IISD Experimental Lakes Area

POLICY BRIEF

# Nanosilver:

## What action needs to be taken to protect Canadians from this emerging contaminant?

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## Key Messages

- **Nanosilver is an emerging nanomaterial** that is widely known for its antimicrobial properties—it releases silver ions that are highly toxic to bacteria.
- **Nanosilver is used in over 440 consumer products** and its widespread application increases the likelihood of its release into aquatic environments via domestic sewage and wastewater treatment plants.
- While there have been limited studies on the effects of nanosilver particles on humans and freshwater environments, emerging evidence suggests that the toxicity of nanosilver could differ from other forms of silver—**nanosilver can attach to cells and affect cellular function.**
- Nanosilver use in consumer products (and its eventual release into the environment) is **currently unregulated in Canada.**
- Canada needs to protect its environment and citizens by **following the precautionary principle of regulating nanosilver** and providing standards and guidelines for manufacturers and consumers alike.

## What Is Nanosilver?

Silver is widely known for its antimicrobial and antibacterial qualities—its ions (Ag+) are highly toxic to bacteria (Canadian Council of Ministers of the Environment [CCME], 2015). Nanosilver refers to tiny particles of silver measuring between 1 and 100 nanometres. With its greater surface-area-to-volume ratio compared to larger particles of silver, nanosilver is more reactive and can release more $Ag^{+}$, which increases its antimicrobial abilities.

These qualities have prompted the widespread use of nanosilver in consumer products today. Nanoparticles are capped to surfaces or embedded into many products, from clothing, cosmetics and cleaning products to electronics, packaging and toys (Lens Research Group, 2015; Organisation for Economic Co-operation and Development, 2017). For example, a computer keyboard can be coated with nanosilver particles to reduce the spread of bacteria and pathogens, and a dishwashing sponge can contain nanosilver to reduce odour-causing bacteria and mould.

## Why Do We Need to Worry About It?

The Project on Emerging Nanotechnologies (2013) currently lists 443 products containing nanosilver (24 per cent of the database—up from 50 products in 2006 [CCME, 2015]). Such widespread use of nanosilver suggests there could be significant releases of silver nanoparticles and silver ions into the environment, resulting in negative effects on aquatic organisms and health risks for humans.

Nanosilver can enter our waterways by leaching out of landfills (Resnik, 2019) and through wastewater (e.g., as a result of washing textiles containing nanosilver [CCME, 2015]). Once in our waters, nanosilver typically sorbs into sediments and therefore may persist in the environment for a long time (U.S. Environmental Protection Agency [EPA], 2018).

Nanosilver has high potential to react with organisms due to its ability to agglomerate on surfaces and in tissues and organs, whereas $Ag^{+}$ may be more easily excreted or egested (i.e., fish gill tissue in respiration).

### Impacts on Aquatic Life: Research at IISD Experimental Lakes Area

Over two years, scientists at IISD Experimental Lakes Area conducted a whole-lake experiment whereby they added nanosilver to a lake and observed the results on trophic levels. They discovered: (1) oxidative stress in fish gill and liver tissues (Martin et al., 2018); (2) bioaccumulation of nanosilver in fish through respiratory and dietary sources (Hayhurst, 2018); (3) reduced consumption of prey and lower metabolic rates in yellow perch (Hayhurst, 2018); (4) declines in fish populations (Hayhurst, 2018); (5) a shift in fish prey sources from nearshore to offshore locations (Tyler Ripku, Lakehead University, personal communication); and (6) evidence of reduced growth in northern pike (Brenden Slongo, Lakehead University, personal communication).

While more research is needed to determine potential impacts of nanosilver on humans, there is already evidence suggesting that nanosilver may cause alterations in the immune system, increases in oxidative stress and cell damage (Nguyen et al., 2013).

Given these new findings and a growing number of nanosilver products already on the market, we urgently need to review the nanosilver regulations and implement an effective management strategy to address these potential hazards and risks.

## What Do Current Nanosilver Regulations Look Like Around the World?

Currently, **Canada** has no policies to regulate the use of nanosilver in consumer products and discharge of nanosilver in the environment and no account for its specific properties (Lens Research Group, 2015). How did this happen and what is currently being done about it?

- The Canadian Environmental Protection Act, 1999 regulates industrial chemical substances in Canada. Under the authority of this act, the Domestic Substances List (DSL) was created by Environment and Climate Change Canada (ECCC) to determine which substances currently exist or are new to the Canadian market, and it is used to assess and manage chemicals (ECCC, 2015).
- Nanomaterials were not treated as new to the Canadian market (the identifiers in the DSL were based only on the chemical composition and did not take the size of particles into account), allowing products containing nanoparticles, and in this case nanosilver, to enter the market.
- Recognizing the unique properties of nanomaterials, ECCC and Heath Canada proposed a new approach to prioritize and manage nano-sized materials that are already part of the DSL, silver included (Environment Canada & Health Canada, 2015; Government of Canada, 2016). This involves collecting more information on nanoscale forms of substances, conducting risk assessments and determining potential regulatory actions (Environment Canada & Health Canada, 2015).
- There have been no subsequent updates since the two consultation documents were released in 2015 and 2016, outlining the new approach. While the Government of Canada has produced a NanoPortal[1] to report on nanotechnology and relevant policy developments, the website is currently non-functional.
- Regarding protection of freshwater resources, Canada has a water quality guideline for silver (in its ionic form) for the protection of aquatic life of 0.25 µg/L (CCME, 2015). However, nanosilver does not have a similar guideline. This is attributed to the uncertainties of measuring the hazard of nanosilver (CCME, 2015) and to the fact that the technologies required to detect and characterize silver released from nanosilver particles versus silver released from ionic sources in the environment do not currently exist (Varner, El-Badawy, Feldhake & Venkatapathy, 2010).

**The U.S.** government is also working within its current legislative and regulatory regimes to address existing nanomaterials and is coming forward with a plan to gather information to assess risk of nanomaterials, specifically nanosilver. Under the authority of the Federal Insecticide, Fungicide, and Rodenticide Act, the U.S. EPA issued its *Nanosilver Final Work Plan* registration review in October 2018. It identified the data and assessment needs to be met to complete the review, including a human health risk assessment and an environmental risk assessment for nanosilver (U.S. EPA, 2018). The final decision is expected in May 2022 (U.S. EPA, 2018). While this work has been initiated, products containing nanosilver may have already entered the U.S. market, or will do so in the future, given that substances are not regulated in the absence of known impacts (Zainzinger, 2017).

**The European Union** takes a different approach and applies a so-called "precautionary principle" in its environmental, health and safety policies—also known as the "no data no market" approach (European Commission, 2016)—which presumes a product to be harmful in the absence of sufficient scientific evidence regarding its human and environmental safety (Faunce, 2010).

[1] http://nanoportal.gc.ca/

## What Needs to Happen Now in Canada?

As evidence of risks and harmful impacts emerges, Canada needs to take steps to proactively address the hazards of nanosilver for humans and for the environment.

Considering there is incomplete or uncertain scientific evidence for nanosilver in the environment, a precautionary approach should be followed by Canadian regulatory regimes for products containing nanosilver.

Canada needs to:

- Prioritize a complete risk assessment for nanosilver as a new substance pursuant to the provisions of the Canadian Environmental Protection Act, 1999.
- Standardize testing methodologies for detection of nanosilver in fresh water, invest in necessary research on nanosilver toxicity needed to update Canadian Water Quality Guidelines for the Protection of Aquatic Life (i.e., CCME, 2015) with a guideline for nanosilver, and improve monitoring.
- Review policies and regulations related to consumer safety and introduce mandatory labelling of nanosilver in products, just as there are specific labelling requirements for mercury in cosmetics (Health Canada, 2005).
- Invest in campaigns to educate the public about the risks of nanosilver and to allow consumers to make informed choices about their product use. This should include relaunching the now defunct NanoPortal (www.nanoportal.gc.ca) as a transparent source of relevant information for Canadians, including the commercial status of nanosilver in Canada, scientific findings of nanosilver risks for human health and the environment, and all relevant policy developments.

The development of the appropriate regulatory framework would necessitate the involvement of ECCC, Health Canada, the Pest Management Regulatory Agency, the Canadian Food Inspection Agency and the Canadian Standards Association.[2]

[2] The CSA Group is the Canadian Standards Development Organization responsible for nanotechnology-related standards development (Haydon, 2012).

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