RISKS OF NANOSILVER IN VINYL COATING:
IS IT TOXIC TO THE GOOD CELLS, BAD CELLS, OR BOTH?

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Nanotechnology, as defined by the Miriam-Webster Dictionary, is "the science of manipulating materials on an atomic or molecular scale especially to build microscopic devices (as robots)." Regarding the production of coated fabrics, nanoscale silver particles, such as colloidal silver, are being hyped by some as a scientific break-through to kill bacteria. This may not be the case, however, according to many credible sources. A recent publication by the Global Environmental Politics[1] notes that:

> "As more and more nano-products are being marketed, scientists and regulatory experts have voiced growing concerns about the safety of some nanomaterials. These concerns are focused on the miniscule size of nanomaterials and their unique physico-chemical characteristics. For example, some nano materials may enter the human body through mucous membranes or the skin and migrate via the bloodstream to vital organs including the brain. Some nanomaterials can also enter cells, interact with their molecular structure, and have cytotoxic or genotoxic effects," (p. 10).

Nano Facts[2]

- Nanotechnology is technology on the atomic and molecular scale.
- A nanometre (nm) is one billionth of a metre.
- A nanoparticle is a particle with one or more external dimensions in the size range 1 nm -- 100 nm.
- The aspect ratio between a nanoparticle and a football is similar to that between a football and Earth.
- Nanotechnology is working on a scale of 100 nm (which corresponds approximately to the size of a virus) down to the size of atoms, about 0.1 nm.
- Nano-scale materials and processes are present in nature, ranging from free molecules in gases and liquids to proteins and organic processes.
- Some substances are produced unintentionally, such as welding dust and diesel particulates.

The Environmental Protection Agency (EPA) is a U.S. government organization which implements Federal laws designed to promote public health by protecting the Nation's air, water, and soil from harmful pollution. This organization has identified nanomaterial (NM) as an "emerging contaminant." As defined by the EPA, "an

1 "Regulating Nanotechnologies: Risk, Uncertainty and the Global Governance Gap," (http://eprints.lse.ac.uk/41579/1/Regulating%20nanotechnologies%20(lsero).pdf), Robert Falkner and Nico Jaspers: Global Environmental Politics. Massachusetts Institute of Technology Published February 2012, Accessed April 2013.

2. "Are Silver Nanopartilces Harmful?" Norwegian Institute of Public Health, Published March 2012, updated: September 2013, Accessed April 2013.

emerging contaminant is a chemical or material that is characterized by a perceived, potential, or real threat to human health or the environment or a lack of published health standards." The potential threats for nanomaterial incorporated in manufacturing fabric and other applications (as identified in the EPA's Nanomaterials Fact Sheet[3] in May 2012) are found in routes of exposure such as:

- The small size, solubility, and large surface area of NMs may enable them to translocate from their deposition site (typically in the lungs) and interact with biological systems.
- NMs, due to their small size, have the potential to pass through both the blood-brain barrier (BBB) and the placenta.
- Some types of NMs that translocate into systematic circulation may reach the liver and spleen, the two major organs for detoxification and further circulatory distribution. Various cardiovascular and other extra pulmonary effects may occur.

The National Resources Defense Council[4] warns that "Nanoparticles are so small that they can be absorbed through the skin and eyes, move through cells and invade the body's life support systems. The particles can act as free radicals and affect our basic genetic components." This is confirmed by an article published in the scientific journal called Toxicology: "Human Skin Penetration of Silver Nanoparticles Through Intact and Damaged Skin[5]." It reports that "the results of our investigations showed that silver can pass through intact human skin," and that "penetration of silver through damaged skin was five times greater than through intact skin with a wide range of results."

Another recently published Toxicology article, "Cytotoxic and Genotoxic Effects of Silver Nanoparticles in Testicular Cells[6]," explains that "Many NPs [nanoparticles], including AgNPs [silver nanoparticles] have been found to cause genotoxic effects, such as DNA-strand breaks, point mutations, and oxidative DNA adducts." A particular threat which was identified in this DNA alteration/damage: "may cause spermatogenic defects that could eventually result in trans-generational defects should the genomic stability of sperm cells be compromised." Results of this study, funded by the Polish-Norweigian Research Fund, supported a past study which was conducted in 2009 at the National University of Singapore, "Cytotoxicity and Genotoxicity of Silver Nanoparticles in Human Cells." Researchers found that "Microscopic observations of treated cells showed distinct morphological changes indicating unhealthy cells." Also, "Earlier reports have emphasized the role played by oxidative stress in nanoparticle toxicity. As discussed earlier, oxidative stress has specific effects in the cells, including oxidative damage to protein and DNA."

3 http://www.epa.gov/fedfac/pdf/emerging_contaminants_nanomaterials.pdf. Available online May 2012. Accessed April 2013.

4 http://www.nrdc.org/living/stuff/promises-and-pitfalls-nanotech.asp: Last edited August 2011. Accessed April 2013.

5 "Human Skin Penetration of Silver Nanoparticles Through Intact and Damaged Skin," Available online August 2008. Accessed April 2013.

6 "Cytotoxic and Genotoxic Effects of Silver Nanoparticles in Testicular Cells," Available online November 2011. Accessed April 2013.

At the recent New England Nanomanufacturing Summit[7], nanomanufacturers were advised about future government regulations:

"Identifying the implications and avoiding additional unintended consequences of nanoscale materials (NMs) is challenging, because many of the models that have served to evaluate potential hazards and exposures in previous decades of chemicals management may no longer be applicable. The Agency is closely evaluating potential risks of new nanoscale chemicals on a case-by-case basis with an eye towards developing consistent approaches in the face of large data gaps. Development of new regulations is also underway on existing chemicals in the nanoscale. These initiatives dovetail research and regulation by other governmental, academic, and industrial stakeholders at the state, federal, and international levels."

The National Science and Technology Council (NSTC) Committee on Technology[8] is a division of the Office of Science and Technology Policy, which is part of the administration for the Office of the President of the U. S. In collaboration with EPA, FDA, and several other government agencies, it warns that "the rise in the use of engineered nanomaterials in commercial products and industrial applications has increased the potential for nanomaterials to be released into the environment, which could pose health and environmental challenges."

Despite the scientific risks that are now under investigation in the new developments of nanotechnology, the U.S. government has yet to regulate it. Why? Because political, economic and societal risks must also be taken into account by those who make the laws in order to avoid making uncomfortable decisions. This situation is compared by a Global Environmental Politics report to that of "the global conflict over trade in genetically modified organisms," (p. 7) resulting in dispute among the 159 members of the World Trade Organization (WTO). "Scientific risk assessment criteria alone cannot guide regulators and policy-makers in such situations. Instead, a wider range of factors enter the calculations that inform regulatory action, from political ideology and societal risk attitudes to national or sectoral economic interests," (p. 6). It explains:

The U.S. EPA has collaborated with the U.K. Natural Environment Research Council and U.K. Engineering and Physical Sciences Research Council to offer grant funding for further research, led by Dr. Pedro Alvarez at Rice

7 Nanotech Commercialization Conference, State of the Union – Nanotechnology, Environmental Health Safety 2012, Research Triangle, Durham, NC, Power Point presentation by Lynn L. Bergeson, Bergeson & Campbell, P.C. www.lawbc.com. Presented April 4, 2012, Accessed April 2013.

8 Nanotechnology for Sensors and Sensors for Nanotechnology: Improving and Protecting Health, Safety, and the Environment (http://eprints.internano.org/1843/1/sensors_nsi_2012_07_09_final_for_web.pdf). Available online July 2012, Accessed April 2013.

9 "Regulating Nanotechnologies: Risk, Uncertainty and the Global Governance Gap," (http://eprints.lse.ac.uk/41579/1/Regulating%20nanotechnologies%20(lsero).pdf), Robert Falkner and Nico Jaspers: Global Environmental Politics. Massachusetts Institute of Technology Published February 2012, Accessed April 2013.

Rice University. "Negligible Particle-Specific Antibacterial Activity of Silver Nanoparticles[10]" was then published in July 2012 to explain the results of the various experimental methods that were used and shed some light on the matter. In the experimentation, E. coli was the model microorganism of choice, to compare the toxicity of AgNPs (silver nanoparticles) with that of silver ions (Ag+). The results were quite telling, as "The nanoparticles had no measurable effect on E. coli up to concentrations thousands of times higher than the minimum lethal concentration of silver ions themselves." However, the "silver ion, released during the toxicity assay can have a notable antimicrobial effect." Since the key factor of killing bacteria is the Ag+ itself, the main variable is the type of the antibacterial agent which delivers it. Agent particles vary in aspects such as size and rate of release (think of transportation via a subway system vs. taxi vs. personal chauffer). Dr. Avarez and his team found that a lower concentration of Ag+ in AgNPs "can activate repair mechanisms of the cells against the toxicant, and this repair process must sometimes overcompensate for the exposure. In other words, as the proverbial saying goes: what doesn't kill them makes them stronger. Their conclusion of this research is presented as follows:

"For nearly a decade, researchers have debated the mechanisms by which AgNPs exert toxicity to bacteria and other organisms (especially whether the AgNPs exert direct 'particle-specific' toxicity). These results demonstrate that the antimicrobial activity of AgNPs is solely due to Ag+ release and that even relatively low (μg/L) concentrations of Ag+ (released or adsorbed to AgNP coatings) can account for the biological response observed in previous studies."

With this in mind, Spradling International continues to uphold its higher standards for the wellbeing of all who enjoy the comfort of its high-quality, vinyl upholstery. It presents key brands, such as SILVERGUARD®, which offer a controlled release of Ag+ through antibacterial particles. This is highly effective against bacteria by destroying microorganisms through multiple paths. Unless it is proven that nanomaterial (particularly nanosilver) does not present a health threat to the end users and a legal threat to its distributors, Spradling International is not willing to present such a risk to its clients and end users.

10 "Negligible Particle-Specific Antibacterial Activity of Silver Nanoparticles" (http://alvarez.blogs.rice.edu/files/2012/10/151.pdf), Zong-ming Xiu, Qing-bo Zhang, Hema L. Puppala, Vicki L. Colvin, and Pedro J. J. Alvarez. Published July 2012, Accessed April 2013.

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