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Sustainability Committee with Health & Safety Network

The Use, Reuse, Refuse, & Recycling of Nitrile Gloves

A Collaboration between the Sustainability Committee and Health & Safety Network

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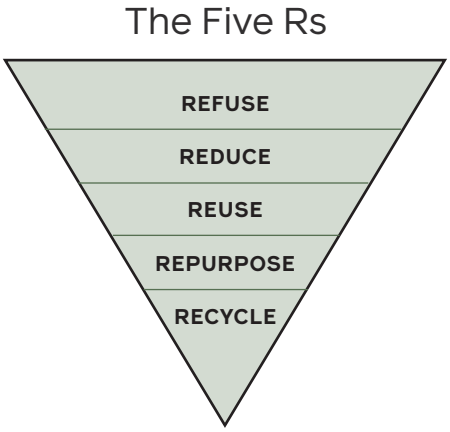
As we try to make more sustainable choices in our work practices, it is important to balance sustainability with safety. To explore these issues, the Sustainability Committee (SC) and the Health & Safety Network (H&SN) present our first collaboration on a topic important from both sustainability and health and safety perspectives: Nitrile glove use, reuse, and recycling.

Sustainability practices recommend the five Rs, which are stated in order of more to least sustainable: refuse, reuse, reduce, repurpose, and recycle. Thus refuse, reduce, and reuse should be prioritized over recycling whenever feasible. When considering use of a product or material, you may choose to refuse to use it if not completely necessary. You might also consider ways to decrease usage by pooling items or tasks together. Reusing is also desirable when a product must be used, but it's not always safe to reuse, as we show in the following section. Repurposing is more practical for non-disposable items, and recycling can be a cover for greenwashing.

We must balance the safe use of disposable nitrile gloves with disposal options, so we have provided information on safely using nitrile gloves as well as on the companies that provide recycling programs or biodegradable alternatives.



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The Use, Reuse, Refuse, and Recycling of Nitrile Gloves

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Latex, polyethylene, nitrile, and vinyl gloves are the most common types of disposable gloves.

Nitrile gloves

A range of glove types have been used in collections care over the years, including cotton, latex, and vinyl. However, nitrile gloves have been determined to be a superior choice for both the safety of artifacts and of the user (Stephens et al. 2021, 2). Disposable nitrile gloves are made from the polymer acrylonitrile butadiene. Other chemicals are added in small amounts to further improve the synthetic rubber's properties, including cross-linking agents, accelerators, stabilizers, and colorants (Halyard 2022). For a comparison of commercially available nitrile gloves, see Stephens et al. (2021).

In 2014, AIC's **Sustainability Committee** and **Collection Care Network** wrote the following conservation-specific definition of sustainability: "Sustainability derives from a commitment to policies and practices that ensure social, economic, and environmental endurance. Applied together, the principles of collection care, preventive conservation, and sustainability enable the preservation of both our world and its cultural heritage."

Use

Considerations When Choosing a Nitrile Glove

Many factors should be considered when choosing a disposable nitrile glove, the foremost being chemical protection. The AIC Health and Safety Wiki explores these factors, including accelerators, thickness, acceptable quality level, size, and expiration date. The chemical compatibility of a glove can vary widely between manufacturers because they use different formulations (Phalen and Wong 2012). If the task involves immersion or constant contact with a solvent (e.g., on a cotton pad), best practice is to make selections based on the specific manufacturer's chemical compatibility data rather than the generic Safety Data Sheet (SDS) Section 8: Exposure Controls and Personal Protection. For example, acetone will permeate nitrile gloves in minutes, so a different glove choice should be made when handling that substance. When using chemical mixtures without test data, the Occupational Safety and Health Administration (OSHA) recommends selecting a glove based on the chemical component with the shortest breakthrough time (Grainger 2019).

Using Nitrile Gloves Safely

In addition to chemical compatibility based on each manufacturer's data, important factors in ensuring safe nitrile glove use include breakthrough time, sweat, and mechanical deformations.

The length of time a glove can be safely worn depends on the task. When using chemicals, do not wear gloves past the manufacturer's breakthrough time. Most disposable nitrile gloves only provide short-term splash protection and not long-term chemical protection. Once a chemical contaminates the surface, the glove can deteriorate and become less protective, so replace gloves immediately if they come into contact with chemicals. This includes surfactants, which means disposable gloves cannot be cleaned and reused (K. Harmon, personal communication June 16, 2021). Likewise, dispose of gloves showing any signs of degradation like color change, swelling, softening, hardening, or brittleness. However, gloves can experience chemical breakthrough even without physical signs of degradation due to microscopic tears and pinholes (University of Pennsylvania 2022; Kimberly-Clark Professional 2009). When it is time to remove gloves, "doffing" must be done carefully to avoid contact with the outside of the glove (AIC Health and Safety Wiki 2021).

It is important to know that breakthrough time test data is completed on unused gloves. The actual protection will be less for a glove that is being worn on a sweaty hand and stressed during use (University of Pennsylvania 2022; Phalen and Wong 2012; Phalen, Le, and Wong 2015; Vinches, Zemzem, and Hallé 2017). Studies with ethanol have shown that mechanical deformations caused by repetitive hand motion significantly decreased the level of glove protection (Phalen and Wong 2012; Phalen, Le, and Wong 2015). Additional studies have shown a failure rate of 12% for worn nitrile gloves and that wearers were unaware of 88% of the failures (Kerr et al. 2004). When using chemicals for a prolonged period of time, it is safest to change them frequently, or choose a reusable alternative.

Refuse

When Might You Not Need Disposable Gloves

Gloves are a useful tool and offer important protection under many circumstances. Keeping in mind specific information about your personal health as well as the materials and stability of the cultural heritage and the collection from which it comes, there are some instances in which you might determine that gloves are not necessary. Before and after handling cultural heritage, hands should always be washed and dried. According to Van der Pal et al. (2021), "washed and dried hands are the least oily approximately thirty minutes after washing." When direct handling is safe for both cultural heritage and conservator, this is an opportunity to minimize waste.

Reuse

Ideally disposable gloves would never be reused, but realistically, we all reuse our gloves at some point. Many of us want to produce less waste and are often acutely aware of the number of gloves we use, sometimes for very brief, non-chemical tasks. The easiest change to make may be grouping similar tasks to one period of time so use of disposable gloves is kept minimal. It is also worth considering if another type of glove intended for reuse would be appropriate for the task at hand. Chemical resistant, reusable gloves like laminate film, nitrile, neoprene, or vinyl may be appropriate for some tasks. Reusable alternatives for dry handling like cotton gloves are not recommended due to build-up of dirt and oils and physical risks due to poor touch sensation and possible snagging (Stephens et al. 2021, 2).

If you do decide to reuse disposable nitrile gloves, keep in mind the following factors as listed in Table 1.

Situation	Reuse not recommended	Consider Reuse	Hazards in Reuse
Handling an artifact, such as retrieval from storage.		X	› Objects can impart hazardous substances such as pesticides onto gloves, which can transfer to other surfaces and objects. › The gloves could become damaged due to over-use, preventing them from providing adequate protection. › Incorrect donning and doffing techniques could deposit fingerprints onto glove surfaces that can transfer to works of art.
Performing non-chemical work, such as brush vacuuming, examination, photography, and rehousing		X	See above.
Non-chemical analysis		X	See above.
Chemical conservation work	X		Chemicals degrade disposable nitrile gloves. Most are not intended for chemical use, let alone reuse. Instead, consider selecting reusable gloves based on the manufacturer's chemical exposure charts.

Table 1: Guidelines for nitrile glove reuse.

Glove Disposal

Regardless of how you use nitrile gloves, thinking about how best to dispose of them is a necessary and complicated component. Excluding recycling, the three most common places where used gloves spend the end of their life cycle are landfills, oceans, and incinerators (and thus into the air, as a gaseous state). It's important to consider the conditions in which materials are disposed of and which waste streams disposal companies are following. Consider what kinds of materials or chemicals you've been working with. Mold, lead, pesticides, and certain pigments all require disposal as controlled waste through

hazardous waste providers. Compliance with these policies can help reduce water pollution and limit both human and animal exposure to hazardous chemicals contamination.

Disposable gloves can easily be ripped and torn, so disposing of them in a bin with a liner ensures that small bits and pieces won't blow away and pollute the natural environment, our natural resources, and cause harm to wildlife.

In the United States, plastic materials may not always be recycled as the type of plastics accepted varies by municipality. According to Edmond (2022), "in 2019, the Center for Environmental Law estimated that production and incineration of plastic would add 850 million metric tons of greenhouse gasses to the atmosphere – equivalent to 189 coal-fired power plants. By 2050 this could rise to 2.8 gigatons of carbon dioxide per year – or 615 coal plants' worth."

RECYCLING

Recycling of any material is energy intensive, cost prohibitive, and in the case of some plastics requires the addition of new or virgin material to be effective (Wilson 2021). For some materials it can only be done a limited number of times before that material must be disposed of either in a landfill or incinerator. If disposed of in the trash, nitrile gloves take at least 100 years to degrade (Ki Culture 2020).

Current options for recycling nitrile gloves include:

Glove Recycling: Terracycle Zero Waste Disposable Glove Box

What is it?

Users of this box can dispose of all brands of nitrile, latex, and vinyl gloves. Gloves used to handle biomedical waste and hazardous materials are not accepted. OSHA characterizes hazardous materials as "any biological or disease-causing agent" (OSHA 1996).

Per Terracycle, received gloves sit undisturbed for at least 72 hours. They are then washed and hand sorted. Cryomilling or another type of processing is used to turn the gloves into a powder. Terracycle pledges to recycle the material (unless required by law to incinerate), to not add virgin plastic, and to ensure resulting recycled products are durable and long lasting (S. Donlon personal communication, June 17, 2022).

Terracycle

Terracycle has freight capabilities so large materials from exhibition build-outs, for example, can also be recycled.

What it Claims to Fix

This box and similar recycling boxes by Terracycle divert waste from landfills, reduce incineration, and keep plastic waste out of bodies of water while extending the usable life of the raw materials (Wilson 2021). Terracycle recycles many materials not accepted in municipal recycling facilities (S. Donlon personal communication, June 17, 2022).

Concerns

While recycling does prolong the use of nitrile glove materials, plastics may only be recycled a limited number of times. Recycling processes are also highly energy intensive due to transportation of the materials between different processing facilities and the energy needed to run them. Terracycle Zero Waste Boxes are expensive, starting at $136 at the time this newsletter went to press, making them cost prohibitive for some individuals and institutions. It is unclear if the materials created from Terracycle's recycled materials can themselves be recycled, though the products made by Terracycle can be.

Even with best practice, nitrile gloves that may have chemical contamination or harmful residues may be unintentionally disposed of in Terracycle boxes. While all gloves are washed, clarity about their screening methods for harmful residues was not clear; the company relies on consumers to follow proper disposal rules for both OSHA and Terracycle.

Glove Recycling: Kimberly Clark (KC)

What it is?

Kimberly-Clark's (KC) RightCycle program is a take-back program not just for gloves, but also for masks and other Kimberly-Clark brand products. KC only takes its own brands of gloves and requires a consultation and written agreement to ship to their facility. There are no local drop-boxes, so the shipper bears the cost.

What it claims to fix

Similar to Terracycle, KC's program prolongs the use life of materials used in their PPE. As of June 26, 2022, according to their website, "Materials are sorted and processed into plastic pellets. Raw materials are molded into consumer products."

Concerns

Kimberly Clark doesn't accept PPE that was used in biologically and chemically hazardous applications, which includes handling solvents, paints, and oil.

Recycling only delays the disposal of plastic. Eventually, the nitrile glove materials will end up in our waste streams.

Gloves with Accelerated Biodegradation: Showa Gloves

What it is?

Nitrile gloves made using EBT (Eco Best Technology) accelerate their biodegradation in biologically active landfills, resulting in organic soil and biogas (methane and carbon dioxide). This occurs in 1 to 5 years, unlike traditional nitrile gloves that take over 100 years to biodegrade.

What it claims to fix

Showa gloves degrade into four byproducts: methane, carbon dioxide, water, and humus (the organic component of soil formed by microorganisms). The gaseous byproducts can be used to generate renewable energy at some landfills (EPA 2022).

Concerns

While Showa gloves do biodegrade, so do all nitrile gloves, just at a different rate. It is important to remember biodegradation is only possible in a landfill, a suboptimal disposal option as almost all landfills have been shown to leak or will at some point in their use life

(Pecci 2018). Landfill profitability is tied to housing the maximum amount of garbage, which creates suboptimal conditions for the biodegradation of Showa gloves. Showa gloves in plastic garbage bags may not be exposed to the conditions within the landfill that accelerate their biodegradation. Showa gloves will not sufficiently break down in home composting. The resulting byproducts may only be harvested for energy sources at select landfills. How the generated greenhouse gasses are used depends on the particular landfill and state (Popovich and Plumer 2020).

Methane and carbon dioxide are two of the greatest contributors to global warming. If Showa gloves are disposed of in landfills that do not harvest gas for energy use, there is the potential that a landfill leak would accelerate the processes of global warming (Devnani 2020).

Greenwashing

"Greenwashing is an attempt to capitalize on the growing demand for environmentally sound products, whether that means they are more natural, healthier, free of chemicals, recyclable, or less wasteful of natural resources" (Kenton, 2021). This marketing spin is often used to detract from manufacturing and supply practices that are not sustainable and may be harming the environment.

Nitrile gloves are no exception; all of the companies mentioned above are trying to capitalize on the desire for more sustainable choices while maintaining profits and selling products, and they all use some greenwashing in their advertising. In 2021, Terracycle and its partners were sued by Jan Dell, founder of the Last Beach Cleanup, over the use of Terracycle's recycling label on product packaging that claimed free recycling of said packaging. Unfortunately, the claim is not true. Not all product packaging with Terracycle's label can be recycled for free. (Wicker 2021).

The term "biodegradable" is often used in greenwashing and is often confused with something that is compostable. Something biodegradable breaks down over time in a natural environment whereas something compostable degrades in a composting environment. While all plastics do break down, many are not conventionally biodegradable. Many plastics degrade into microplastics that accumulate, especially near waterways and oceans where they can harm natural habitats and (potentially) us (Plastic Soup Foundation 2022; Torchinsky 2022).

5 Rs

5 R's to follow in order:

- Refuse
- Reduce
- Reuse
- Repurpose
- Recycle

Conclusion

A disposable nitrile glove will begin degrading the moment you put it on your hand. Visual indications of sweat accumulation, physical damage, or particulate transfer from the objects should be monitored during prolonged use and the glove replaced as needed. When using chemicals, check compatibility and change the gloves frequently. **Never reuse gloves after use with chemicals or after handling hazardous collections.**

Just as your own health and safety is an important consideration in how you select and use nitrile gloves, consider their appropriate disposal carefully. None of the options for recycling or biodegradable gloves are perfect. When researching sustainable options, it is important to think about the true costs and benefits of using a product and to critically evaluate a company's marketing claims to recognize greenwashing. Doing this is time consuming and difficult because there are a vast number of cradle-to-grave considerations for any product we use.

The most appropriate disposal choice to minimize your negative impact is dependent on your municipality, collection, and institution. Follow the 5 R's in order.

Be smart about if and when you can safely reduce the amount of glove waste you create. Advocate to elected officials, from local to federal, on the need for more sustainable choices, ease of disposal, and true clean sources of energy.

—Kate Fugett, Justine Wuebold, Susan Costello, Kate McEnroe

STiCH

STiCH is a great tool to learn more about how life cycle analysis can be used to make sustainable choices in conservation and collections care.

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