Liberty Mutual INSURANCE

Microplastics are a type of Phthalate, a broader category defined as manufactured chemicals used to soften plastics to make them more flexible.

Microplastics

Microplastics are fragments of any type of plastic less than 5 millimeters (mm) in length[1] and are an increasing topic of risk discussions due to their prevalence in the environment and negative impacts they potentially pose to the earth and its inhabitants. The term microplastics was first introduced to differentiate these smaller fragments from their larger counterparts, macroplastics, which describe larger plastic waste, such as plastic bottles.

Two classifications of microplastics are currently recognized.

- Primary microplastics include any plastic fragments or particles that are already 5 mm (5,000 µm) in size or less before entering the environment. Primary microplastics are purposefully manufactured and can include feedstock for manufacturing plastic products, such as plastic pellets (also known as nurdles), microfibers from clothing, microbeads in personal care products, glitter, and industrial abrasives. Once in the environment, microplastics can degrade to be even smaller in size.
- Secondary microplastics arise from the breakdown of larger plastic products through natural weathering processes after entering the environment. Sources of secondary microplastics can include water and soda bottles, fishing nets, plastic bags, shedding of fibers from polyester/nylon clothing, and tire wear. Over time, a culmination of physical, biological, and photodegradation can reduce the structural integrity of plastic debris to a size that is eventually undetectable to the naked eye. This process of breaking down large plastic material into much smaller pieces is known as fragmentation.

Microplastics can be further divided into four sub-groups based on particle size:

- Large microplastics (100–5000 µm)
- Small microplastics (1–100 µm)
- Sub-micron plastics (100–1,000 nm) (0.1– µm)
- Nanoplastics (1–100 nm) (0.001–0.1 µm)

Because of their smaller size, nanoplastics can present additional risks and challenges:

- They may bypass filtration methods intended for larger microplastics.
- They may be less likely to settle, have greater mobility, and may be transported further.
- They may be more likely to enter and bioaccumulate in the food chain.
- Due to their higher surface area, faster leaching of plastic additives can occur.
- They may act as pollutant “vectors” because their higher surface area also allows for more adsorption of metals and other pollutants.

> Microplastics can also be categorized according to type of polymer, additives used, and shape.

1 U.S. National Oceanic and Atmospheric Administration (NOAA) and the European Chemicals Agency (Note: 1 mm = 1,000 micrometers [µm] = 1,000,000 nanometers [nm])

Source of microplastics in the environment

There are countless sources of both primary and secondary microplastics in the environment, including the following:

- Cosmetics: Microplastic "scrubbers", "microbeads", or "micro-exfoliates" used in hand cleansers and facial scrubs have replaced traditionally used natural ingredients, including ground almond shells, oatmeal, and pumice. These products are typically composed of polyethylene, a common component of plastics, but they can also be manufactured from polypropylene, polyethylene terephthalate (PET), and nylon. The beads may be washed into the sewage system immediately after use.
- Textiles and clothing: Many synthetic fibers, such as polyester, nylon, acrylics, and spandex, can be shed from clothing and persist in the environment. The process of washing clothes causes garments to lose an average of over 100 fibers per liter of water. Each garment in a load of laundry can shed more than 1,900 fibers of microplastics, with fleeces releasing the highest percentage of fibers.
- Tires: Car and truck tires. which are composed partly of synthetic styrene-butadiene rubber, erode into tiny plastic and rubber particles as they are used. The estimated per capita emission ranges from 0.23 to 4.7 kg/year, with a global average of 0.81 kg/year. In air, 3–7% of the particulate matter (PM2.5) is estimated to consist of tire wear and tear.

> It has been estimated that 80% of microplastic pollution comes from textiles, tires, and city dust.

- Plastics manufacturing: Plastic pellets (aka nurdles), 2.0–5.0 mm in size, which are used as a raw material to create other plastic products, can enter the environment through spills and other accidents.
- Air blasting: This process involves blasting acrylic, melamine, or polyester microplastic scrubbers at machinery, engines, and boat hulls to remove rust and paint. As these scrubbers can be used repeatedly until they diminish in size and their cutting power is lost, they may become contaminated with heavy metals such as cadmium, chromium, and lead.
- Fishing industry: Recreational and commercial fishing, marine vessels, and marine industries can be sources of macroplastics and secondary microplastics.
- Wastewater treatment plants: The size of microplastics prevents them from fully being retained by preliminary treatment screens at wastewater plants, thereby allowing some to enter rivers and oceans. Wastewater treatment plants only remove an average of 95–99.9% of microbeads. This leaves an average of 0–7 microbeads per liter being discharged. Sewage sludge that is reused as fertilizer after the wastewater treatment has also been known to contain microbeads.

Persistence of microplastics in the environment

Microplastics are persistent and ubiquitous in the environment, particularly in aquatic and marine ecosystems. The most significant transport pathways to surface water are presumed to be via dust and stormwater runoff. It has been estimated that there are 51 trillion individual pieces of microplastics in the world's oceans, estimated to weigh 236,000 metric tons.

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Microplastics can also accumulate in the air and terrestrial ecosystems but the cycle and movement of microplastics in the environment is still not fully understood. Microplastics have also been found in deep layer ocean sediments and in the high mountains, at great distances from their source.

According to the U.S. EPA:

- Of the total plastics released to oceans (4.8–12.7 million tons (Mt)/year), 15%–1% originate as microplastics from homes and industrial products.
- About half of the total (3.2 Mt/year) microplastics released, or about 1.5 Mt/year, ends up in oceans.

The following are the estimated sources of microplastics to oceans:

- Washing synthetic textiles (35%)
- Tire wear (28%)
- City dust (24%)
- Road Markings (7%)
- Marine Coatings (3.7%)
- Microbeads (2%)
- Plastic pellets (0.3%)

Ecological impacts of microplastics

The existence of microplastics in the environment has been established through aquatic studies. These include taking plankton samples, analyzing sandy and muddy sediments, and observing vertebrate and invertebrate consumption. Because plastics degrade slowly (often over hundreds to thousands of years), microplastics have a high probability of ingestion, incorporation into, and accumulation in the bodies and tissues of many organisms. The toxic chemicals that come from both the ocean and runoff can also adsorb to microplastics and biomagnify up the food chain. However, some studies involving exposure of aquatic organisms to microplastics have demonstrated no adverse effects while others have indicated the possibility of harmful effects.

Some studies have shown that adverse effects to growth and reproduction of aquatic organism are correlated with microplastic particle size and concentrations. Larger microplastics exhibit toxicity at lower concentrations than microplastics smaller than 0.1 um. Adverse effects may also be related to the particle shape or type of polymers. "Food dilution" may also occur when organisms consume non-nutritional plastic instead of food.

Due to their even smaller size, nanoplastics can cross cellular membranes and affect the functioning of cells. Nanoplastics are lipophilic (combine or dissolve in fats) and models show that polyethylene nanoplastics can be incorporated into the hydrophobic core of lipid bilayers. Nanoplastics are also shown to cross the epithelial membrane of fish accumulating in various organs including the gallbladder, pancreas, and the brain.

Microplastics may also provide surfaces on which bacteria and other microorganisms colonize in aquatic environments.

In terrestrial ecosystems, microplastics have been demonstrated to reduce the viability of soil ecosystems and reduce the weight of earthworms.

Health hazards of microplastics

In humans, exposure to microplastics can occur by ingesting drinking water, eating food, and inhaling dust. Potential human health effects of exposure to microplastics are not yet fully understood.

Inhalation of microplastics in dust may cause health effects by the release of monomers, dyes, inorganic oxides, and plasticizer chemicals used in the manufacturing of plastics and fibers. Microplastics may also serve as vectors by providing surfaces on which pathogens absorb, potentially resulting in higher exposures to pathogens in air.

It has been hypothesized that nanoplastics absorbed onto tissues may cause physical damage to cells with subsequent inflammatory response, disproportionate tissue repair, and eventual loss of function. As an example, occupational exposure to microfiber dust has been linked to adverse health effect in the lungs. Health effects may also be caused by the release of monomers, dyes, inorganic oxides, plasticizers, and other persistent organic pollutants present in plastics.

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Legislation and regulation

There are regulations in place and pending legislation in the U.S. and other countries regarding microplastics. Affected industries include plastics manufacturers, cosmetics, commercial launderers, wastewater treatment facilities, beverage manufacturers, and the tire industry.

There have been two general approaches to microplastics regulations. The European Union (EU) is primarily focused on removing microplastics from consumer use and production chains. The U.S. and Canada, on the other hand, are implementing monitoring programs and regulations to better understand the nature and extent of microplastics.

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Examples of laws and regulations related to microplastics include:

United States federal government

On December 18, 2015, Congress amended the Federal Food, Drug and Cosmetic Act (FD&C Act) by passing the Microbead-Free Waters Act of 2015. The Act prohibits the manufacturing, packaging, and distribution of rinse-off cosmetics containing plastic microbeads. This law also applies to products that are both cosmetics and over-the-counter drugs, such as toothpastes. The law was passed to address concerns about microbeads in the water supply but does not address consumer safety. The law provided deadlines for rinse-off cosmetics (2017–2018) and rinse-off cosmetics that are also non-prescription drugs (2018–2019).

U.S. Environmental Protection Agency (EPA)

The U.S. EPA has not yet developed regulations concerning the release of microplastics to the environment.

U.S. state regulations

Seven states in the U.S. have engaged in legislation banning microbeads, and numerous states have implemented bans on plastic in various forms, including bags, straws, and Styrofoam cups. As states move forward with microplastic initiatives, they are expanding beyond only microbeads. The Great Lakes and St. Lawrence Cities Initiatives, a binational coalition, is active in microplastic studies and tracking regulatory updates, and at least five states are working to address microplastic pollution in water, stormwater, and wastewater. Of these states, California is leading the way with establishing microplastics regulations and monitoring requirements for drinking water.

California passed a package of bills in 2018 to help increase the knowledge of the risks of microplastics and microfibers on the marine environment and in drinking water. The first part of the legislative package was satisfied in June 2020 when the State Water Resources Control Board's adopted an official definition of microplastics in drinking water. A July 2021 deadline was set to establish standards for analytical methods, lab accreditations, provisions for health-based guidance levels, and the initiation of four years of testing drinking water for microplastics.

In 2018, California also passed Senate Bill 1263 which requires the California Ocean Protection Council (OPC) to adopt and implement a statewide strategy for lessening the ecological risks of microplastics to coastal marine ecosystems. On December 21, 2021, OPC released the draft Statewide Microplastics Strategy for public comment and finalized the strategy in February 2022 after the comment period ended. The strategy identifies early actions and research priorities to reduce microplastic pollution in California's marine environment and provides a roadmap for California to manage microplastics pollution with a comprehensive two-track approach that 1) identifies actions to reduce and manage microplastics pollution and 2) outlines research priorities to inform future activities. A progress report along with recommendations for policy changes or additional research is required by the end of 2025.

Canada

In May 2021, Canada added plastic manufactured items to its list of toxic substances on the Canadian Environment Protection Act's schedule 1.

In December 2021, the Canadian government released draft regulations to ban single-use plastics including grocery/plastic bags, stir sticks, beverage six-pack holders, cutlery/plates, straws, and food packaging made from plastics. The single-use plastics regulations were open for public comment until early March 2022, and a final decision was anticipated later in 2022. The Canadian government also works with companies that manufacture or sell plastic products to introduce them to new standards and targets and make them responsible for their own waste as they move towards a Canada-wide strategy to attain zero plastic waste by 2030.

United Nations resolution

In March 2022, the United Nations Environmental Assembly (UNEA) hosted its fifth meeting with representatives from 175 countries to discuss a legally binding, international "Plastic Treaty" to combat plastic pollution by 2024. The treaty's goal is to enhance or bridge the gaps of current actions or agreements and to focus on the entire lifecycle of plastics, with special attention to the design and production phases. Towards the end of 2022, a newly formed Intergovernmental Negotiating Committee started composing a draft treaty that is scheduled to be complete by end of 2024.

European union

In 2017, the European Commission requested the European Chemical Agency (ECHA) to evaluate regulatory actions throughout the region to address microplastics. In 2019, ECHA proposed extensive restriction on microplastics in products placed on the European Union/ European Economic Area (EU/EEA) market to avoid or reduce their release to the environment, essentially banning the addition of microplastics to products such as cleansers, cosmetics, fertilizers, and others. These restrictions would potentially stop about 500,000 tons of microplastics from being released over a 20-year period. In February 2022, the European Commission opened consultation on microplastic pollution with a focus on microplastic release to the public and stakeholders and a proposed regulation was expected by the end of 2022. Once promulgated, REACH (Registration, Evaluation, Authorization and Restriction of Chemicals) will regulate the approved restrictions.

Furthermore, to reduce plastic pollution as part of larger efforts for Zero Waste Europe, the EU adopted a single-use plastic ban on 10 specific products that took effect on July 2, 2021. The ban includes plastic bottle caps, cutlery, straws, plates, and Styrofoam food and beverage containers.

Interstate Technology and Regulatory Council (ITRC)

The ITRC, a state-led environmental coalition, is developing a guidance document to address the nature and extent, distribution, health effects, sampling, and treatment of microplastics, as well as current regulations. The ITRC recently submitted a survey to all 50 states requesting information to understand where microplastic data is collected and in which media. Additionally, the ITRC has several subcommittees tracking the microplastics movement and has committed to providing guidance and training resources for the distribution, potential effects, and current regulations.

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Regulatory levels for microplastics

Currently, regulatory levels for microplastics are still being evaluated. The state of California has reviewed toxicological studies to determine if sufficient data is available to establish toxicity values for microplastics, with the objective of deriving health-based guideline levels. A toxicity value has not yet been derived to support regulatory decision-making because of the considerable uncertainty in identifying threshold doses of microplastics that result in observable health effects. However, a screening toxicity value (6.5 nanograms per kilogram per day) has been derived that may be used to establish analytical detection limits for environmental monitoring of microplastics.

Furthermore, the state of California has proposed screening levels for surface water to protect against food dilution and food chain transfer effects in aquatic organism. The proposed draft values are:

- Non-regulatory drinking water screening level: 1.2 particles per liter
- Surface water screening level based on food dilution: 0.5 to 94 particles per liter
- Surface water screening levels based on tissue translocation: 236 to 14,397 particle per liter

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