Antibacterial Nano-Se Coating

AxenaTechnologies

Antibacterial Nano-selenium Coating For HVAC

Developed by
Nanomedicine Laboratory
Brown University, USA

Man Loong Leong
Axena Technologies (Asia) Sdn. Bhd.

Introduction

Brown University – Ivy league institution founded in 1764 in Providence, RI USA.

Nanomedicine Laboratory – World leader in nano-medicine research and development.

Man Loong Leong – Contributes two patents for JCI.


(WO/2005/044446) NANO COMPOSITE PHOTOCATALYTIC COATING

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(WO/2005/044446) NANO COMPOSITE PHOTOCATALYTIC COATING

Bibliographic Data | Description | Claims | National Phase | Notices | Documents

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Applicants: YORK INTERNATIONAL CORPORATION [US/US]; 631 South Richland Ave., York, PA 17403 (US) (All Except US).
LEONG, Man Loong [MY/MY]; No. 1, Lorong IM 11/1, Astana Golf & Country Club, Pahang, 25200 Kuantan (MY) (US Only).

Inventor: LEONG, Man Loong [MY/MY]; No. 1, Lorong IM 11/1, Astana Golf & Country Club, Pahang, 25200 Kuantan (MY).

Agent: SATTIZAHN, Brian, T.; McNees Wallace & Nurick LLC, 100 Pine Street, P.O. Box 1166, Harrisburg, PA 17013 (US).

Title: NANO COMPOSITE PHOTOCATALYTIC COATING

Abstract: A photocatalytic coating composition and method of coating articles, the composition containing solvents for rapid evaporation at room temperature, polyalkylphenylsiloxane, xylene, nano densified hydrophilic fumed silica, nanostructured composite photocatalyst powder and nano inorganic anti-bacteria powder. The coating may be applied by conventional coating methods to organic or inorganic structured surfaces where photocatalytic activity is desired, such as in a forced air-circulating environment. Once applied, the coating quickly dries to leave an adherent, flexible, durable, and long-lasting photocatalytic coating having a large surface area and exhibiting high surface activity against pathogens and pollutants such as bacteria, viruses, mold, fungi, and volatile organic compounds. Although, the applicants ...

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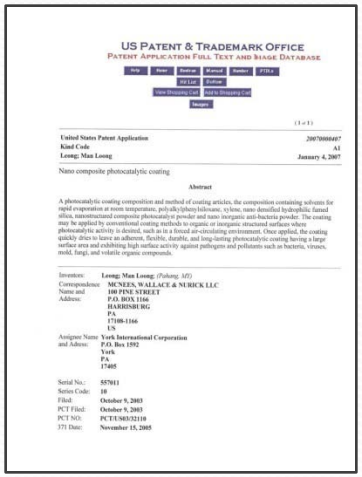
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(1 of 1)

United States Patent Application 20070086687

Kind Code A1

Leong; Man Loong January 4, 2007

Nano composite photocatalytic coating

Abstract

A photocatalytic coating composition and method of coating articles, the composition containing solvents for rapid evaporation at room temperature, polyalkylphenylsiloxane, xylene, nano densified hydrophilic fumed silica, nanostructured composite photocatalyst powder and nano inorganic anti-bacteria powder. The coating may be applied by conventional coating methods to organic or inorganic structured surfaces where photocatalytic activity is desired, such as in a forced air-circulating environment. Once applied, the coating quickly dries to leave an adherent, flexible, durable, and long-lasting photocatalytic coating having a large surface area and exhibiting high surface activity against pathogens and pollutants such as bacteria, viruses, mold, fungi, and volatile organic compounds.

Inventors: Leong; Man Loong (Pahang, MY)

Correspondence Name and Address: MCNEES, WALLACE & NURICK LLC
100 PINE STREET
P.O. BOX 1166
HARRISBURG
PA
17108-1166
US

Assignee Name and Address: York International Corporation
P.O. Box 1592
York
PA
17405

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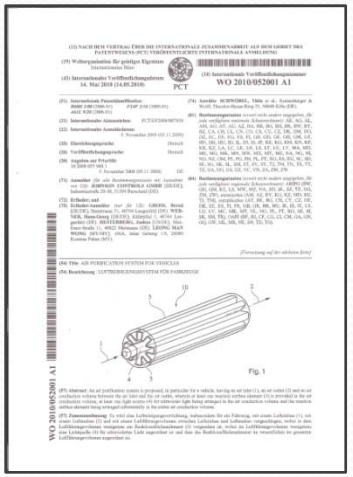
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Fig. 1

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WO 2010/052001 A1

Nano Composite Photocatalytic Coating
(USA and PCT patent filing)

Air Purification for Vehicles
(EU and PCT patent filing)

What is Selenium?

- Periodic Symbol: Se
- Atomic number: 34
- Non metal

- A safe FDA approved Micronutrient.
- Occurs in several forms: Black, gray, and red selenium.
- USDA recommends daily consumption.
- Vitamin supplement sold over the counter.

Benefits of Selenium (Se)

- Important antioxidant.
- Significantly reduces the risk of cancer.
- Inhibits harmful free radicals that damage cells.
- Lowers the risk of coronary artery disease.
- Helps regulate blood pressure.
- Aids gland function and regulates hormones.
- Essential for tissue elasticity.
- Strengthens the immune system.

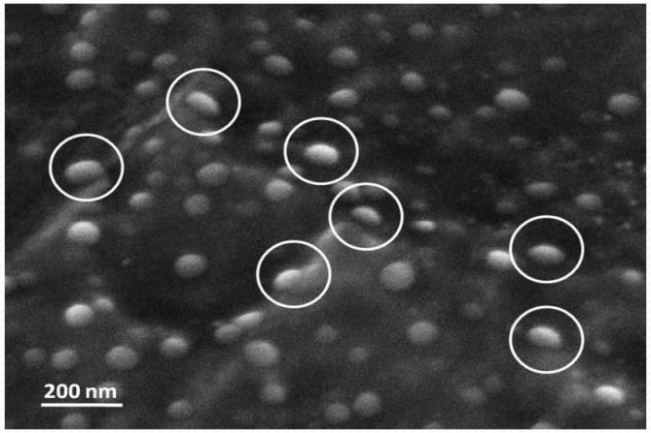
Common Selenium Food Sources

Selenium is found in many common foods, including rice, meats, and vegetables.

Foods with high amounts of selenium:

- Brazil nuts
- Mushrooms (button, shiitake, reishi)
- Fish (cod, flounder, halibut, herring, mackerel, salmon, tuna)
- Seafood (lobster, oyster, scallops, shellfish, shrimp)
- Eggs

Introducing N-Se Protector 101



- Developed at the Nanomedicine Laboratory at Brown University, U.S.A.

- Non-toxic microbial nano-coating.
- Enhances the antimicrobial properties of elemental selenium by reducing selenium particle size into the nano-scale.
- Effectively kill and prevent microbes growth up to 99.9%.
- Good adhesion and washable.

Advantages of N-Se Protector 101

- Effectively kills bacteria, fungi and mold.
- Does not generate any Volatile Organic Compound (VOC)
- Does not release anions or negative ions to the environment.
- Destroys airborne pathogens without ozone exposure.
- Increases the efficiency of coated filters.
- No special maintenance required.
- Cost effective and easy to apply.
- Safe, environmentally friendly ingredients.

Advantages of N-Se Protector 101 (Continue)

Standard, untreated filtration

	Removes Large Particles	Removes Biological VOC's	Eliminates Mold	Eliminates Bacteria	Eliminates Viruses
Conventional air filters	Yes	No	No	No	No
HEPA filters	Yes	No	Yes	No	No

N-Se Protector 101 Treated Filtration

	Removes Large Particles	Removes Biological VOC's	Eliminates Mold	Eliminates Bacteria	Eliminates Viruses
Conventional air filters	Yes	**Yes**	**Yes**	**Yes**	**Yes**
HEPA filters	Yes	**Yes**	Yes	**Yes**	**Yes**

Application Of N-SeProtector Treatment Nano-selenium: Simple and Robust Process

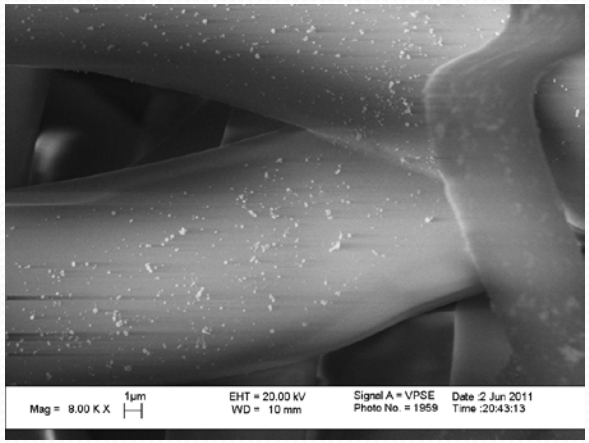
- **Spray or dip coat-process treatment**
- **No special maintenance**

- No effect on HVAC system, including:
  - Air flow
  - Energy consumption
  - Installation
  - Weight
  - Spacing
  - Pollutant loading
  - Pressure
  - Temperature
  - Moisture

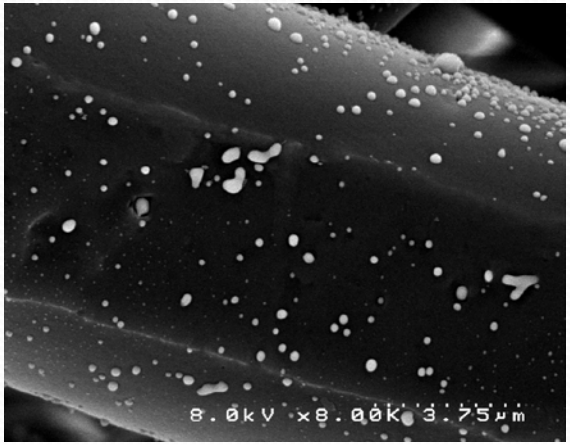
Treatment of Filters with N-Se Protector 101

Application of N-Se Protector 101 to filters is a simple and robust process.

No special maintenance is necessary with treated filter material.



Selenium nanoparticles on standard filter fiber.

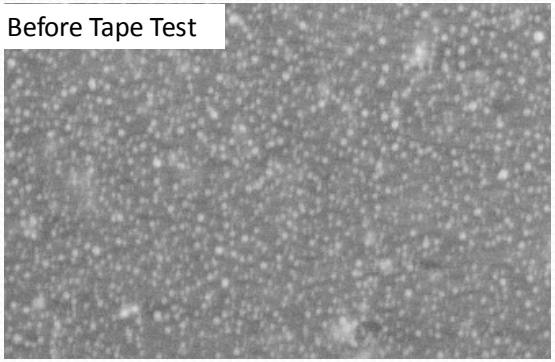


Selenium nanoparticles on HEPA filter fiber.

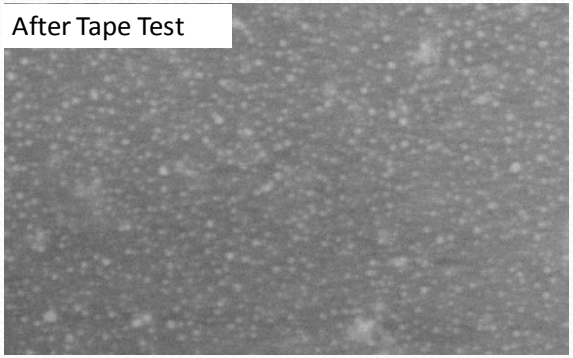
Adhesion of N-Se Protector 101 to filters

Selenium nanoparticles are firmly attached to fibers when filters are treated with N-Se Protector 101.

- Fluid vortex and sonication has no effect on coating durability.
- Adhesion strength was also tested against ASTM standard tape testing with ***no observable impact***.



Left: SEM image at 8000X magnification of selenium nanoparticles before tape test.

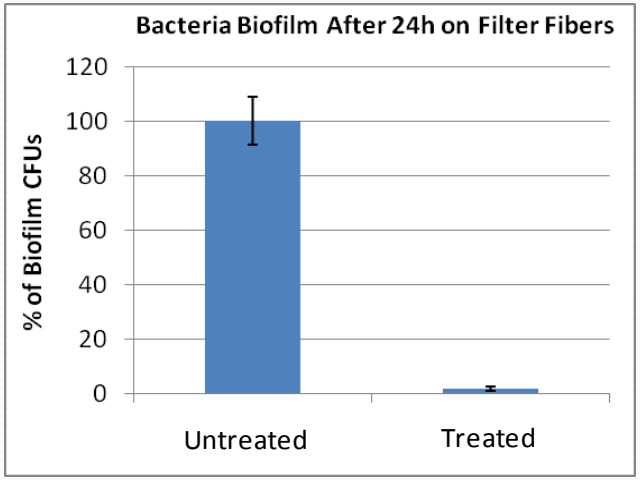


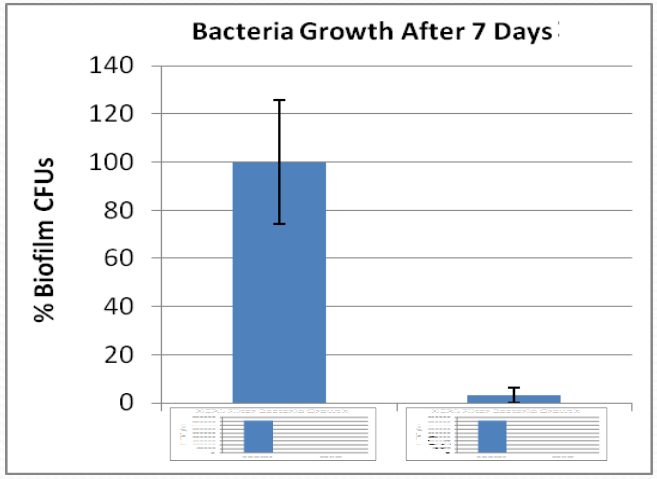
Right: SEM image of the same position after tape test (image quality is degraded due to extended imaging of the same position).

Effectiveness of N-Se Protector 101

- Treated materials saw up to a 2-log reduction in pathogen biofilm growth, which is equal to 99% reduction in colony forming units (CFUs) of pathogens.

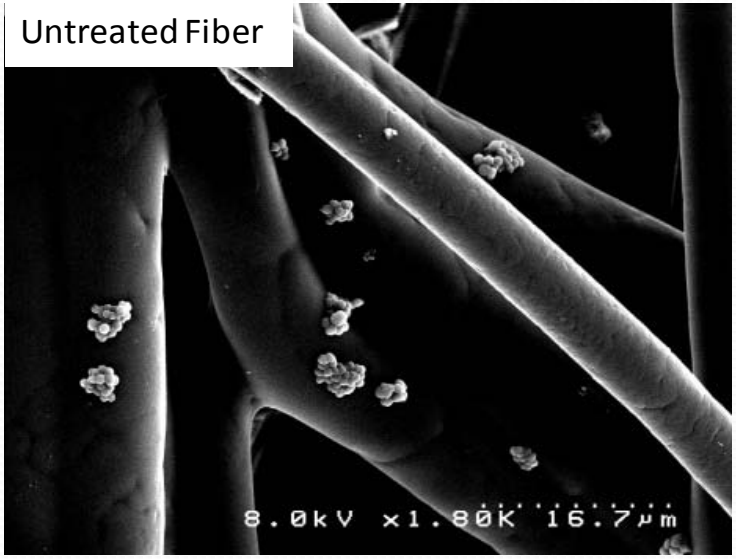
- The nano-selenium coating was also shown to be effective for extended periods of time.





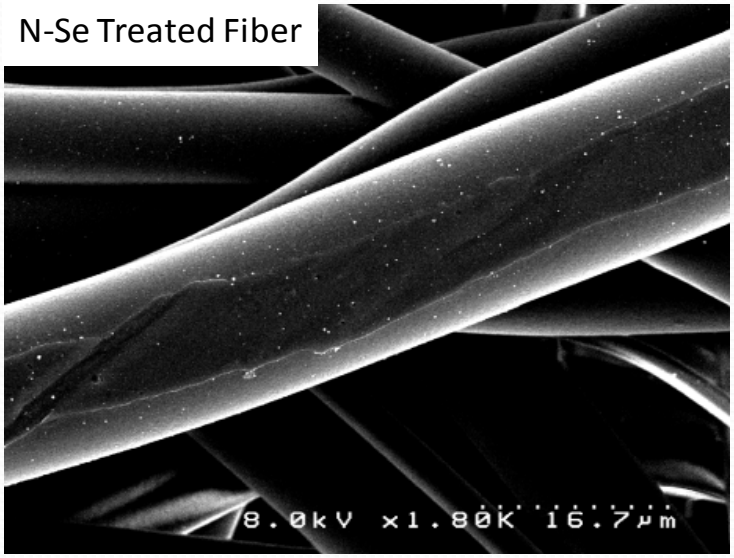
Effectiveness of N-Se Protector 101 (Continue)

Untreated Fiber



Left: SEM image under 1800X magnification of uncoated fiber showing bacteria colonization.

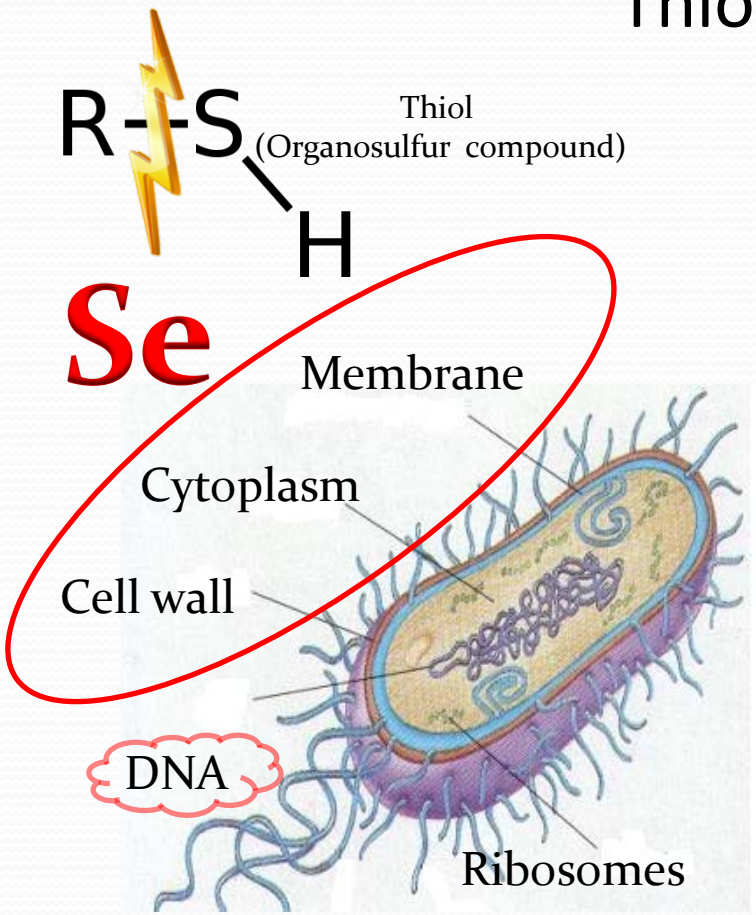
N-Se Treated Fiber



Right: SEM image under 1800X magnification of coated fiber showing selenium nanoparticles and no bacteria colonization.

How Nano-selenium Works:

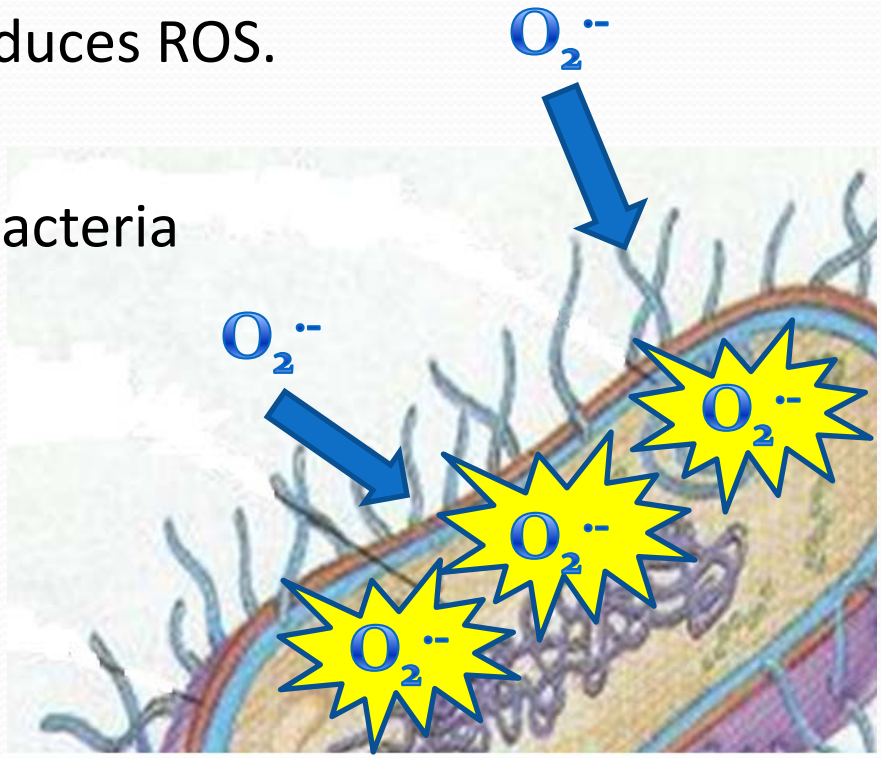
Thiol Depletion



- Thiols protect against dangerous Reactive Oxygen Species (ROS).
- Structures closer to Se more vulnerable.
- Selenium breaks carbon-sulfur bonds of thiols.
- Nano-selenium also creates DNA instability by breaking zinc proteins.

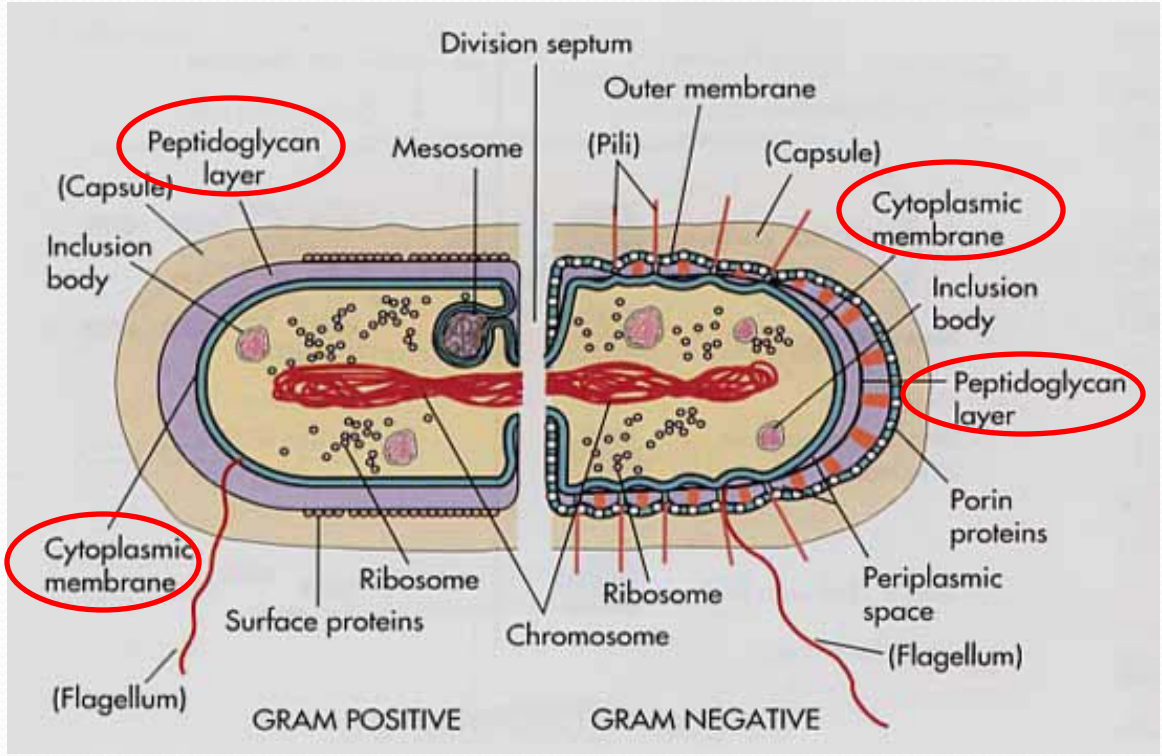
No Thiols – Bacteria Kill Themselves

- ROS occur naturally occur in environment.
- Bacteria metabolism also produces ROS.
- Without thiols, ROS destroy bacteria systems.



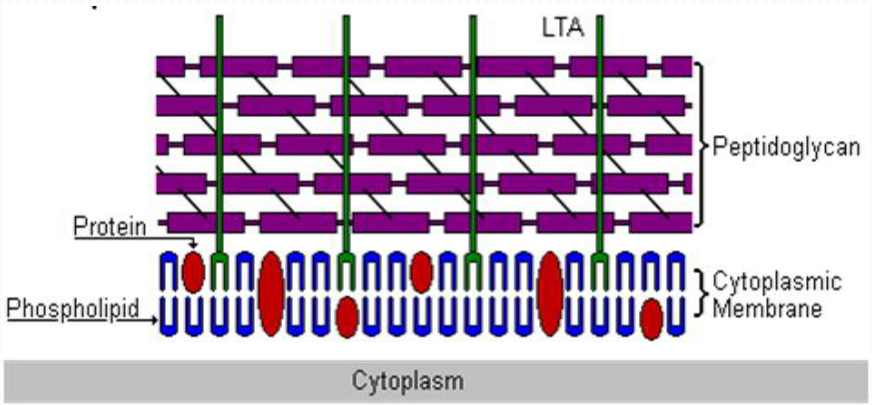
Antibacteria Capability of N-Se Protector 101

Bacteria Cell Structure and Targets

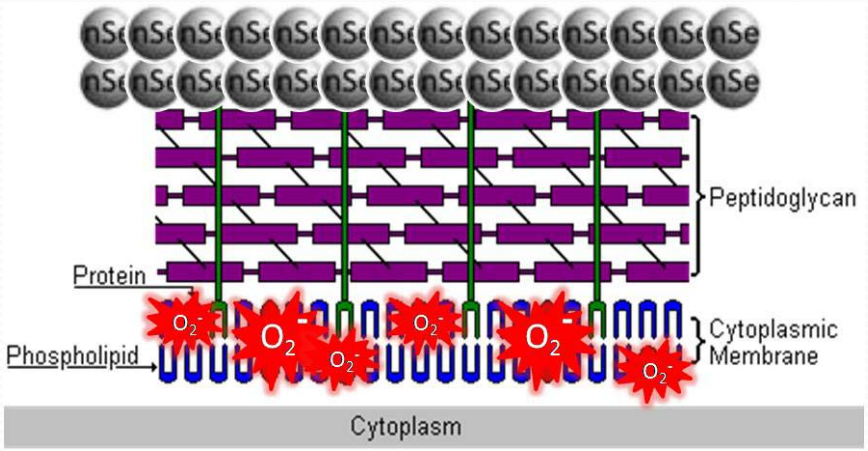


Antibacteria Capability of N-Se Protector 101 (Continue)

Attack on Cytoplasmic Membrane (Gram Positive Cell Wall)



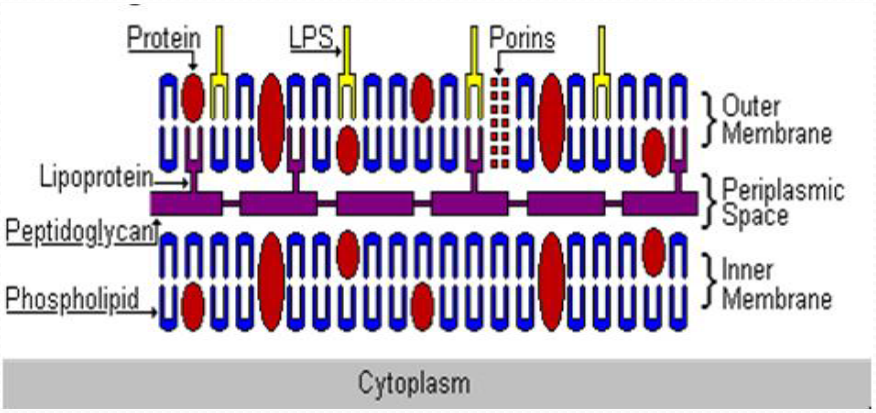
Before oxidizing thiols.



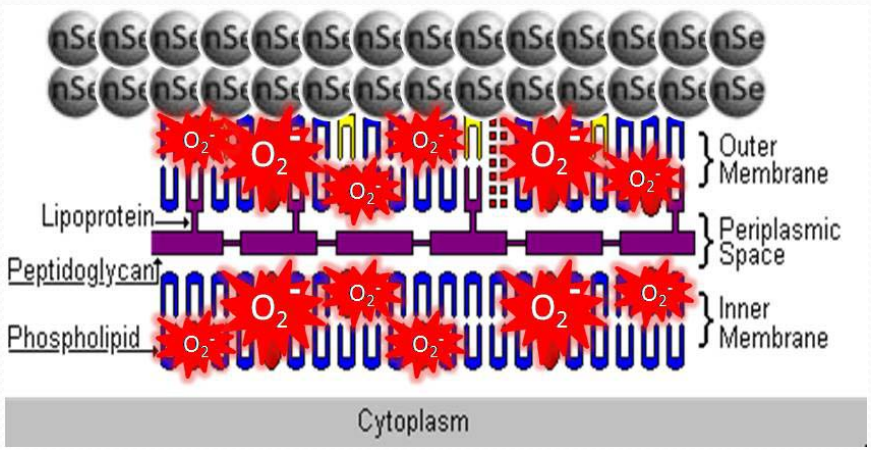
The depletion of thiols allows self-produced and naturally occurring ROS to destroy cell systems.

Antibacteria Capability of N-Se Protector 101 (Continue)

Attack on Cytoplasmic Membrane (Gram Negative Cell Wall)



Before oxidizing thiols.



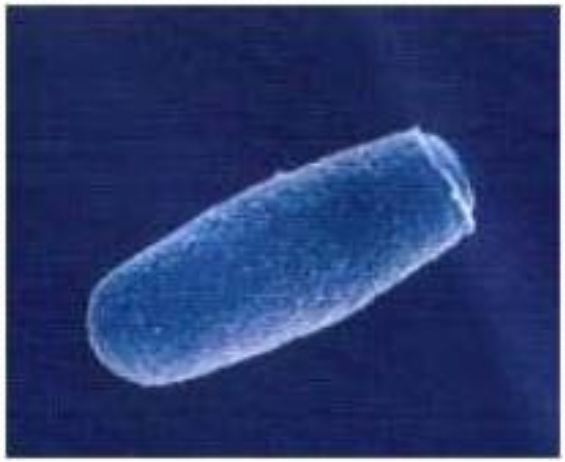
The depletion of thiols allows self-produced and naturally occurring ROS to destroy cell systems.

Antibacteria Capability of N-Se Protector 101 (Continue)

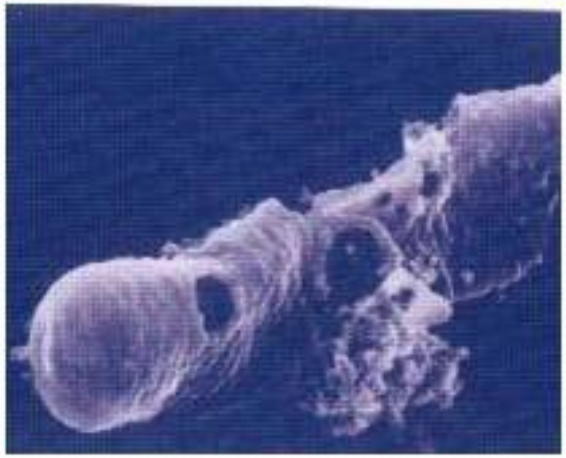
The depletion of thiols and its protective functions has the following effects:

- Natural and self-produced ROS damage the cells' systems and structures.
- Osmotic stress from the internal loss of potassium ions and water, which can induce cell shock.
- Prevent microbial growth in low pH environments.
- Prevent microbial growth in low reduced sulfur environments.

Anti-Bacteria Capability of N-Se Protector 101 (Continue)



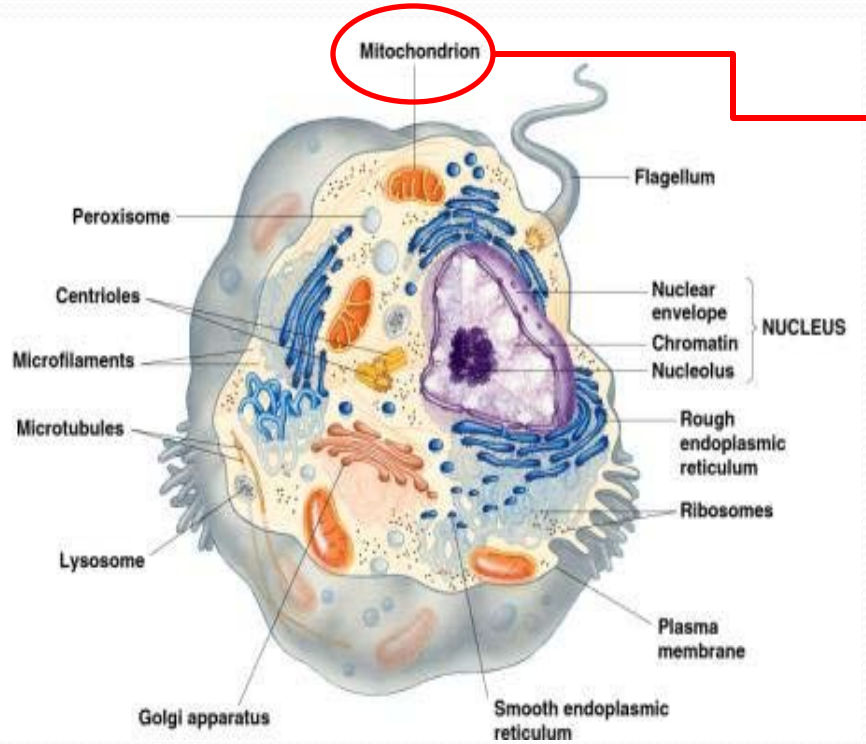
A scanning electron micrograph of bacteria cell before the inhibition of cell wall synthesis, inhibition of protein synthesis and disruption of cytoplasmic membrane.

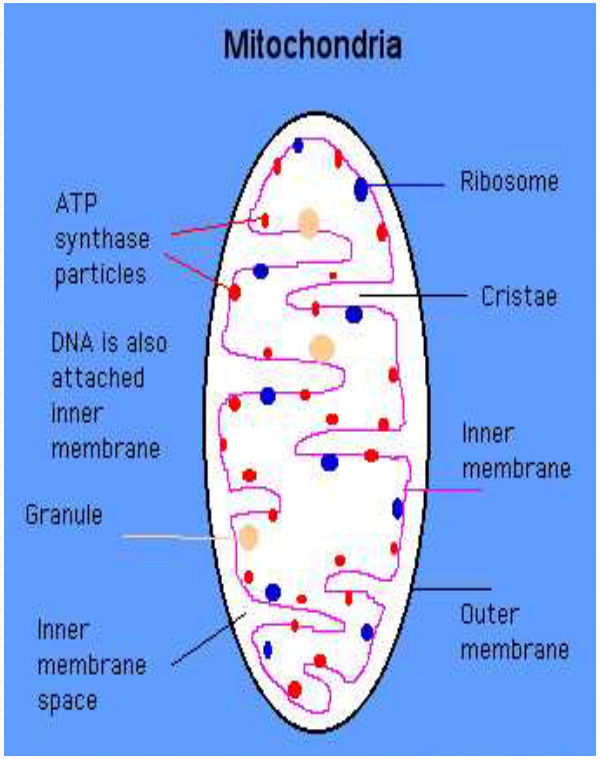


A scanning electron micrograph of bacteria cell bursts from osmotic pressure due to the integrity of peptidoglycan is not maintained. This is due to the followings:

a. *Inhibition of cell wall synthesis where bacteria cell walls are destroyed.*
b. *Inhibition of metabolic pathways.*
c. *Disruption of cytoplasmic membranes.*

Antifungal Capability of N-Se Protector 101

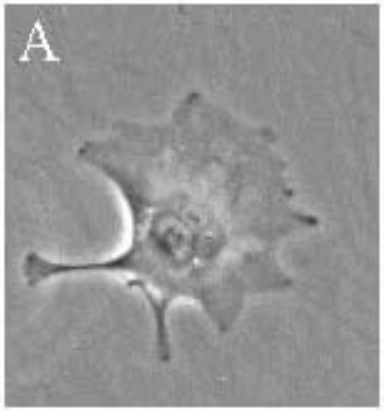




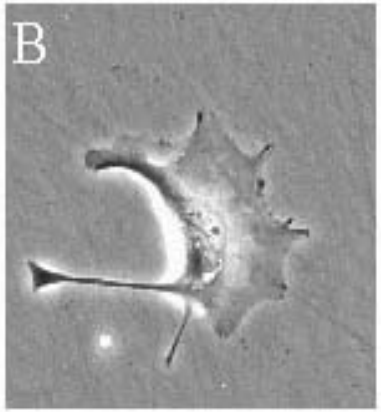
Eukaryotic Cell

Antifungal Capability of N-Se Protector 101 (Continue)

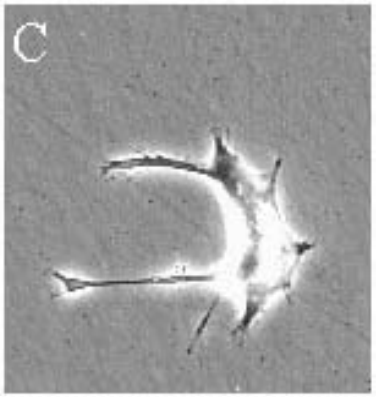
Attack on Fungal Cell Wall (Apoptosis or Cell Suicide)



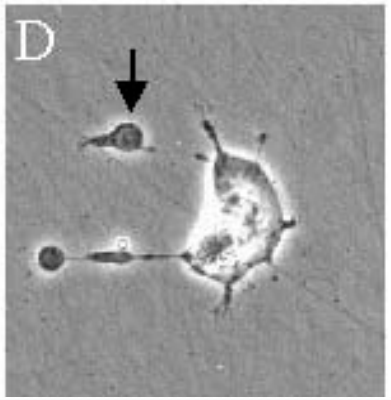
The breakdown of chromatin (combination of DNA and proteins) in the nucleus.



Cells continue to shrink.



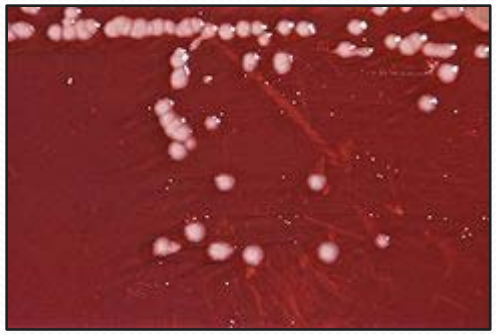
Packaging themselves into a form that allows for their removal by macrophages.



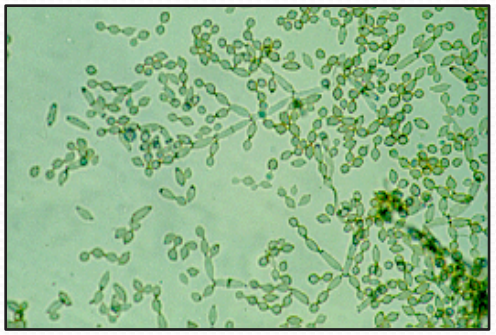
Blisters process. The arrow shows the small vesicles called apoptotic bodies are also sometimes observed.

Common Airborne Microbial Pathogens Associated With HVAC Systems

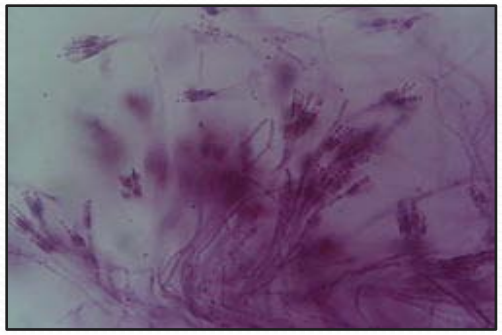
Legionella pneumophila
Detected in cooling tower.
Legionnaire's disease & pontiac fever.



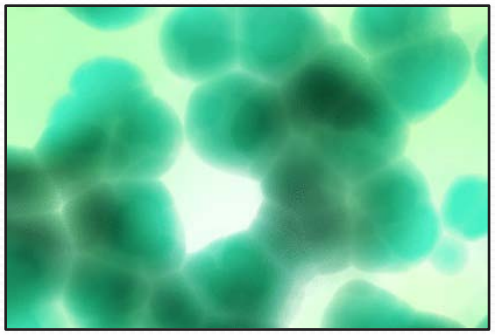
Pseudomonas aeruginosa
Potable water to stagnant water.
Inflammation and sepsis in lungs, urinary tract and kidneys.



Cladosporium cladosporioides
Fungi in cooling coils.
Hypersensitivity pneumonitis.



Penicillium corylyphilum
Fungi in dirty HVAC system.
Allergenic.



Endotoxins
Any watery area.
Respiratory system.

Combination of Nano Selenium coated filters and Nano TiO2 Photocatalytic Oxidation

Photocatalytic Oxidation is now a recognized technology by US Environmental Protection Agency (EPA).

- Air is cleaned and sterilized when flow through the Nano TiO2 PCO system.
- No trapping.
- Eliminate virus, bacteria, fungi, smoke, odor, biological VOC's and VOC's.

Nano Selenium Coating by Brown University is the newest microbial coating in the world.

- Air is cleaned and sterilized through "trap and kill" approach.
- Eliminate virus, bacteria, fungi and biological VOC's.

The Advantages of the Combination of these two technologies:

- Kills virus, bacteria and fungi.
- Removes air particles.
- Removes biological VOC's and VOC's.
- Removes smoke and odor.
- Double assurance of air pathogens killing efficiency.

Advantages of Nano Selenium coated filters Compared to other technologies

	Nano Selenium Coated Filter	Electrostatic Precipitator	HEPA Filter	UVGI
Removes Large Particles	✓	✓	✓	
Removes Biological VOC's	✓			✓
Kills Fungi	✓			✓
Kills Bacteria	✓			✓
Kills Virus	✓			✓
Zero Electricity Requirement	✓		✓	
Small Pressure Drop	✓			
Zero Ozone Exposure	✓		✓	
Washable	✓	✓	✓	
Latest Technology	✓			
Low Cost	✓			

The Recurrence of H5N1 in 2011

- The Food and Agriculture Organization of the UN
  - **8 people have died in Cambodia**
- World Health Organization (WHO)
  - **151 people have been infected in Egypt**
- Hong Kong's Hospital Authority (HA)
  - **27 year old female certified dead on Jan 27, 2011**

Virologists warned that there was no vaccine against the latest mutant strain of H5N1 bird flu. ***Reuters (August 30, 2011)***

N-SeProtector 101 – Market Opportunity

Market Differentiation	• Newest, non-toxic microbial technology in the world
Leading Technology	• Technology developed by world renowned Brown University in USA.
Global Demand	• Reoccurrence of H1N5 in Asia especially in Hong Kong and China
Higher Value, Enhance Product	• High performance microbial filter, economical price

THANK YOU