THE SILVERINSTITUTE

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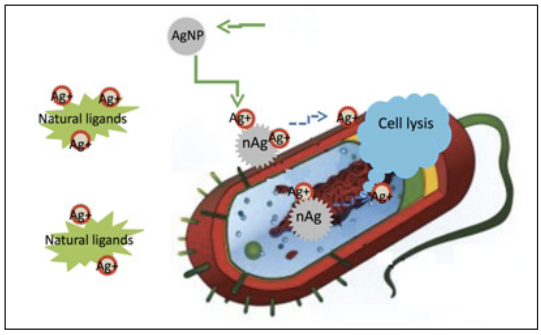
Silver News

Tests Show That Silver Ions – Not Nanoparticles Themselves – Help Kill Bacteria

Researchers Hope that Experiments End Nanoparticle Debate



ZONGMING XIU/RICE UNIVERSITY

New research at Rice University found that silver ions, and not the nanoparticles themselves, appear toxic to bacteria.

The antibacterial properties of silver nanoparticles are the result of the release of silver ions and are not caused by the nanoparticles themselves, according to recent research. This is important to the study of alleged nanoparticle toxicity because it shows that nanomaterials - just because of their size - are not dangerous.

According to researchers at Rice University, and reported in the American Chemical Society journal *Nano Letters*, scientists and others have known for a long time about silver's antibacterial properties. When silver nanoparticles appeared on the scene, some observers questioned their safeness and that of other nanoparticles. Some had suspected silver nanoparticles themselves may be toxic to bacteria, particularly the smallest of them at about 3 nanometers. Not so, according to the Rice team.

Indeed, when the ionization property is taken away from the silver, the nanoparticles are practically benign in the presence of microbes, said Pedro Alvarez, George R. Brown Professor and chair of Rice's Civil and Environmental Engineering Department. "You would be surprised how often people market things without a full mechanistic understanding of their function," said Alvarez, who studies nanoparticles in the environment and their potential toxicity, particularly to humans. "The prefix 'nano' can be a double-edged sword. It can help you sell a product, and in other cases it might elicit concerns about potential unintended consequences."

Alvarez and others suggest that the insoluble silver nanoparticles do not kill cells by direct contact. But the soluble ions, when activated by oxidation in the vicinity of bacteria, kill microbes.

During their tests, the researchers controlled the release of the silver ions by placing them in a chamber without oxygen and testing their toxicity to bacteria. They thought that the size had something to do with it. Instead, they could not get any changes based solely on nanoparticle size, which ranged from 3 to 11 nanometers. "We could not get consistent results," he said. "It was very frustrating and really weird," said Zongming Xiu, a Rice postdoctoral researcher and lead author of the paper. "We found the particles, even up to a concentration of 195 parts per million, were still not toxic to bacteria," Xiu said. "But for the ionic silver, a concentration of about 15 parts per billion would kill all the bacteria present."

"Ultimately, we want to control the rate of (ion) release to obtain the desired concentrations that just do the job," Alvarez said. "You don't want to overshoot and overload the environment with toxic [to bacteria] ions while depleting silver, which is a noble metal, a valuable resource – and a somewhat expensive disinfectant. But you don't want to undershoot, either."

continued on page 3

An Interview with James Turk, Co-Founder of GoldMoney

James Turk and his son Geoff Turk founded GoldMoney in 2001 as a way for customers to make the purchase and storage of gold -- and later silver, platinum and palladium -- over the internet. The company currently stores more than $1.9 billion in assets for more than 22,000 customers. We spoke to James Turk about his firm and the outlook for silver.

James Turk

SN: Describe the idea of GoldMoney. What was the impetus for its creation?

Mr. Turk: GoldMoney is based on a simple concept. Namely, gold has been money for 5,000 years, and it is just as useful as money today as at any time in the past – perhaps even more so now because gold is undervalued. The same is true for silver, which actually was more frequently used as money throughout history than gold. Our aim is to provide our customers with a convenient, economical and, most importantly, safe way for them to buy, store, and sell precious metals.

SN: Discuss the addition to your company of "SilverMoney."

Mr. Turk: Once we launched, we began receiving a lot of feedback from our customers. While they liked what we were offering with gold, they also wanted silver. We therefore added it, and later added platinum and palladium as well.

SN: Describe the available silver products and how the system works for buying, selling, storage, security, etc. Can you offer some statistics on sales, holdings?

Mr. Turk: The process is very simple and very convenient because access is provided through the Internet 24/7 wherever you happen to be. The first thing is to open a Holding, which is free. Because of regulations, we need to confirm our customer's identity, which can be done online in North America and the UK in minutes. The next step is to wire money to make a purchase, which is shown in your Holding and held in a customer- segregated funds account at a bank until you are ready to purchase. When ready, you place an order from your Holding. There is no minimum or maximum amount.

We now safeguard approximately 27 million ounces of silver and over 20 tons of gold owned by our customers. Like gold, the silver is stored in secure bullion vaults in Canada, Hong Kong, Switzerland, and the UK, which are insured and regularly audited. These audit reports are available to our customers when they login into their Holding.

SN: In general, who are your customers for silver money? Are they investors, traders…? What are their reasons for buying silver from you?

Mr. Turk: It is hard to make a sweeping generalization about our customers, given that they live in over 100 countries. It is a diverse group, but there nevertheless is one clear theme. The vast majority see precious metals as a safe haven, which, of course they are, because physical gold and physical silver are tangible assets. So they do not have counterparty risk, meaning their value is not dependent on any governments or any bank's promise. Gold and silver are valuable because the market chose them as money thousands of years ago. Gold and silver do not need some government imprint to make them valuable. But here's an important point. Those unique attributes that made them as money in the first place have not disappeared. Rather, they have simply been ignored or forgotten, which is why precious metals are so undervalued at present. So as well as gold and silver have done over the past decade, I expect their price to continue to rise. Not only are they undervalued, but gold and silver are the ultimate safe haven from the ongoing financial and monetary turmoil wreaking havoc around the globe.

SN: How often do people take possession of physical silver?

Mr. Turk: Rarely. Storing silver can be inconvenient, so one reason our customers choose us is to make storing their silver safe and convenient. Also, in many countries – and indeed in all of Europe, where we are based – governments levy a value-added tax. If the silver a customer owns is removed from the bonded vaults we use, the tax is immediately due and payable. In the UK, for example, the tax is 20 percent, which is comparable to most European countries. This high tax is another deterrent that keeps people from taking possession of their silver.

SN: Gold and silver prices have traditionally tracked each other. Some suggest this relationship is fraying because of the increasing use of silver as an industrial metal. Your thoughts?

Mr. Turk: First, gold and silver prices do generally track each other in that they both rise in bull markets and fall in bear markets. However, that is where the comparison ends. When looking at the relationship of prices compared to each other, it is clear that silver is more volatile. For example, in April 2011, one ounce of gold was equal to 31 ounces of silver. A few months later, it took 58 ounces of silver to equal one ounce of gold. I think it is important to follow this gold/silver ratio to see the relative performance of these two precious metals to better understand their respective demand, which brings me to the second point.

> "I'm very bullish for both the near-term outlook for silver as well as for its prospects over the next few years. The silver price will be increasingly driven by monetary demand."

The demand for gold and silver are different in one important way. Demand for gold is driven by monetary factors. Gold's usefulness in economic calculation explains why gold is fabricated into bars, coins and high-karat jewelry and stored in safe places. Gold's value comes from its monetary usefulness first and foremost, and the few ways it is used in other areas is inconsequential to the demand for gold as money. In contrast silver has both an industrial component as well as a monetary dimension, like gold. These two demands interact with one another and explain why silver is so volatile compared with gold, as evidenced by the big swings in the gold/silver ratio.

SN: What's your outlook for silver in terms of demand, price, etc.

Mr. Turk: I'm very bullish for both the near-term outlook for silver as well as for its prospects over the next few years. The silver price will be increasingly driven by monetary demand. I base this conclusion on two things. First, the gold/silver ratio is in the 50s, which is much higher than its historical average of 16. That means silver is undervalued relative to gold, which leads to the second point. Owning 58 ounces of silver accomplishes the same thing one ounce of gold. It is a liquid safe haven for your money outside the banking system.

If you can accept the higher volatility that comes with silver, I recommend owning some because it is likely to do even better than gold in the months and years ahead. Even if the gold/silver ratio doesn't reach 16 again, I expect it will fall to at least 20, which is a long way from the present level around 58 and portends significant outperformance by silver relative to gold.

continued from page 1

According to Alvarez, his experiments move the debate from the size, shape and coating of silver nanoparticles to the amount of ions that are released. “The key determinant of toxicity is the silver ions, so the focus should be on mass-transfer processes and controlled-release mechanisms.”He suggested that one way of controlling the release of silver ions is through polymer coatings that hold the silver and disperse it at intervals based on time or environmental conditions.

The work was supported by a joint U.S.-U.K. research program administered by the U.S. Environmental Protection Agency and the U.K.’s Natural Environment Research Council.

Silver-Oxygen Catalyst Helps Speed Industrial Processes

Engineers are always on the lookout for new ways to save money, prevent waste and speed chemical processes involved in consumer and industrial applications. Traditionally, they have used catalysts to increase the speed of reactions and recently have discovered that silver – placed in a specific nanostructure pattern – can act as a catalyst to promote reactions at low temperatures using safe and abundant materials like oxygen.

Chinese researchers report that the silver-based catalyst draws oxygen from the air and converts it into a chemically reactive form that speeds the production of industrial chemicals. These chemicals are often starting points, also called precursors, for the ultimate production of chemical products. Unlike previous oxygen-using catalysts, this technique can be performed at low temperature which is important because it takes energy to produce a high-temperature environment for chemical reactions to take place. Lower temperature means lower costs.

Another advantage of this technique is that only oxygen and silver are used. In many catalysts, harsh, even toxic chemicals are employed to help move along a chemical process. These additional substances are not only dangerous to workers but costly and leave behind hazardous waste after they have been utilized.

The silver-oxygen catalyst is also helping chemists learn more about how to better use oxygen for other chemical processes and other applications for silver. Oxygen is a very stable substance and is actually very slow to react with other chemicals (think of rust, which is oxygen mixing with iron). Because of this stable configuration, individual oxygen atoms must be broken apart before they can react with other chemicals. The new catalyst breaks the oxygen atoms apart thus freeing them to combine and react with other chemicals and form new substances. By watching the catalyst work, scientists are learning more about how silver atoms react with other substances which many lead to additional applications for the catalyst and silver itself.

The new catalyst is still in the development state and more testing is being done to show how it can be used in a wide range of industrial applications.

First Pomegranates; Now Strawberry Tree Leaves Used to Produce Silver Nanoparticles

On the heels of scientists who are using pomegranates as a safe, non-toxic method for producing silver nanoparticles, (June, 2012 *Silver News*) researchers from Greece and Spain have synthesized the nanoparticles by using strawberry tree leaf extract.

The benefit of both of these fruity techniques is that unlike traditional methods for making silver nanoparticles, these techniques may reduce the need for toxic or hazardous chemicals to be used in the process.

By mixing silver nitrate and the leaf extract, scientists at the Aristotle University of Thessaloniki in Greece and Madrid’s Carlos III University immediately produced silver nanoparticles within several minutes of stirring the mixture.

Not only is the method fast and safe, but it can control the size of the produced particles from 5 to 40 nanometers. The method can also form different particle shapes including spheres, pyramids or cubes. In addition, the nanoparticles remain stable for up to 6 months.

As with the pomegranate technique, the leaf extract acts a reducing agent, pulling silver out of the silver nitrate and then stabilizing the product by producing an organizing layer around the particles.

Strawberry leaves offer an inexpensive, non-toxic way to extract silver particles from chemicals such as silver nitrate.

Low Temperature Silver Ink Printing Promises Smaller, More Powerful Electronic Gear

Is there a limit to how small an electronic gadget can be made while increasing the number of circuits and components it contains?

Not yet.

One of the ways in which smartphones, for example, are becoming more powerful in smaller packages is by embedding thin silver circuitry onto surfaces that take the place of wires and even some components like resistors and switches. While this idea is not new, component producers were hitting a wall because they could not make ‘silver inks’ that could be printed with everyday printing machines.

Now, Xerox reports that it is embedding silver particles just five nanometers in size onto circuit boards – and the silver ink melts at less than 140 degrees C. This lower than usual melting point (silver usually melts at 962 degrees C) means that the process is cheaper relative to other ‘printing’ techniques because it can be accomplished using inkjet printers.

The company’s PARC research center in Palo Alto, California, is developing new ways to use the inks such as producing display screens, sensors, RFID antennas and individual components by layering the inks on top of each other in complex, 3-dimensional shapes.

A Survey of New Forms of Antimicrobial Silver in Construction Applications

by Jeffrey R. Ellis, Senior Technology Consultant to the Silver Institute

Silver has a long history of construction applications. Impregnation of building interior wood framing with silver nitrate has long been used to prevent microbial and mold attack.

Silver as an antimicrobial is also used in construction industry adhesives and sealants. Especially for commercial buildings that are used for food processing and for medical treatment, silver is also a component of the surfaces of walls and flooring. In Europe, additional use has been seen in nursing homes and day-care centers. Research within the last ten years has also shown that many forms of silver and silver compounds are also effective as wood preservatives although adoption has been very limited because of cost issues. Silver has also been found to be effective against termites probably because it interferes with protozoan digestion of cellulose in the gut of these insects. An additional use that has achieved commercial utility is the use of silver based coatings in the duct work of climate control systems to minimize the growth of harmful organisms such as *legionella*.

Mold continues to be a concern for homeowners, builders, contractors, building managers and insurance companies. The combined damage and remediation from mold claims exceeds several billion dollars (U.S.) annually. Despite major efforts from insurance companies, architectural trade organizations, building code enforcers, and the Centers for Disease Control on measures to prevent dampness and promote immediate remediation for moisture leakage, mold is still a serious problem. The CDC has issued a recommendation that architectural paints contain a biocide additive to prevent mold and mildew formation on surfaces.

Many organic biocides that are used to prevent mold are not long lasting and have odor problems. Borates are inexpensive, but are also seen as having a limited lifetime. Silver is long-lasting, non-toxic to humans and pets, and with the development of new technologies that would use silver more efficiently, is likely to be more cost effective. Among these new technologies are spray formulations and the use of nanoparticle forms of silver metal. The use of ultra–small particles of silver will allow for efficient use by weight of the metal and at the same time allow for even faster biocide activity (usually within minutes) because of the large surface area of the nanoparticles.

Other factors that can influence the adoption of silver-based formulations is the adoption and enforcement of stricter building codes regarding mold prevention, and regulatory agency requirements regarding substantiation of biocide claims. The Silver Institute and the Silver Nanotechnology Working Group have been actively working successfully with the US Environmental Protection Agency and other regulatory agencies to develop policies that both advance technology and protect the public health and environment. A further possible source of growth in the use of silver for construction applications may be in making buildings safe against bioterrorism agents.

Based on results from previous research, it is anticipated that silver-based formulations, especially those containing nanosilver, will be further investigated to determine their effectiveness in preventing mold from infesting buildings. Of particular importance is determining whether these new products containing silver will be effective in preventing the formation of the initial biofilms on which mold, fungi, and mildew need to gain a foothold. With a revival of both commercial and residential construction, there are opportunities for significant uses of silver for protecting construction materials.

Silver Applied to Artificial Skin Reduces Infection Growth

Just as silver is being applied on a regular basis to help healing skin fight off infection, scientists have found a way to imbed silver in artificial skin to keep bacteria at bay.

This is an important move in infection control because artificial skin is extremely delicate and previous attempts to 'stamp' it with silver have resulted in damage to the man-made surface.

A multidisciplinary team of researchers from the University of Wisconsin-Madison, University of Colorado-Denver, and University of California, Davis, have described in the August, 2012 issue of *Annals of Surgery* their success in applying silver-imbedded artificial skin on mice.

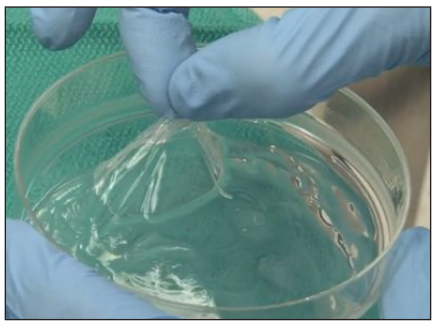
The team developed polymer nanofilms that contain precise amounts of silver nanoparticles that release over 10 days. They said they were influenced by sophisticated stamping techniques used in the electronics industry and developed a method to 'stamp' the nanofilms onto the soft bottom layer of commercially-available artificial skin. "One of the advantages of the nanofilms is that they don't change the properties of the dressings," said Dr. Michael Schurr, a corresponding author on the paper, formerly a clinician and professor of surgery at UW-Madison and now a professor of surgery in the University of Colorado School of Medicine. Until now it has not been possible to incorporate silver into artificial skin because traditional methods, such as 'dip-coating,' are too harsh on the delicate biological components in artificial skin, said Ankit Agarwal, a UW-Madison honorary research associate in chemical and biological engineering and co-lead author of the paper.

Schurr noted that about 20 percent of patients develop infection in their wounds. "The real question is bacteria in wounds. If you take an antibiotic pill, the antibiotics circulate through your body but don't really contact the surface of your skin. That's why we're heading to antibacterial dressings."

When applied to wounds or burns, artificial skin not only promotes healing but reduces pain. The man-made skin consists of two layers, the bottom layer that touches the wound and encourages new skin to grow through biological compounds and the top layer that protects the area. Silver is incorporated into the bottom layer.

The test results were promising. After applying the silver-imbedded artificial skin to wounds of various depth on mice, and then adding bacteria, the treated wounds showed slightly less bacteria after a short period of time.

The U.S. National Institutes of Health provided funding for the study.



WAKE FOREST SCHOOL OF MEDICINE

Artificial skin like this produced in laboratories can be stamped with silver to help stop the growth of bacteria.

Silver Essential for Concentrated Solar Power

By Samuel Etris, Senior Technical Consultant to The Silver Institute

Even though solar energy installations today largely make use of thin-film technology, the most proven and lowest cost large-scale solar power technology available today incorporates silver-coated mirrors. Their value has been shown, for instance, in commercial-scale, solar power plants now operating in the Mojave Desert for some 20 years. These plants have served the residential electrical demand of about 800,000 people in Southern California, and use an estimated 80,000 troy ounces of silver to coat the plant's 650,000 mirrors.

Two types of commercial solar power systems rely on silver-coated mirrors. Both concentrate sunlight onto heat collecting fluids whose temperatures reach 400C (735F) and turn water into steam to power steam turbines that generate electricity. The first type uses silver-coated mirrors of parabolic shape to focus the sunlight onto a heat-collecting pipe in the middle of a trough. The second type uses similar mirrors to focus the sunlight onto the heat-collecting point on a single high tower. The hot fluid system maintains its heat long after the sun goes down, a feature not possible with systems, such as photovoltaics, that convert sunlight directly into electricity.

The two mirror systems require a substantial plant to support and turn the mirrors to face the sun as it moves across the sky. The silver-coated mirrors also need low-iron glass for the best transmission of solar radiation to the silver backing. Ordinary glass, called green glass because of its iron content (common in all commercial bottles, windows, etc.), reduces the solar transmission input to the silver coating by some 8 to 10 percent. Green glass melts at a lower temperature, requiring less gas to heat the glass furnace. Because no glass manufacturer runs the low-iron glass continuously because of its melting cost, the changeover to produce iron-free glass as needed for the solar power plants is significant, resulting in a higher cost for mirror glass.

It is in the existing capital-intensive mirror system that the new 3M Solar Mirror Film 1100 promises to be a game changer. This adhesive-backed silver-coated plastic film provides the same solar reflectance as glass mirrors without their higher weight and special fabrication. The overall reduction in the capital costs of a plant using the 3M film is about 25 percent.

3M

A demonstration system that features 16,579 square feet of 3M Solar Mirror Film 1100 and the Gossamer Space Frames to mount the lighter-weight mirrors at the Sunray Energy facility in Daggett, California, home of the longest operating parabolic trough solar facility in the United States.

Upcoming Events

The 11th China International Silver Conference Slated for October in Xiamen

Registration is open for the 11th China International Silver Conference (CISC), which will be held in the scenic, coastal city of Xiamen, China from October 16-18, 2012.

The CISC has become the most highly recognized international silver conference in the world for market participants and offers attendees an excellent forum for networking and learning more about the increasingly important role that China plays in the silver market. With China launching their first silver futures contracts earlier this year, silver's role as an investment has grown even more prominent. Conference attendees will include silver industry organizations, leading global silver mining companies, refiners, manufacturers, government officials, investors, researchers, media, silver traders and futures brokers.

For more information on the CISC, and to register for the event, please visit the conference web site at: http://silver2012.metalchina.com/en.html

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