

Industry Comments on EPA OPP Proposed Nanopesticide Policy

Rosalind Volpe, D.PH
Executive Director,
Silver Nanotechnology Working Group



*Presented on behalf of the **Silver Nanotechnology Working Group (SNWG)**, an industry effort intended to foster the collection of data on silver and nanotechnology in order to advance the science and public understanding of the beneficial uses of silver nanoparticles in a wide-range of consumer and industrial products.*

Presentation to the
Office on Management and Budget,
The White House
August 2010

EPA OPP Proposed Nanopesticide Policy



On April 29, 2010, EPA's Office of Pesticide Programs (OPP) introduced a new policy interpretation with regard to nanopesticides with the intent of issuing a final decision by notice in the Federal Register in June 2010:

- OPP's working definition of nanomaterial is:
 - An ingredient that contains particles that have been intentionally produced to have at least one dimension that measures between approximately 1 and 100 nanometers.
- The notice will announce a new interpretation that the presence of a nanomaterial is reportable under FIFRA 'adverse effect reporting' provision Section 6(a)(2) - applies to already registered products as well as products pending registration
- The notice will memorialize OPP's view that an active or inert ingredient would be considered "new" (FIFRA and PRIA) if it is a nanomaterial - even if the parent material is already registered.

EPA OPP Proposed Nanopesticide Policy



In this presentation SNWG will outline why the proposed policy will:

- Add to the job losses already incurred by antimicrobial silver producers due to EPA's refusal to define a regulatory path for nanoscale silver products
- Stifle innovation without any benefit to human health and/or the environment
- Deter investment in green chemistry and sustainable pesticide development
- Promote a negative public perception regarding nanotechnology
- Institutionalize an arbitrary and unsupportable definition of nanotechnology
- Improperly characterize numerous decades-old pesticides and inerts as a "new" materials – prompting unnecessary and burdensome review
- Contradict the statutory language and purpose of section 6(a)(2) of the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA)
- Contradict the statutory language and purpose of the Pesticide Registration Improvement Renewal Act (PRIA)
- Place a significant and unjustifiable economic and reporting burden on the pesticide industry as a whole

OPP's Stated Justification for New Policy



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- Generic “Potential Human Health Concerns”
- Generic “Potential Environmental Concerns”
- Though no adverse environmental or health effects from the use of commercial nanomaterials have been documented

OPP's decision to introduce broad new regulation based on unsupported generalities and theoretical risks contradicts the measured and scientifically grounded 'case-by-case' approach to risk assessment supported by the 20+ agencies coordinated under the National Nanotechnology Initiative

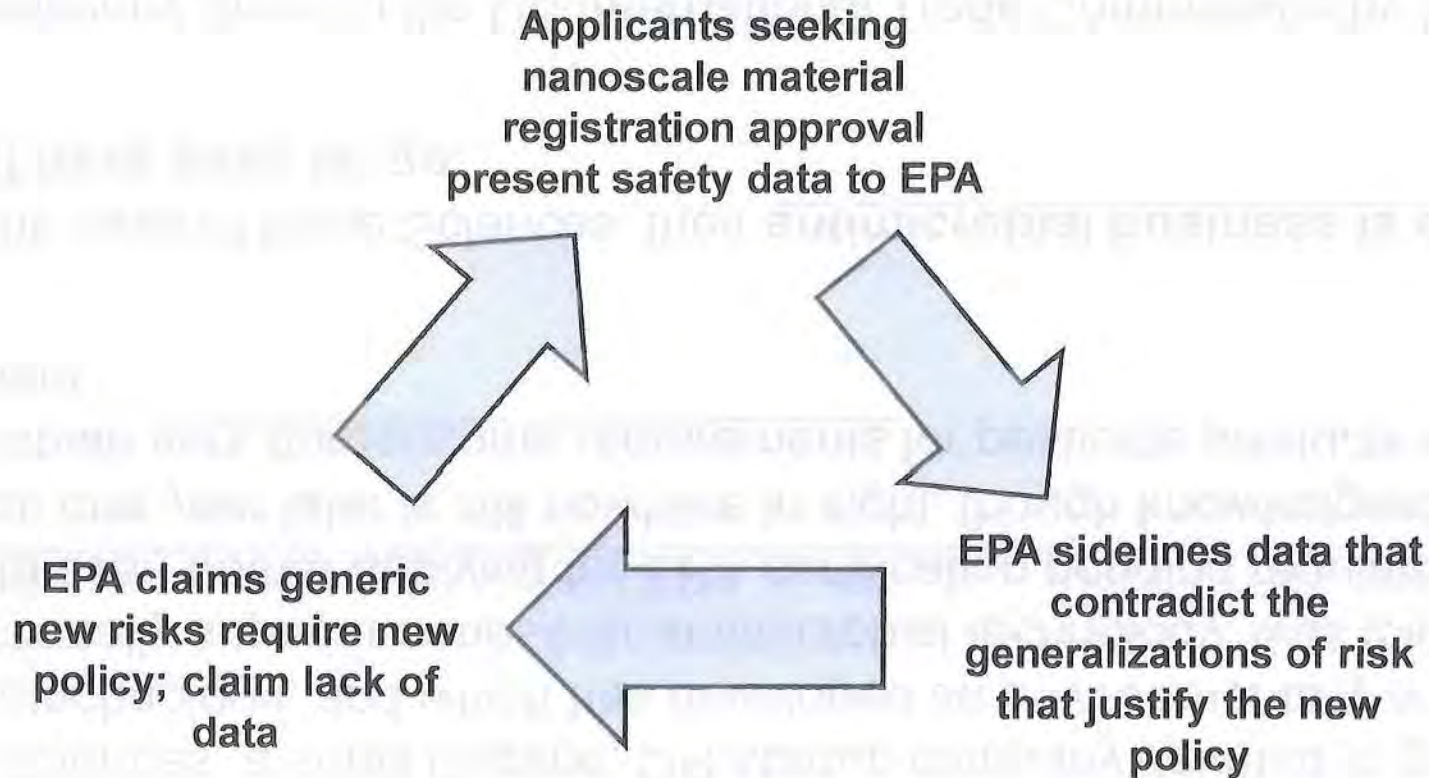
EPA Has Sidelined Contradictory Data



Industry has provided EPA with an enormous amount of data that clearly show that there is no reasonable justification for the ‘potential concern’

- Dermal absorption (so small they may pass through cell membranes)
 - *EPA SAP member Prof. F. Filon-Larese has published multiple studies showing that dermal absorption of silver nanoparticles is negligible or non-existent.*
 - *FDA has approved many nanoscale silver bandages with no reported dermal issues*
- Inhalation (go to the deep lung and may translocate to the brain i.e, could cross the blood brain barrier)
 - *EPA SAP member Prof. Il Je Yu has published GLP studies that the inhalation risks of nanoscale silver are minimal and the resultant NOAEL was equivalent to that currently recommended for ‘conventional’ silver compounds*
- High durability or reactivity of some nanomaterials raises issues on the fate in environment
 - *U.S. EPA, National Risk Management Research Lab (C. Impellitteri et al.)“recent research suggests that the environmental risk from nanoscale Ag particles is low”*

Job Losses and Stifled Green Innovations



Since 2008, manufacturers of nanoscale pesticidal and antimicrobial products have been locked in this loop resulting in:

- Indefinite delays in commercialization
- Loss of confidence by potential customers and investors
- Loss of jobs

Job Losses and Stifled Innovation



Example #1. Dune Sciences



“Dune Sciences, a small Eugene, OR startup company devoted to green nanotechnology, and which has developed an environmentally and functionally superior nanosilver antimicrobial technology, was told a year ago not to even bother applying for EPA certification pending regulatory clarity which one year later is still nowhere in sight, though knowledgeable experts anticipate very burdensome requirements for pesticide products with 'nano' content.”

“In the case of Dune Sciences, their antimicrobial business is on hold and staff have been let go.”

- Testimony given to the US International Trade Commission by Skip Rung, President and Executive Director of the Oregon Nanoscience and Microtechnologies Institute, March 12, 2010.

Job Losses and Stifled Innovation



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Example #2. NanoAgri Systems



“William Norwood, president of nanoAgri Systems, said the Environmental Protection Agency told him that he wasn’t permitted to market his company’s new nanosilver, antibacterial packaging.

“He said he couldn’t get a clear answer from the EPA on why he couldn’t move forward with the process his company developed.

“Nano is now a fear word and restrictions haphazardly applied will stifle many needed advancements that can improve health and other vital areas,” Norwood said. “Nanotechnology isn’t being given a chance by federal regulators and environmental activists.”

*from “Nano packaging of food kills deadly bacteria, but government says no go.”
Andrew Schneider, ColdTruth.com, August 10, 2009.*

Green Chemistries at Risk



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- In 2005 EPA registered under FIFRA nanoscale copper wood preservatives to replace toxic Copper Chromium Arsenate (CCA) products.
- Nanoscale copper (marketed as 'micronized copper') shows less leaching than CCA because the small particles (<80 nm) penetrate the wood.
- This technology was nominated for an EPA Green Chemistry Award in 2007.

If this product was submitted for initial registration today, the environmental benefits would be indefinitely delayed.

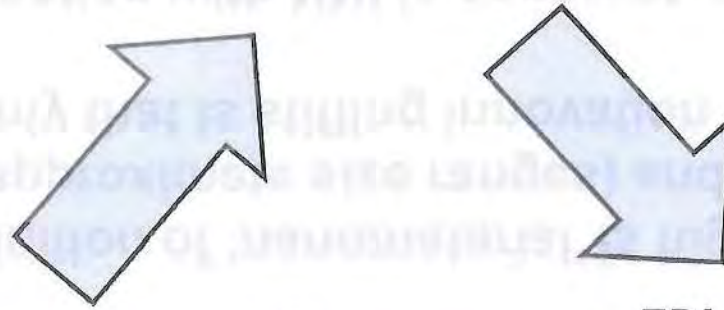


“Microdistribution of copper-carbonate and iron oxide nanoparticles in treated wood.” H. Matsunaga, M. Kiguchi, P. Evans. J Nanopart Res. 11,5. 1087-1098 (2009).

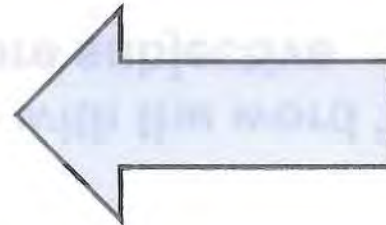
http://www.epa.gov/greenchemistry/pubs/docs/award_entries_and_recipients2007.pdf

Job Losses and Stifled Green Innovations

**Applicants seeking
nanoscale material
registration approval
present safety data to EPA**



**EPA claims generic
new risks; data
requirements unclear
or unjustifiable**



**EPA sidelines data that
contradict the
generalizations of risk
that justify the new
policy**

**If the proposed EPA policy on nanomaterials is not rescinded,
the nanomaterials industry will be indefinitely trapped in a
bureaucratic loop resulting in continued job losses,
compromising US leadership in nanomaterials innovation**

Issues with the Proposed Policy: An Arbitrary Definition of ‘Nanomaterial’

- The 1 to 100 nm range introduced by NNI is arbitrary and has been soundly rejected as scientifically defensible delineation for regulatory purposes
- Qualifying the size range with the word ‘approximately’ does not make it less arbitrary, merely more subjective
- The proposed definition of ‘nanomaterial’ is highly subjective (intentionality and approximate size ranges) and will perpetuate the regulatory uncertainty that is stifling innovation
- The lack of coordination with NNI is apparent, as similar definitions have been evaluated and rejected by other agencies (FDA, EPA TSCA)
- The proposed definition has not been validated through independent review; the EPA Scientific Advisory Panel has NOT reviewed the proposed definition despite recent public assertions to the contrary

Issues with the Proposed Policy: An Arbitrary Definition of ‘Nanomaterial’



“First, we have the problem of definitions...Unfortunately, the generally accepted definition of nanotechnology—“the understanding and control of matter at dimensions between approximately 1 and 100 nanometers, where unique phenomena enable novel applications” is what the US National Nanotechnology Initiative uses—is one of expedience, not of science. It serves the purpose of stimulating new research and technology innovation in an exciting new area brilliantly. *But it doesn’t clearly define a set of products and processes that have common and specific safety issues; and it was never intended to.*

As a result, attempts to apply the generally accepted definition of nanotechnology to material and product safety ends up in a messy mismatch. Materials that are probably benign come under suspicion, while others that we should be worried about potentially slip the net.”

- Dr. Andrew Maynard
Project for Emerging Nanotechnologies
“Ten things everyone should know about nanotechnology safety”
2020 Science

Issues with the Proposed Policy: An Arbitrary Definition of 'Nanomaterial'



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“The NNI has arbitrarily drawn the line at 100 nanometers. Does that mean that something that is 101 nanometers is no longer toxic? I would suggest otherwise. But that we need to get away from labeling things and get down to the business of hazard identification, exposure assessment and risk analysis.”

**- Prof. Martin Philbert
EPA SAP member
Meeting of the FDA Nanotechnology Task Force
October 2006**

EPA should defer to NNI for a scientifically valid and harmonized definition.

The proposed arbitrary and subjective definition will perpetuate the irrationality that has marked EPA's nanomaterials review process to date



Issues with the Proposed Policy: Misuse of FIFRA 6(a)(2) Adverse Effects Reporting



- The planned policy would require the presence of nanomaterial in a registered pesticide to be reported under the ‘unreasonable adverse effect’ provision though EPA acknowledges that there is no nexus to risk.
- The new policy will unquestionably stigmatize the use of nanomaterials as commentators will equate nanomaterials with “adverse effect reports.”
- The policy contradicts the statutory language and intent of FIFRA section 6(a)(2) which is meant to be a post-registration check on known risks
- The policy gives no indication as to the level of certainty on particle size that would trigger a report and would likely result in a deluge of haphazard information of little value to EPA for risk assessment purposes
- Other approaches, such as modifying Part 158 requirements to obtain this information without the “adverse effects” label, are legitimate alternatives.

Issues with the Proposed Policy: Misuse of FIFRA 6(a)(2) Adverse Effects Reporting



The stigma of associating nanomaterials with 'adverse effect reporting' will further the negative perception of nanotechnology already created by EPA's unwarranted risk generalizations

X-static

**All the
Anti-Microbial
Benefit...
None of the Nano.**

**99.9% Pure
Metallic Silver**

100% EPA, FDA, CE, REACH,
OEKOTEX REGISTERED

**Confidence to
the Power of**

www.x-static.com

The advertisement for X-static is presented in a vertical, halftone-style format. It features the brand name 'X-static' at the top in a large, bold, sans-serif font. Below the name, the text 'All the Anti-Microbial Benefit... None of the Nano.' is centered. Further down, it states '99.9% Pure Metallic Silver' and lists regulatory approvals: '100% EPA, FDA, CE, REACH, OEKOTEX REGISTERED'. At the bottom, it says 'Confidence to the Power of' followed by the website 'www.x-static.com'. The background of the ad is a grid of dots of varying sizes, creating a textured effect.

After 10 years and \$10B in federal nanotech development, EPA has succeeded in making 'nano' a fear word in some of the largest global industries

Issues with the Proposed Policy: OPP Actions Have Already Created A Stigma



Micro vs Nano

Why Micro-silver technology is better for you than Nano-silver.

X-Static® the silver fiber is a *micro* technology (a size of one *millionth* of a meter). Its silver is entirely visible and is permanently bonded to synthetic fibers which are applied topically – next to the skin. There is no danger of ingesting silver and silver is applied directly to affected, targeted areas of discomfort, infection or pain. X-Static® the Silver Fiber is registered with the US Food and Drug Administration (with several products holding 510K status) and is EPA approved.

About Silver

Power of Silver

X-Static® The Silver Fiber

Micro vs Nano

Health Benefits

“The United States Environmental Protection Agency has recently begun investigating whether silver ions in nano sized application could pose an environmental threat by killing beneficial bacteria in the environment, or even be harmful to humans. Their investigation is on going.”



the size of a pinhead. The United States Environmental Safety Agency has recently begun investigating whether silver ions in a nano sized application could pose an environmental threat by killing beneficial bacteria in the environment, or even be harmful to humans. Their investigation is on going

X-Static® beats nano-silver every time.

Issues with the Proposed Policy: Mischaracterization of Nanomaterials as 'New'

- Nanoscale silver has been intentionally produced and commercially available for +100 years.
- 1969. Carey Lea colloidal silver produced using same methodology as 1889¹
- *Carey Lea* colloidal silver **average size 7 - 10 nm**
- Confirmed as metallic silver by X-ray diffraction
- Colloidal silver shown as particles within range of 1 to 100nm



Fig. 1. Electron micrograph of a *Carey Lea* silver sol [2]

¹ MC. Lea, "On Allotropic Forms of Silver", *American Journal of Science*, 37 (1889) 476.

² G.Frens, J.Th.G.Overbeek, "Carey Lea's colloidal silver", *Kolloid-Zeitschrift und Zeitschrift für Polymere*, 233(1-2) (1969) pp922-929.

Issues with the Proposed Policy: Mischaracterization of Nanomaterials as 'New'

- There are many *historic, current* and *potential* applications for silver nanoparticles:
 - Pigments
 - Photography
 - Wound treatments
 - Conductive/antistatic
 - Catalysts
 - Antimicrobial
 - etc.
- Silver nanoparticles as an *antimicrobial* (FIFRA):
 - Textiles *eg. sportsclothing, socks*
 - Medical articles & devices *eg. plasters, wound care*
 - Coatings *eg. wall paint*
 - Plastics *eg. keyboards*

Issues with the Proposed Policy: Mischaracterization of Nanomaterials as 'New'

1954:

Nanosilver colloidal algaecides (~10 nm) first registered by EPA

1960s:

EPA-registered silver-impregnated carbon filters (2-15 nm) widely used to protect municipal water supply

1998:

First FDA approved nanocrystalline silver wound care devices are approved

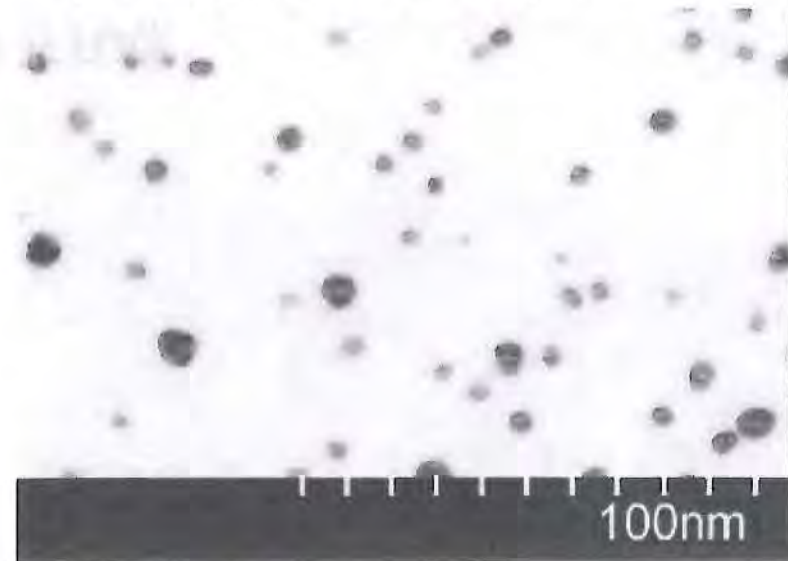
2002:

First nanosilver spray disinfectant approved by EPA (~50 nm)

Present:

Estimated **82%** (75 of 92) of EPA-registered products contain **nanoscale particles** or ionic (picoscale) silver

TEM Image of first FIFRA registered silver product (nanosilver algaecide) from 1954



Issues with the Proposed Policy: Mischaracterization of Nanomaterials as 'New'

Negative Economic Impacts of Being Mischaracterized as 'New'

The manufacturer of the very first FIFRA registered silver product from 1954 was recently told by EPA that their product would be designated as “new” under the proposed new policy and that they would have to reregister with extensive new testing – EVEN THOUGH THEY HAVE HAD NO REPORTED AVERSE EVENTS IN 50+ YEARS OF COMMERCIAL USE.

The manufacturer expects that the new policy will put them out of business.

TEM Image of first FIFRA registered silver product (nanosilver algacide) from 1954



Issues with the Proposed Policy: 'Nano = New': A Violation of PRIA

The Pesticide Registration Improvement Act of 2003 (renewed in 2007) is in essence a pact between EPA and Industry to:

- improve the predictability and speed of the pesticide registration process

in exchange for

- increased fees schedule to EPA to add resources for review.

The statutory language and definition is clear:

“New Active Ingredient. An active ingredient that is not currently contained in as an active ingredient in any registered pesticide product.”

The proposed policy contradicts both the intent (predictability) and statutory language (newness is based on fact, not arbitrary definitions) of PRIA.

Alternatives Approaches



SNWG and the industry groups believe that EPA needs access to information with a nexus to risk.

By EPA's own admission, there is no evidence that nanomaterials *per se* contribute to adverse effects.

The long history of safe use of numerous nanomaterials (colloidal silver, colloidal sulfur, fumed silica, carbon black, etc.) reinforces that existing regulations are adequate for managing identified risks.

Alternative approaches that do not rely on arbitrary definitions and the stigma of 'adverse effects' reporting have been outlined in "The Adequacy of FIFRA to Regulate Nanotechnology-Based Pesticides, American Bar Association, Section of Environment, Energy, and Resources, May 2006."

Until EPA fully considers the job losses, economic burden, negative impact on green chemistry and innovation, and the stigma to nanotechnology development the proposed policy should be indefinitely delayed or completely rescinded.



Additional Slides



Background / Timeline



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- May 2008. ICTA, Greenpeace, Friends of the Earth, and other NGOs petition EPA to stop sale of 'unregulated' nanoscales silver products and to adopt the viewpoint that nanoscale versions of existing pesticides should be designated as 'new' materials.
- July 2008. Several FIFRA registration applications for nanoscale silver products are denied by EPA. With no public notice or stakeholder involvement, EPA informs applicants that it has adopted the viewpoint that nanoscale versions of existing pesticides are now designated as 'new' materials, though the term nanomaterial is not defined.
- Dec 2008. Silver Nanotechnology Working Group formed to promote regulatory clarity and to provide data to EPA for risk assessment purposes.
- Mar 2009. OPP first public acknowledgement that it has adopted the viewpoint that nanoscale versions of existing pesticides are 'new' materials.

Background / Timeline



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- Jan-Aug 09. Silver Nanotechnology Working Group and member companies present data to EPA. Though no new data is requested by EPA, all applications are indefinitely on hold.
- Nov 2009. EPA hold SAP review of nanosilver. Panel indicates that EPA should review historic use of nanosilver but expresses the general need for additional data.
- Mar 2010. EPA lists “Silver” as new active ingredient in Federal Register.
- Apr 2010. EPA proposes new definition of nanomaterial and new policy interpretations
- Present. Applicants report that no new data requirements are pending, yet no applications for new nanoscale silver have been approved since 2007. No guidance on timeline / requirements has been proposed.

Nanoscale Silver - Origins

- Comparison of colloidal silver to silver nanoparticles...

	Colloidal silver	Silver nanoparticles
<i>Engineered?*</i>	Yes. Rationally synthesized	Yes. Rationally synthesized
<i>Size range?**</i>	1 through 100 nm ($\mu\mu$) ¹	1 through 100 nm ²
<i>Size distribution?</i>	Wide range possible	Wide range possible
<i>Character?</i>	Silver metal	Silver metal
<i>Color?</i>	Brown/yellow color	Brown/yellow color

- Colloidal silver and silver nanoparticles are the **same material**
- Difference is only **terminology** used at different points in history

¹ A.Ede, "The rise and decline of colloid science in North America, 1900-1935. The neglected dimension", *Science, Technology and Culture 1700-1945 series*, Ashgate Publishing (2007).

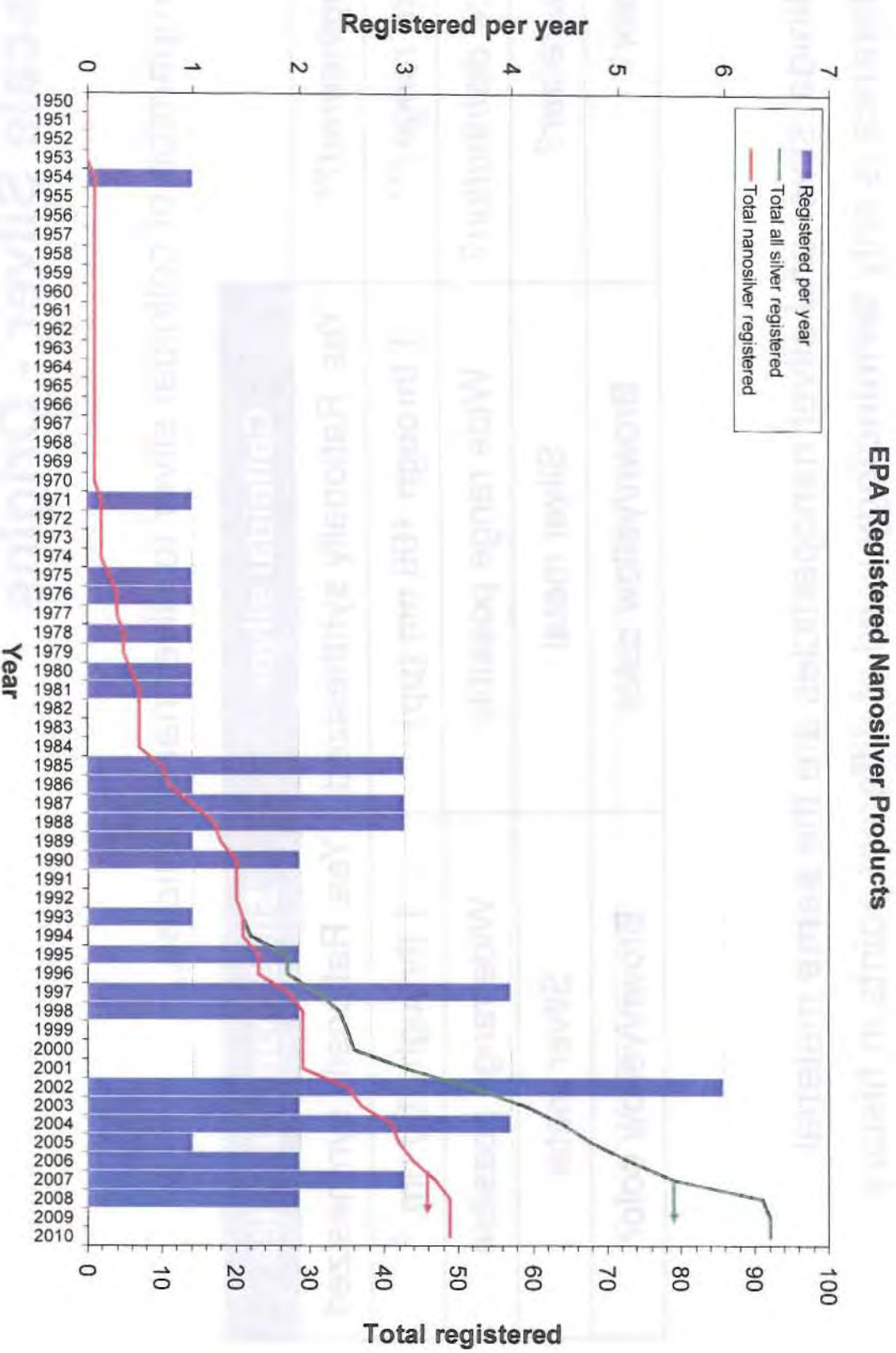
² EPA, "Nanotechnology White Paper", (2007).

* Colloidal silver and silver nanoparticles share common synthesis methods.

** Size range is arbitrarily set by convention in both cases. Size range 1 to 100nm expresses a range of conventional interest.

EPA Registered Nanosilver products

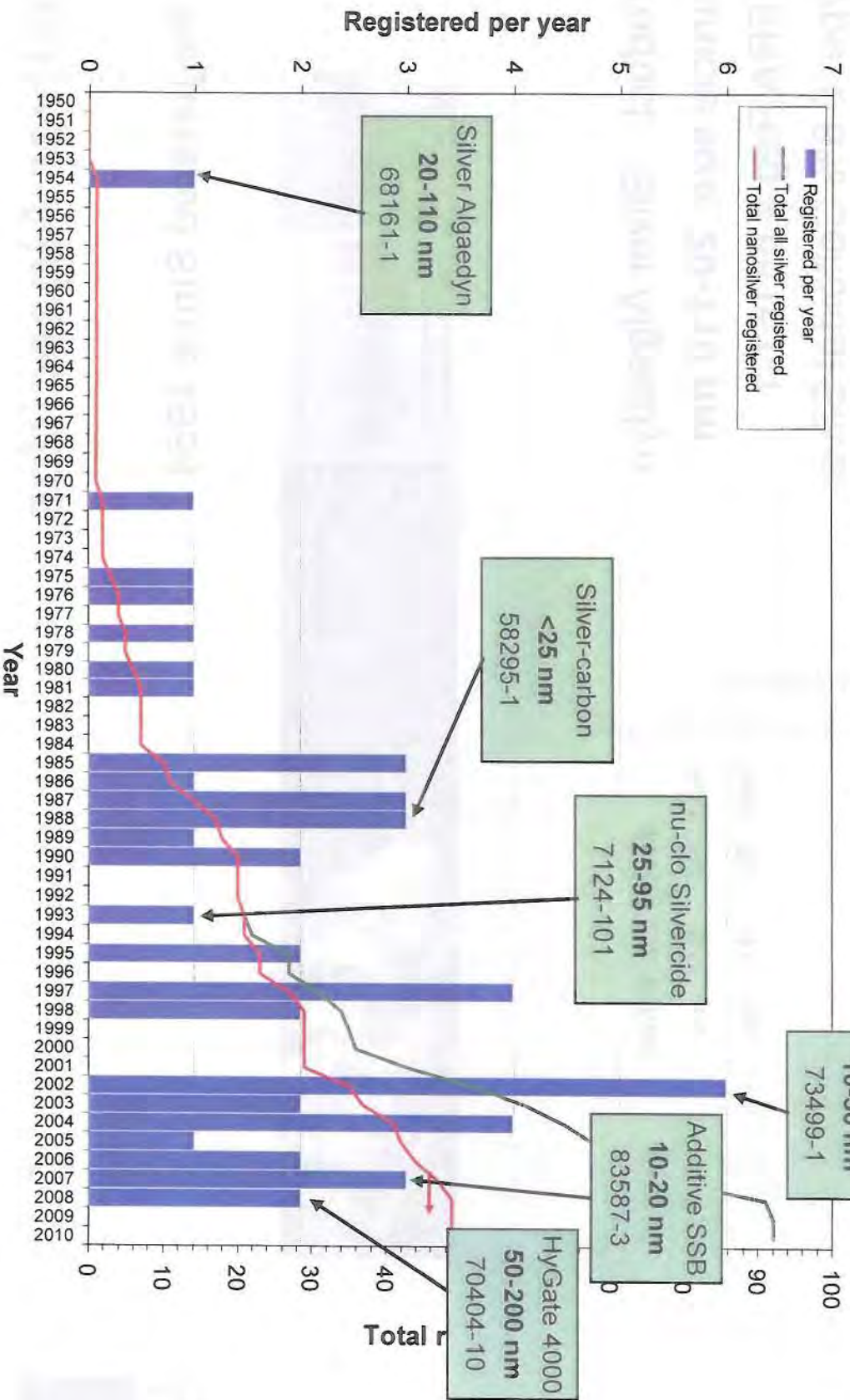
- Many EPA registered nanosilver products over 6 decades



EPA Registered Nanosilver products

- Many EPA registered nanosilver products over 6 decades

EPA Registered Nanosilver Products



Nanosilver Algaecides

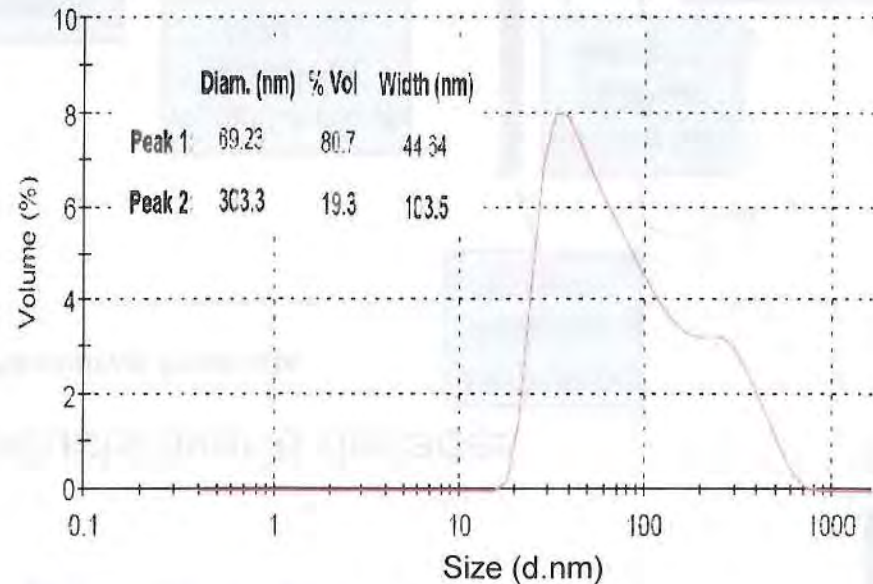
EPA-Registered Since 1954



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Product: Silver Algaedyn
Particle size: 20-110 nm
FIFRA Reg # 68161-1
Type: 0.8% Colloidal Silver
First Registered: 12/31/1954¹



¹ NPIRS Public <http://ppis.ceris.purdue.edu/npublic.htm>

Dynamic light scattering (DLS) data courtesy of NanoHorizons Inc.

Nanosilver Algaecides

EPA-Registered Since 1993

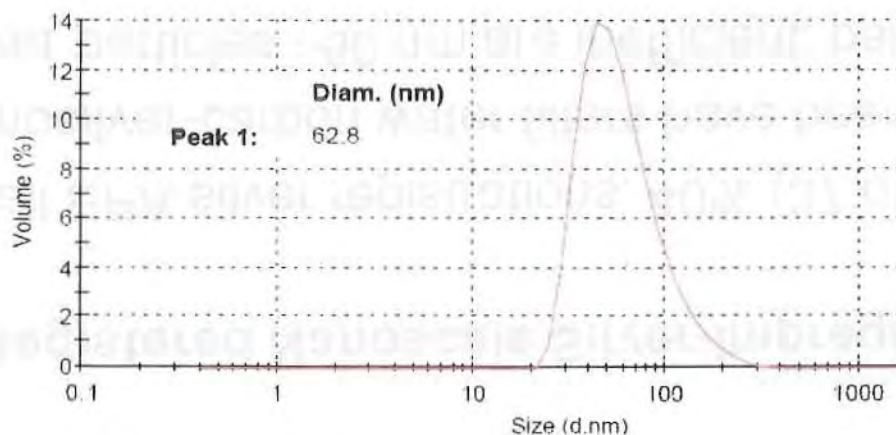
Product: nu-clo Silvercide

Particle size: **25-95 nm**

FIFRA Reg # 7124-101

Type: 0.8% Colloidal Silver

First Registered: 6/15/1993¹



¹ NPIRS Public <http://ppis.ceris.purdue.edu/npublic.htm>

Dynamic light scattering (DLS) data courtesy of NanoHorizons Inc.

Nanoscale Silver-Impregnated Carbon



EPA-Registered Nanoscale Silver-Impregnated Carbon Filter Media

- Of all EPA silver registrations, 40% (37 of 92) are silver-impregnated filters
- Nanosilver-carbon water filters have been **commercial for over 40 years**
- Silver particles >50 nm are inefficient; particles 2-15 nm are required



Ryu et al.²

“...for proper efficiency, the silver must be dispersed as particles of colloidal size (less than 250 Å [25 nm] in crystallite size...)”¹

FIFRA Reg #s	First registered
58295-1	12/01/1988 ³
58295-2	11/01/1989 ³
58295-3	01/16/1990 ³

¹ U.S. Patent #3,374,608 (1968). “Silver Impregnated Carbon”, Assigned to Pittsburgh Activated Carbon Co. (now Calgon Carbon)

² S.K.Ryu, S.Y.Eom, T.H.Cho, D.D.Edie, “Distribution of Silver Particles in Silver-containing Activated Carbon Fibers”, Carbon Science, 4(4), 168-174 (2003).

³ NPIRS Public <http://ppis.ceris.purdue.edu/npublic.htm>

Nanosilver Disinfectants



EPA-Registered Nanosilver Disinfectants: American Biotech Labs

Product: ASAP-AGX
Particle size: 10-50 nm
FIFRA Reg # 73499-1
Type: 0.001% Silver
First Registered: 2/27/2002¹

Product: ASAP-AGX-32
Particle size: 10-50 nm
FIFRA Reg # 73499-2
Type: 0.032% Silver
First Registered: 4/23/2003¹

“These engineered silver particles currently vary in size between about **10-50 nanometers** in diameter...”

William D. Moeller, President, American Biotech Laboratories
Testimony on Malaria before the U.S. House of Representatives, International Relations Committee, Subcommittee on Africa, Global Human Rights, and International Operations, April 26, 2005.

“We believe our **nano-silver product** is an important non-toxic broad-spectrum anti-pathogenic...”

Keith Moeller, VP Marketing, American Biotech Laboratories
ABL press release, Tuesday November 28, 2006.

¹ NPIRS Public <http://ppis.ceris.purdue.edu/npublic.htm>

Nanosilver Disinfectants



EPA-Registered Nanosilver Dental Line Cleaners

“The Maintenance Treatment contains a controlled, minute amount of **colloidal silver** to keep things clean”¹

Product: H2Pro™ Maintenance Treatment
Particle size: 1- 500 nm (est)
FIFRA Reg # 75829 -1
Type: 0.0015% Silver
First Registered: 9/9/2004²



¹ <http://www.garrisondental.com/>

² *NPIRS Public* <http://ppis.ceris.purdue.edu/npublic.htm>

Nanosilver Antimicrobials

EPA-Registered Antimicrobial Additives: Ciba / Bio-Gate



Product: HyGate 4000
Particle size: 50-200 nm
Agglomerate size: 2-5 μm
FIFRA Reg # 70404-10
Type: 100% Silver
First Registered: 09/05/2008¹



Product: MicroSilver BG-R
Particle size: 50-200 nm
Agglomerate size: 2-5 μm
FIFRA Reg # 84146 -1
Type: 100% Silver
First Registered: 03/18/2008¹



Press Release: "Ciba Specialty Chemicals forms marketing cooperation with Bio-Gate for silver antimicrobial technology"
14.12.2005, Basel, Switzerland.

¹ NPIRS Public <http://ppis.ceris.purdue.edu/npublic.htm>

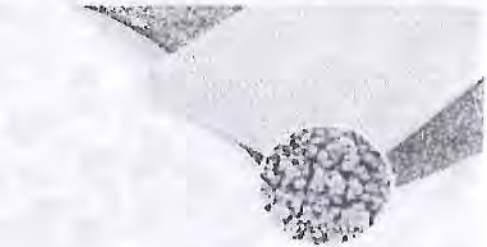
FDA-Approved Nanosilver Products



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- Acticoat Wound Care with Nanocrystalline Silver
 - FDA approved in **1998**
 - Clinically proven to reduce wound infection
- I-Flow SilverSoaker Nanosilver Catheters
 - FDA approved in **2005**
 - Recommended by NGOs to reduce hospital acquired infections
- Other FDA approved nanosilver products:
 - Baxter Needless IV Connectors
 - SilverSol Nanosilver Wound Care Gel
 - Bard Silver-coated Endotracheal Tubes

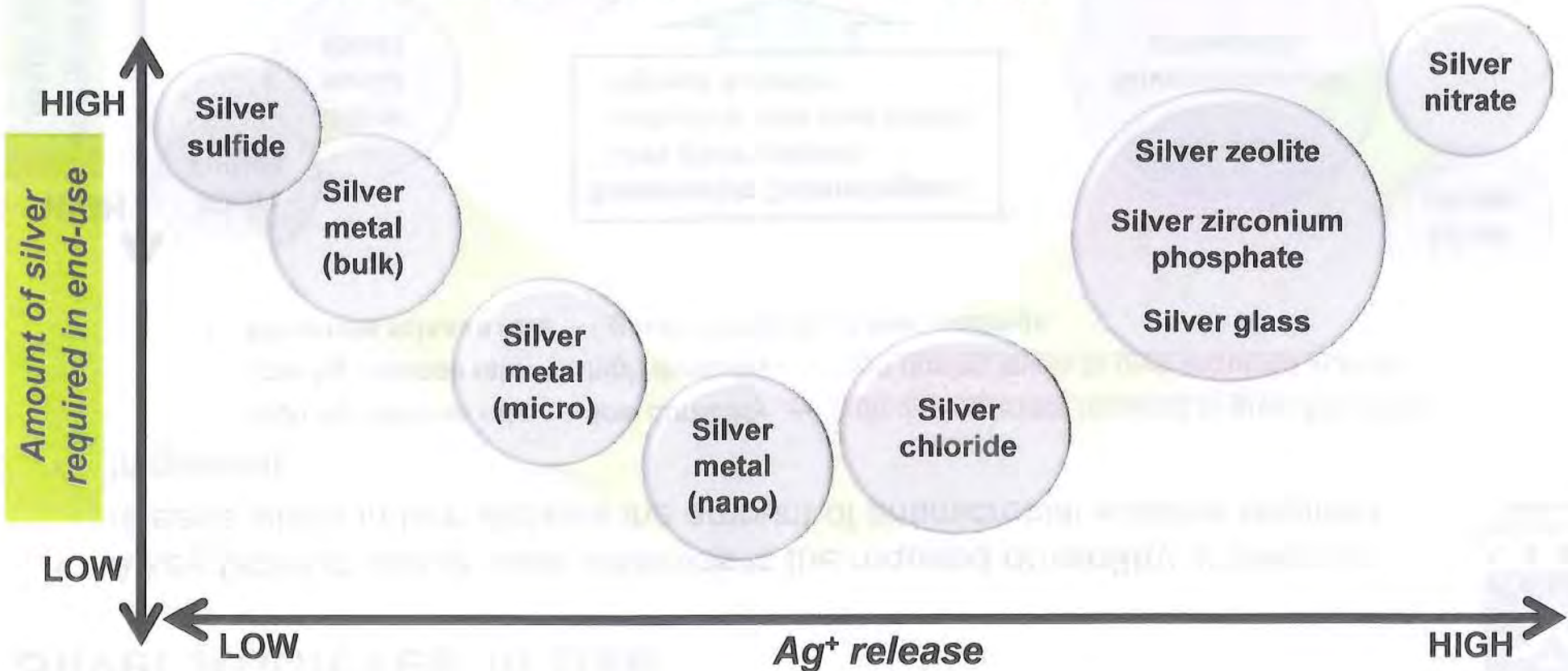
ACTICOAT*
Antimicrobial Barrier Dressing
SILCRYST®



SilverSol® Gel

Silver Additives in Use

- A key factor in use of silver additives is the required **durability** of silver ion release which in turn dictates the amount of antimicrobial additive required.
- In general:
 - High Ag^+ release rate \rightarrow low durability \rightarrow high dosing levels required to give durability
 - Low Ag^+ release rate \rightarrow high durability \rightarrow high dosing levels to give required activity
 - **Moderate release rate** \rightarrow **good durability at low loadings**

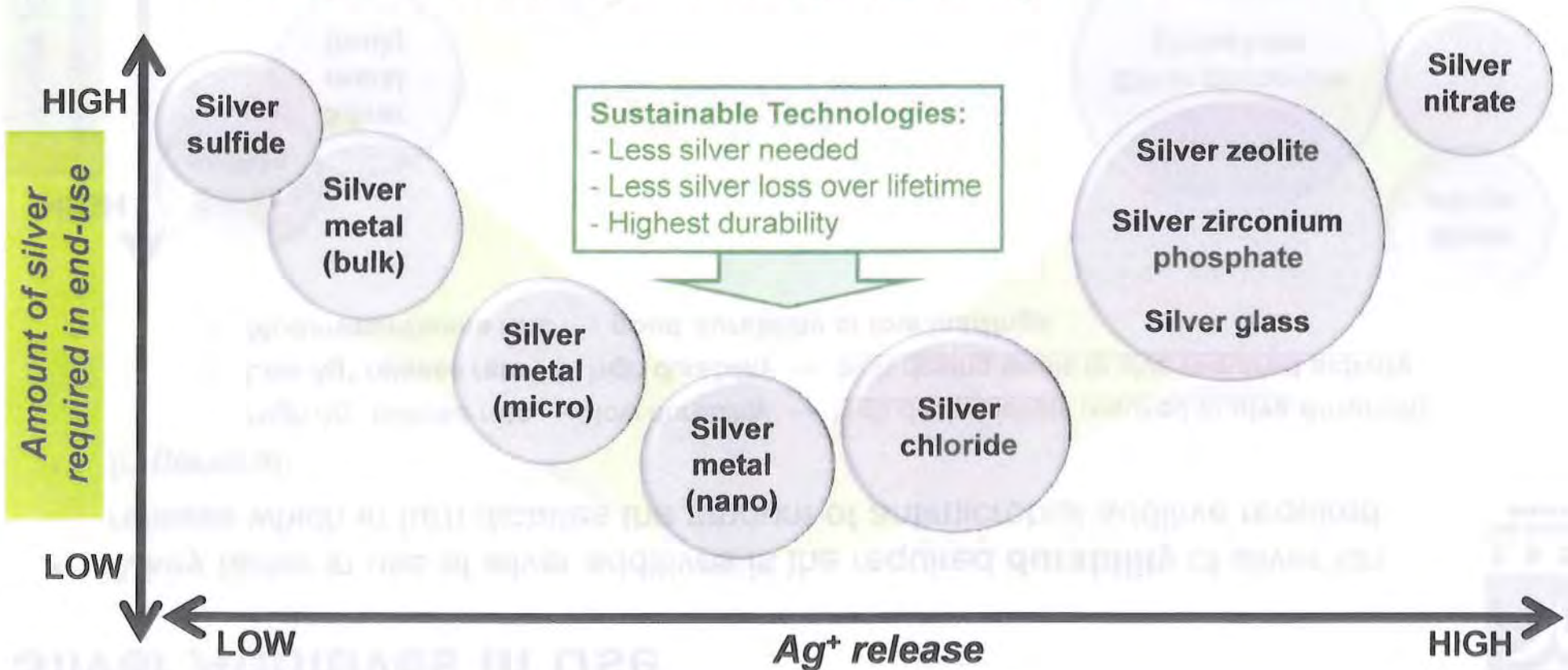


Silver Additives in Use

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Nanotoxicology in 1926:

Bone Marrow Reactions with Nanoscale Silver

Experimental Bone Marrow Reactions: I. Anemia Produced by Collargol. by Muller, G.L. *The Journal of Experimental Medicine*, Vol 43, 533-553, 1926.



The collargol or colloidal silver employed is said to contain 78 per cent of metallic silver and a small percentage of egg albumin and its oxidation product (11). It is manufactured by the Heyden Chemical Works, and distributed by Schering and Glatz, New York. The size of the particles has been determined by Bechhold (12) to average 20 millimicra ($\mu\mu$), the individual particle consisting of aggregates of metallic silver and the protective colloid. The concentration of the colloidal suspension, which was made up in small doses in sterile distilled water and filtered immediately before use, varied between 0.1 and 2 per cent. Physiological saline as a solvent was tried, but a white precipitate was formed on stand.

IV administration of small amounts of collargol [20 nm metallic silver particles] produced a stimulation of the endothelium. The animal's health remained unimpaired and the blood counts were normal.

Human Health Perspective



Particle Sizes of Common Colloidal Silver Products

Product	Use	Particle Size (nm)	Reference
Argyrol	Anti-Infective (early 1900s)	35	DLS Study, NanoHorizons, 2009.
Collargol	Anti-Infective (early 1900s)	10-20	Muller, 1926 (1). Bogdanchikova, 1992 (2).
Mesosilver	"Dietary Supplement"	2	DLS Study, NanoHorizons, 2009.
Protargol	Anti-Infective (early 1900s)	2	Bogdanchikova, 1992 (2).

- (1) Experimental Bone Marrow Reactions: I. Anemia Produced by Collargol. Muller, G.L. The Journal of Experimental Medicine, Vol 43, 533-553, (1926).
- (2) Activity of colloidal silver preparations towards smallpox virus, Pharmaceutical Chemistry Journal, N. E. Bogdanchikova, A. V. Kurbatov, V. V. Tretyakov, P. P. Rodionov. 26, 9-10, 778 (1992).

