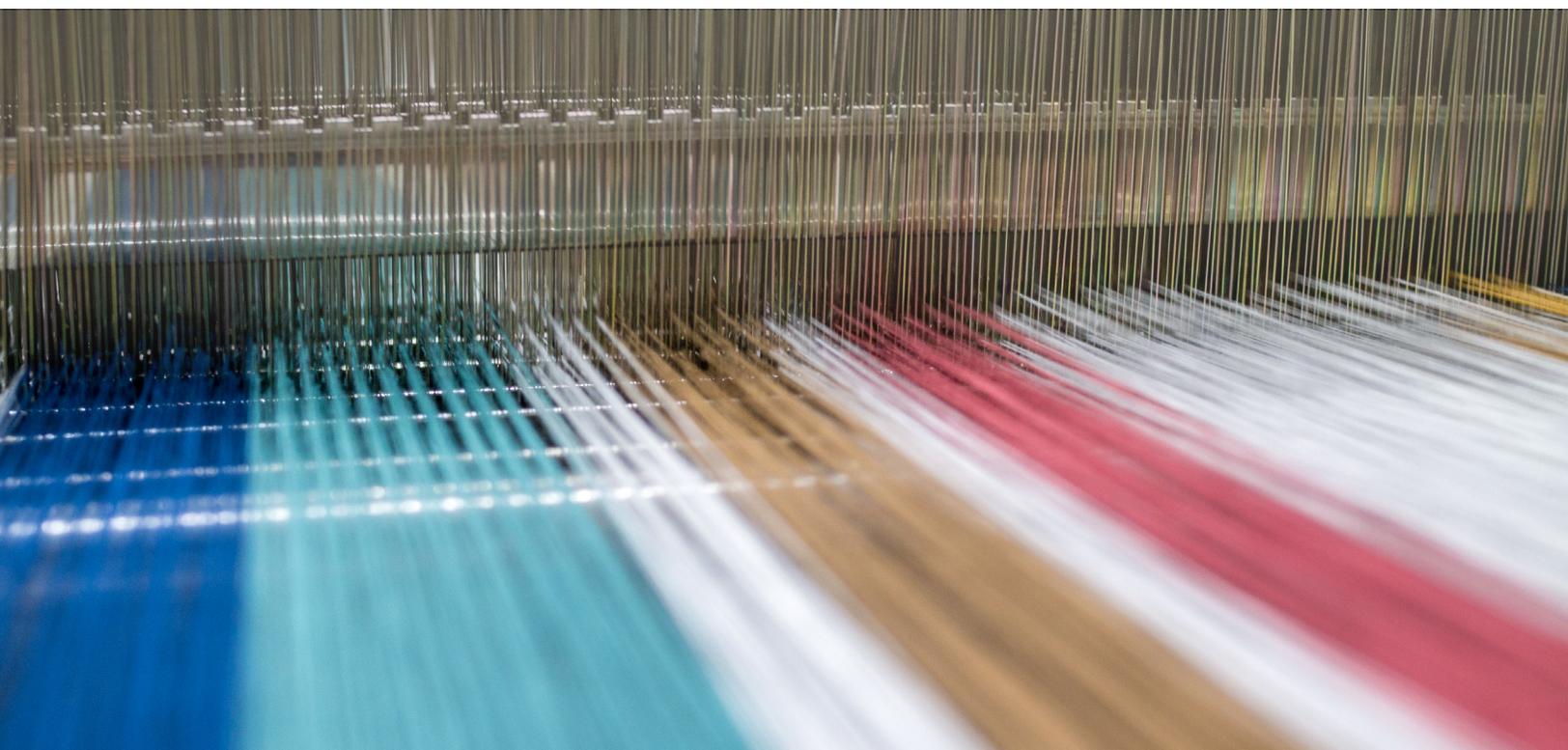
The extent to which microfibers and microplastics impact aquatic life has been the subject of extensive research by scientists and environmentalists. To cite the findings of just one such study, researchers found anthropogenic material in the guts of 25% of fish samples and 33% of shellfish samples purchased in markets near San Diego, CA, with textile fibers representing 80% of the waste material collected.⁷ Other studies have linked the ingestion of fibrous microplastics to retarded growth in crabs and freshwater crustaceans, as well as reduced rates of reproduction.⁸

Perhaps not surprisingly, microfibers and microplastics are also being found in tap water. In a study published in 2018, researchers found that 81% of 159 tap water samples tested contained anthropogenic particles, with fibers between 0.1-5 mm in length representing 98.5% of the particles found. Based on the results of their study, the researchers estimate that an average person ingests over 5800 particles of synthetic debris each year.⁹

We have found little current research on the potential impact on human health from exposure to or ingestion of microfibers and microplastics. However, the smallest microplastics are known to interact with proteins and other essential nutrients in the body and are capable of crossing biological barriers such as the blood-brain barrier, potentially affecting the human nervous system.¹⁰ This makes prolonged exposure to, or ingestion of, microfibers and microplastics a genuine concern for human health.

Potential regulations on microfibers in textiles

Despite the growing evidence of the potential impact of microfibers on the environment, efforts to develop regulations and standards related to microfibers in textiles are still in the earliest stages. In the European Union (EU), a study conducted on behalf of the EU Commission and published in early 2018 identified several specific approaches for reducing the release of microfibers into the aquatic environment. The study, which also provided a cost-benefit analysis of specific solutions related to microfibers in textiles, could serve as a basis for future regulatory action by the Commission.¹¹



Separately, the European Chemicals Agency (ECHA) has requested comments on its March 2019 proposal to restrict intentionally added microplastics under the scope of the EU's REACH Regulation. Although the proposal does not expressly identify microfibers in textiles, the proposed restrictions would support efforts to reduce the overall environmental effects related to the use of microfibers.¹² Member state representatives to the European Committee on Standardization (CEN) have proposed the addition of a preliminary project to CEN's work program to further investigate analytical methods for quantifying "microplastics" generated by textile production and textile laundering.

In the U.S., regulatory activity related to textile-based microfibers has primarily taken place at the state level, where several state legislatures have proposed laws and regulatory action that would reduce the impact of microfibers. For example, the state of Connecticut's 2018 legislative "Act Concerning Clothing Fiber Pollution" encouraged textile industry representatives to actively participate in a Working Group established by the state Legislature to develop a consumer education program to increase awareness about pollution related to microfibers. A draft report to the Connecticut Legislature on the findings of the Working Group was published in January 2019 and includes several recommendations to the Legislature on specific steps that can be taken to reduce microfiber-related pollution.¹³

In a separate action, the Environmental Conservation Committee of the New York State Assembly has introduced a bill into the 2019-2020 legislative session (A1549). That bill would require manufacturers of garments comprised of more than 50% synthetic materials to amend any federally-required care label to include the statement "This garment sheds plastic microfibers when washed." For clothing suitable for machine washing, the statement would add "Hand washing recommended to reduce shedding." If the proposed legislation passes as drafted, the requirements will become effective as of January 1, 2021.¹⁴

Legislators in California have taken an even more ambitious approach to the regulation of microfibers in textiles. Under Assembly Bill (AB) No. 129, introduced in late 2018, the California State Water Resources Control Board would be required to develop a standard methodology for evaluating residential microfiber filtration systems and to conduct testing to quantify the amount of shedding that occurs from different types of clothing during laundering. Based on its findings from those efforts, the Board would then be required to identify best practices to be adopted by clothing manufacturers to reduce the number of microfibers released into the environment.

AB No. 129 would also require both public and private entities that use industrial or commercial laundry systems to install filtration systems suitable for the capture of microfibers shed during the laundering cycle. Public entities and private entities that contract with a state agency for laundry services would be required to meet the filtration system requirements by no later than January 1, 2020, while private entities would have until January 1, 2021, to meet the requirements.¹⁵

While there are currently no proposed changes to U.S. federal law regarding microfibers, any definitive legislative or regulatory action in individual states with large consumer markets would likely have implications across the entire U.S. The cost of producing specially designed products for individual state markets is prohibitive; textile manufacturers typically develop products that can legally be sold in every state. As a result, the implementation of microfiber requirements in states like California or New York would, in practice have the same impact on manufacturers as federal regulations.

Emerging microfiber testing methods

In the meantime, the textile industry in the U.S. is moving forward with efforts to develop testing methods that can be used to measure the number of microfibers and microplastics released from textile products. The American Association of Textile Chemists and Colorists (AATCC) is working on a draft test method, "Fiber Release During Laundering: Accelerated." The draft test method is being developed by the AATCC's Committee RA100 on Global Sustainability Technology and is intended to support industry efforts to objectively measure the release of microfibers during the laundering process.

The AATCC's draft method involves round-robin testing using an accelerated laundering machine that simulates the equivalent of five home laundings in a single cycle. This is achieved by increasing the abrasion fabrics are exposed to during the laundering process. This method is achieved by primarily adding small steel balls to the canister in which the fabric under test is placed. Glass fiber filters that meet the requirements of ASTM D3977 Part B are washed and allowed to dry and then weighed prior to their installation in the laundering machine, and then weighed following the completion of the laundering cycle. The measured pre and post-weights are then used to calculate the total fiber loss and the percentage of mass loss.

It is important to note that the requirements of the AATCC draft test method are subject to change before its final approval. However, when published, the draft test method will serve as an effective tool in measuring the extent of microfiber shedding from textiles and facilitate efforts to benchmark the results against comparable fabrics. The test method can also provide important information during the product development process, and allow manufacturers to assess the extent to which variations in chemical composition influence microfiber shedding. Finally, even in the absence of current regulations on the testing or labeling of textiles with microfiber content, the data produced by the AATCC draft test method can help support claims of a manufacturer's efforts to produce products that are less harmful to the environment, an important factor for a growing number of consumers.

How UL is working with the textile, apparel and footwear industry to address the microfiber challenge

For more than 65 years, UL has partnered with the textile, apparel and footwear industries to help meet sustainability requirements and expectations of modern consumers around the world. As a participant in AATCC's Committee RA100 on Global Sustainability Technology, the Environmental Committee of the American Apparel & Footwear Association (AAFA) and other standards organizations, UL technical experts have worked side-by-side with industry professionals and regulators, leveraging our extensive knowledge and experience in an effort to help create standards and test methods that support those goals. The development of the AATCC's draft test method for assessing microfiber shedding from textile products during the laundering process is just one example of that commitment.

In addition to our contributions to standards and test methods development, UL is also an official Contributor to the Zero Discharge of Hazardous Chemicals (ZDHC) Program, an independent consortium of manufacturers, supply chain partners and other interested parties committed to the elimination of hazardous chemicals in the global textile, leather and footwear value chain. UL's onsite wastewater assessments are structured to complement the ZDHC's wastewater guidelines, going beyond regulatory compliance requirements to help ensure the safety of both consumers and the environment.

Summary and conclusion

Apparel products made from microfiber-based textiles offer several potential advantages to consumers, including lower cost, lighter weight, and increased durability. However, synthetic textiles are now known to shed microfibers and microplastics during normal use and through laundering, which can have a potentially adverse impact on our oceans, fish, livestock, and other natural resources. Methods to assess fiber shedding that are now under development can help manufacturers assess the extent to which current and future synthetic textiles contribute to this problem, while also supporting the development of textile products that are less harmful to the environment.

For more information about UL's microfiber testing or our other services supporting the textile, apparel and footwear industry, go to <https://crs.ul.com/en/industries/textiles-apparel-and-footwear/>. Or contact us at QAInfo@ul.com.



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Official sources

- ¹“Man-Made Fibers Continue to Grow,” posting to the website of Textile World, February 3, 2015. Web. 28 April 2019. <https://www.textileworld.com/textile-world/fiber-world/2015/02/man-made-fibers-continue-to-grow/>.
- ²“Synthetic Fibers Market Research Report-Global Forecast till 2023,” a report by Market Research Future, November 2018. Web. 28 April 2019. <https://www.marketresearchfuture.com/reports/synthetic-fibers-market-5284>.
- ³“NBA Introduces New Game Ball,” posting to the website of the National Basketball Association, June 28, 2006. Web. 28 April 2019. http://www.nba.com/news/blackbox_060628.html.
- ⁴See, for example, “Accumulation of Microplastic on Shorelines Worldwide: Sources and Sinks,” paper by Mark Anthony Brown published in Environmental Science and Technology, a publication of the American Chemical Society, September 6, 2011. Web. 28 April 2019. <https://pubs.acs.org/doi/abs/10.1021/es201811s>.
- ⁵“Our Clothes Are Contaminating Our Planet with Tiny Plastic Threads,” the first in a three-part series of articles posted to the website of Ensia, June 19, 2018. Web. 28 April 2019. <https://ensia.com/features/microfibers/>.
- ⁶“Microfiber Shedding: Hidden Environmental Impact,” published in AATCC Review, September/October 2017. Web. 28 April 2019. <https://www.aatcc.org/wp-content/uploads/2018/06/MicrofiberA2Rev17.5.1.pdf>.
- ⁷“Anthropogenic debris in seafood: Plastic debris and fibers from textiles in fish and bivalves sold for human consumption,” published in Scientific Reports, September 2015. Web. 28 April 2019. <https://rochmanlab.files.wordpress.com/2016/08/rohman-et-al-2015-sci-rep.pdf>.
- ⁸“Humans, Fish and Other Animals Are Consuming Microfibers in Our Food and Water,” the second in a three-part series of articles posted to the website of Ensia, July 2, 2018. Web. 28 April 2019. <https://ensia.com/features/microfiber-impacts/>.
- ⁹“Anthropogenic contamination of tap water, beer, and sea salt,” research article posted to the website of PLOS|ONE, April 11, 2018. Web. 28 April 2019. <https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0194970>.
- ¹⁰“Never Good News Having Particles in Your Brain,” posted to the English-language website of Spiegel Online, January 22, 2019. Web. 28 April 2019. <http://www.spiegel.de/international/zeitgeist/toxicologist-rosemary-waring-on-the-danger-of-microplastics-a-1249144.html>.
- ¹¹“Investigating Options for Reducing Releases in the Aquatic Environment of Microplastics Emitted by Products,” a report prepared for the European Commission, 23 February 2019. Web. 28 April 2019. <https://www.eunomia.co.uk/reports-tools/investigating-options-for-reducing-releases-in-the-aquatic-environment-of-microplastics-emitted-by-products/>.
- ¹²“Annex XV Restriction Report: Proposal for a Restriction,” issued by the European Chemicals Agency, 20 March 2019. Web. 28 April 2019. <https://echa.europa.eu/documents/10162/12414bc7-6bb2-17e7-c9ec-652a20fa43fc>.
- ¹³“Report to the Legislature on the Findings of the Synthetic Microfiber Working Group,” draft released by the Connecticut Department of Energy & Environmental Protection, January 2019. Web. 28 April 2019. https://www.ct.gov/deep/lib/deep/p2/microfiber_pollution/Draft_strategy_January_2019.pdf.
- ¹⁴“An Act to amend the environmental conservation law, in relation to requiring additional labels on certain microfiber clothing,” State of New York Assembly, A1549, January 15, 2019. Web. 28 April 2019. <https://legislation.nysenate.gov/pdf/bills/2019/A1549>.
- ¹⁵“Assembly Bill No. 129, An act to add Section 116376.5 to, and add Chapter 10 (commencing with Section 119450) to Part 15 of Division 104 of the Health and Safety Code relating to environmental protection,” introduced to the California Legislature, December 4, 2018. Web. 28 April 2019. https://leginfo.ca.gov/faces/billTextClient.xhtml?bill_id=201920200AB129.