Lifting the Nano Veil:
A Peek at Nanosilver With GreenScreen®

Coming Clean Fall 2016

What are nanomaterials, and why should we be concerned? Nanomaterials are often touted by manufacturers and retailers as extremely beneficial to society, and that they'll soon become practically essential to everyday life. It's easy to see why nanomaterials could be so appealing: they help make our computers smaller, lighter, and faster; they are used as stain- or odor-resistant fabric treatments; they help make lighter and stronger metals used in bicycles and car parts; they are used to make chip-resistant paints and coatings.

Nanomaterials are generally defined as engineered objects so tiny they have at least one dimension between 1 to 100 nanometers (nm)[1]. How tiny is that? Most nanomaterials are on the same scale as viruses (which range from 20-250nm). Viruses and nanomaterials are far too small to be seen with even the most powerful light microscopes and are about 100 times smaller than average bacteria or red blood cells. Nanosilver particles are roughly 10,000 times smaller than the width of a human hair.

Unfortunately, retailers and the general public often have little or no information on the potential health and safety hazards of these nanomaterials. Even more concerning, scientists and regulators also acknowledge the many gaps in understanding what hazards these materials may present to people and the environment. What science or health information does exist indicates that some nanomaterials could pose serious public health problems throughout the product manufacturing, use and disposal lifecycle; and that the hazards are tied to the specific form (shape, size, etc.) of the nanomaterial; i.e. non all nanosilvers are alike.

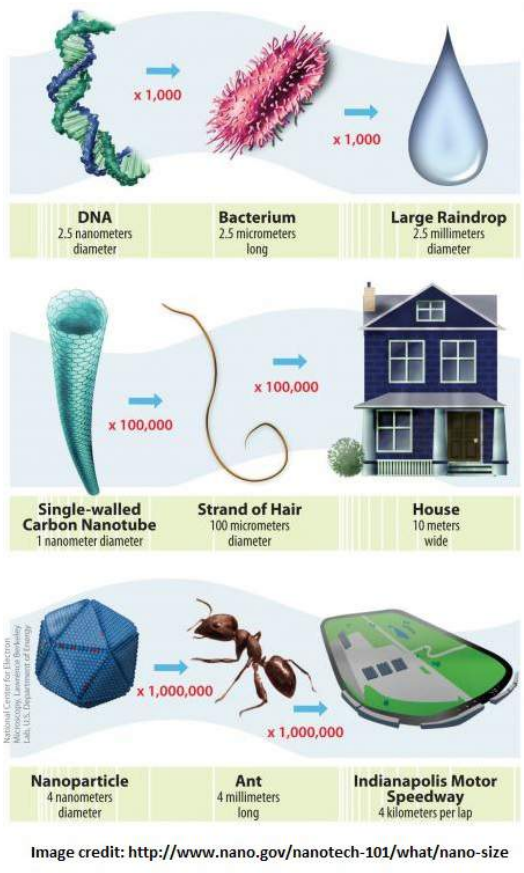


Image credit: http://www.nano.gov/nanotech-101/what/nano-size

Nanosilver: Slipping through the cracks of government health and safety rules. The US Environmental Protection Agency (EPA) approved the use of nanosilver in textiles in 2013, ushering in the manufacturing of a broad range of nanosilver-treated consumer products **without any studies on potential long-term health or environmental impacts**.[2]

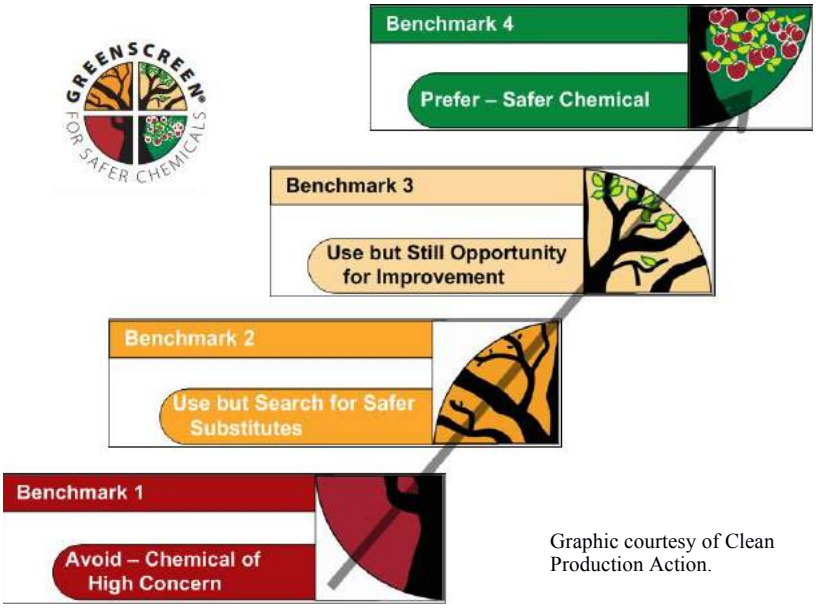
Nanosilver is now used in such things as bed sheets and blankets, kids plush toys, socks, and undergarments, despite knowing almost nothing about the dangers it may pose during its manufacture, consumer use, and disposal.[3]

Nanosilver can found in items such as baby blankets. Photo: S. Spitzer

Nanosilver is just one example of a rapidly growing class of new materials called 'nanomaterials', defined by their infinitesimal, sub-microscopic size. Federal regulatory agencies have, so far, failed to appropriately assess potential hazards from this new generation of product materials. This is partly because the size, shape and substance that nanomaterials are made from can affect the hazardous properties of the material and make the assessment process difficult. The rapid research and manufacture of nanomaterials is vastly outpacing our scientific and public understanding of its potential health and environmental impacts, and that means our health may be at risk from unsafe exposures. We must do better at understanding the health and safety issues, and take a precautionary approach to nanomaterials hazards in the workplace and in products we purchase and use.

Peeking at hazard data for silver and nanosilver. Scientists and people concerned about toxic chemicals in products, worked together through the organization Coming Clean – an environmental health and justice collaborative – to address our concerns about the known and unknown hazards of nanomaterials. We didn't buy EPA's assertion that there were no readily available tools to assess the hazards of nanomaterials.

So, we adapted an off-the-shelf hazard assessment tool, called GreenScreen® for Safer Chemicals (GreenScreen), to quickly and easily pull together the publicly-available science on hazards of different nanosilver materials, and identify critical gaps of information where hazards are not yet known. Specifically, we compared a nanosilver product that EPA had approved, called AGS-20, with other nanosilver forms that EPA used to fill data gaps in its AGS-20 assessment, and conventional or "bulk" sized silver.



Graphic courtesy of Clean Production Action.

GreenScreen® for Safer Chemicals: proven effective at assessing chemical hazards.

GreenScreen is a method for comparative chemical hazard assessment using existing information. The method itself is freely and publicly available[4] and provides guidance, templates and training for assessing, classifying and reporting hazards associated with a chemical for 18 hazard "endpoints" including: human health harms like cancer, endocrine disruption, neurotoxicity, environmental impacts like aquatic toxicity, and, physical-chemical properties like persistence and flammability. As a hazard assessment method, GreenScreen is particularly valuable in that it shows us where health or environmental impacts information is available, but also indicates where data gaps exist, because sometimes what we don't know can still hurt us.

GreenScreen and other hazard assessment methods can help inform decision-making for regulators and for manufacturers as they decide whether or not to use a chemical in a particular product. Hazard assessments can help drive the market towards safer substitutes for highly-toxic chemicals, rather than accepting a chemical that causes us harm.

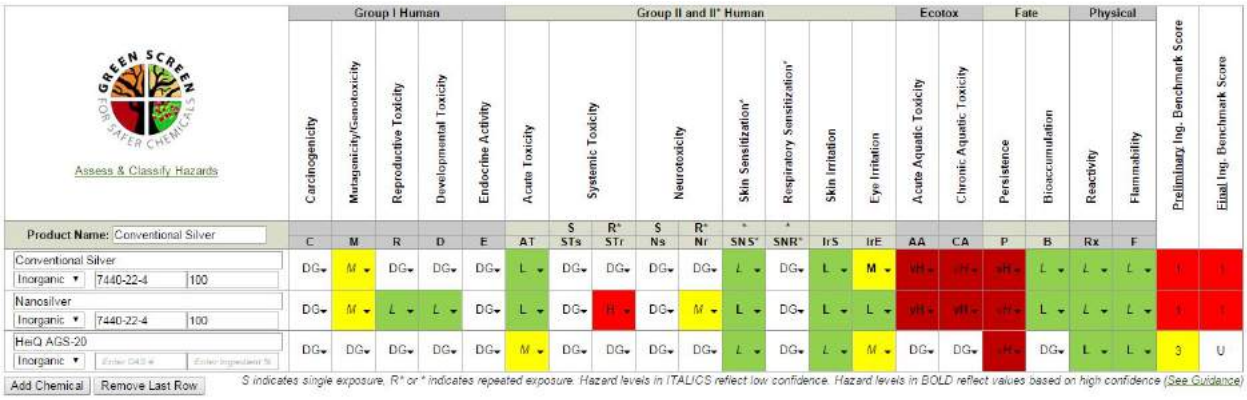
For this work we modified the traditional GreenScreen method to be more suitable for nanomaterials as follows:

GreenScreen for conventional materials	**GreenScreen for nanomaterials**
Single chemical entity	A nanomaterial may encompass different substances (for example, AGS-20 is a silver-silica composite)
One CAS# or unique identifier	May include several CAS#s , or a conventional CAS# and 'nano'
Characterized by four physical-chemical properties	Characterized by at least 10 physical-chemical properties that can influence hazard: shape, surface area, surface charge, surface chemistry (including composition and reactivity), agglomeration and/or aggregation, experimental media of test
Level of concern based on mass-dose	Alternative dose metrics (e.g. surface area, particle number) may be more suitable
Use of analogs and predictive models	Current state of knowledge limits the use of analogs and predictive models
Toxicity data often from standardized test protocols	Standardized test protocols may not always be appropriate for nanomaterials

What we found: silver and nanosilver have different toxic properties.

On November 8, 2016, the peer-reviewed journal *Environmental Health* published the results of our nanosilver GreenScreen research.[5] Results show that nanosilver may be harmful to our health and the environment – and still more research is needed to fill data gaps where hazards may exist but are, as of yet, unknown.

GreenScreen hazard tables from each assessment are available from the *Environmental Health* publication, and also on the Coming Clean website, along with comprehensive reports with summaries of supporting data. And, below is the GreenScreen hazard table for nanosilver with additional summary details on what we found.



Nanosilver was assigned a Benchmark Score of 1 based on its very high persistence; high systemic toxicity (which could mean hazards to workers); and very high eco-toxicity (nanosilver has highly-toxic properties in water and to aquatic species).

The nanosilver-silica composite, AGS-20, was assigned a Benchmark score of U (Unspecified) based on numerous health and safety data gaps.

Conventional silver was assigned a GS Benchmark Score of 1 based on very high persistence coupled with very high aquatic toxicity, as determined in standardized tests. There were also a surprising number of data gaps for conventional silver – a substance which most people would expect to be far better understood, but which has apparently been subjected to little scrutiny.

Our research demonstrates that:

- Cost-effective hazard assessment methods are available today using existing data to guide the regulation of nanomaterials;
- These hazard assessment methods can have advantages over EPA's current methods, and are easy for companies, government agencies and the public to understand;
- EPA should look closely at the potential hazards of specific forms of nanomaterials (what EPA's own Scientific Advisory Panel recommended) rather than generalizing their assessments and potentially allowing a hazardous material to slip through the regulatory cracks;
- Workers and the general public face potential health and environmental risks presented by nanosilver in consumer goods and products already on store shelves; and,
- GreenScreen® for Safer Chemicals could be effectively used as a hazard screening method for other, additional nanomaterials.

Recommendations: we must move markets toward safer solutions and substitutions.

The nanosilver GreenScreen assessment should be used by companies, government agencies, and consumers to help protect people and the environment from harm, especially when they can avoid harm by switching to safer products or processes. Based on the findings of the nanosilver hazard assessment, we recommend:

- *Governments should only approve a nanomaterial for manufacture and use, when it has been thoroughly assessed by its various intentional uses and any unintentional exposure pathways, and with the information made publicly available.* If there isn't sufficient testing to adequately inform regulatory decisions, then new chemicals shouldn't be allowed to enter the marketplace,

our homes, or our bodies. The Louisville Charter for Safer Chemicals, endorsed by hundreds of health, community, science and environmental organizations, offers a comprehensive guidepost for meaningful reform of the chemical industry, including heeding early warnings about chemical hazards.

- *Companies, institutions and agencies should use GreenScreen and other robust hazard assessment tools to assess the harm of nanomaterials and avoid dangerous ones in favor of safer substitutes.* For additional guidelines on chemical disclosure and safe substitutes, check out the *Five Essential Practices for Retailers, Brand Owners and Suppliers* can be used as a guide to shape corporate policies for safe products. And, you can read up on success stories about companies, schools and government agencies that have already made the switch to safer substitutes.
- *Consumers should be aware that nanomaterials like nanosilver may be lurking in products, and may pose health hazards to our families and communities.* Support campaigns that demand corporate accountability for preventing harm. Go to Coming Clean's Safe Markets website and the Campaign for Healthier Solutions for more information on how you can take action to protect public health from toxic chemicals in products.

Consumers have a right to know what toxic chemicals are in products, and have access to safe substitutes. Photo courtesy of the Campaign for Healthier Solutions.

You can support collaborative science research to advance advocacy for environmental health and justice. Find out more at http://comingcleaninc.org/donate.

[1] ISO/TS. ISO/TS 80004-1:2015, Nanotechnologies — Vocabulary — Part 1: Core terms [Internet]. 2015 [cited 2016 May 9]. p. 3. Available from: https://www.iso.org/obp/ui/

[2] Sass J and Wu M. 2013. Superficial Safeguards: Most pesticides are approved by flawed EPA process. NRDC Issue Brief. March 2013. https://www.nrdc.org/sites/default/files/flawed-epa-approval-process-IB.pdf

[3] Vance ME, Kuiken T, Vejerano EP, McGinnis SP, Hochella MF, Rejeski D, et al. Nanotechnology in the real world: Redeveloping the nanomaterial consumer products inventory. Beilstein J. Nanotechnol. [Internet]. 2015 [cited 2015 Sep 7];6:1769–80. Available from: http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=4578396&tool=pmcentrez&rendertype=abstract. And, Ministry of Environment and Food of Denmark. Environmental Protection Agency. Assessment of Nano-enabled Technologies in Cosmetics. Part of the "Better control of nano" initiative 2012-2015 [Internet]. Copenhagen; 2016. Available from: http://mst.dk/service/publikationer/publikationsarkiv/2016/feb/assessment-of-nano-enabled-technologies-in-cosmetics

[4] GreenScreen was developed by the non-profit Clean Production Action and information and training materials are available at http://cleanproduction.org.

[5] http://ehjournal.biomedcentral.com/articles/10.1186/s12940-016-0188-y