THE SILVERINSTITUTE

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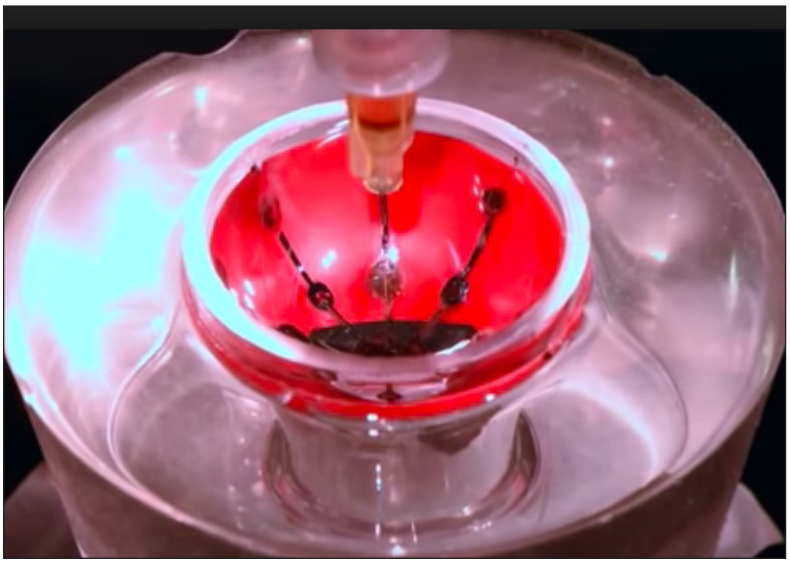
# Silver News



## A Bionic Eye Closer to Reality



UNIVERSITY OF MINNESOTA

Click the image to watch the bionic eye.

*"Bionic eyes are usually thought of as science fiction, but now we are closer than ever using a multi-material 3D printer."*

The dream of producing a bionic eye has taken a step closer thanks to silver.

The challenge of making such a prosthetic has always been to layer light-sensitive materials onto an orb without the distortion inherent in placing two-dimensional objects -- even thin ones like wires -- onto a rounded surface.

Researchers at the University of Minnesota claim to be the first to use a 3D printer to overlay light receptors on a hemispherical glass surface. Michael McAlpine, a co-author of the study *3D Printed Polymer Photodetectors*, and Associate Professor of Mechanical Engineering, said in prepared remarks: "Bionic eyes are usually thought of as science fiction, but now we are closer than ever using a multi-material 3D printer."

Using a custom-made 3D printer, the research team took a base ink of silver particles and sprayed it on the glass surface. Instead of running down the curved surface like other materials, the silver ink stayed where it was applied and did not drip. They then used semiconducting polymer materials to print photodiodes, devices that convert light into electricity. The process took an hour.

McAlpine noted that he was surprised by the efficiency they obtained in converting light into electricity – 25 percent.

He added: "We have a long way to go to routinely print active electronics reliably, but our 3D-printed semiconductors are now starting to show that they could potentially rival the efficiency of semiconducting devices made in microfabrication facilities. Plus, we can easily print a semiconducting device on a curved surface, and they can't."

McAlpine and his team are known for integrating 3D printing, electronics, and biology on artificial surfaces,

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including their work in producing sensitive bionic skin. (See *Silver-Silicone 'Fingertips' Allow Greater Touch*; June 2017 *Silver News*.)

Future research will focus on producing a prototype with a greater number and more efficient light receptors. They also will be working on a way to print on a hemispherical surface that is softer than glass so it can be implanted into a human eye socket.

The team's research was funded by the U.S. National Institute of Biomedical Imaging and Bioengineering of the National Institutes of Health, The Boeing Company, and the Minnesota Discovery, Research, and InnoVation Economy (MnDRIVE) Initiative through the State of Minnesota.

# Pig Skin and Silver Nanoparticles Help Heal Burn Wounds

Doctors often treat burn victims by covering the affected area with pig skin because the animal's skin is similar in many ways to that of humans. The temporary covering, known as a xenograft, allows the wound to heal until permanent skin grafting can be accomplished using human cadaver skin or artificial skin.

As with all grafting, the wound is subject to infection, so researchers from the Luis Guillermo Ibarra National Institute of Rehabilitation in Mexico City have developed a new therapy to treat second-degree burns that involves using silver particles to keep harmful bacteria at bay.

The wound covering is composed of sterilized pig skin, stems cells and silver nanoparticles. The goal is to keep the burn wound area moist, which promotes healing, while keeping it free from infection.

"Silver nanoparticles (AgNPs) represent a very good option as topical antibacterial agents to treat locally infected lesions or to prevent wound infections," researcher Roberto Sanchez, Phd. stated in the research paper in which he described the method. "Because of their size, AgNPs can penetrate the bacterial wall, affecting its integrity and consequently, the viability of bacteria."

Skin grafts from patients themselves are always the best course of treatment but it's not possible when the person is burned in over 50 percent of their total body area. This was the impetus for Sanchez's exploration into using this technique.

# Silver and Lasers Hold Promise to Kill One of the World's Most Common Fungi

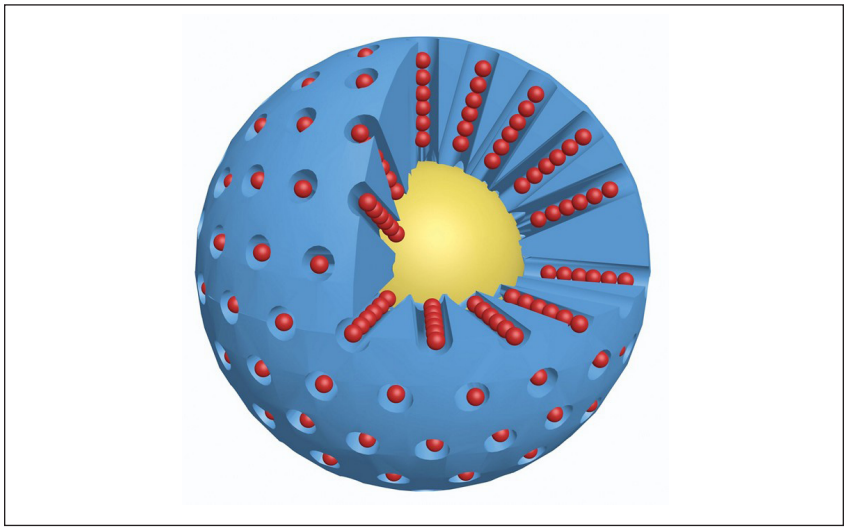
The fungus that causes athlete's foot, nail infections and ringworm -- *Trichophyton rubrum* -- is one of the world's most common maladies. Pharmaceutical scientists have had success in producing anti-fungal treatments, but they come with drawbacks, especially the need for long-term applications (some as long as 18 months), and adverse side effects such as liver damage or drug interactions. Also, there is growing evidence that the fungus is becoming more immune to the antibiotic treatments.

Also, and more serious than just being unsightly or embarrassing, the fungus can be transmitted to others, and patients with diabetes or weakened immune systems can experience serious, even fatal complications from fungal nail infections.

One area in which scientists have had success is in using certain wavelengths of light, such as those from a laser, to kill the fungus. However, these blasts of light have a serious drawback: the materials often used to collect the light, the photosensitizers, are water soluble; they become diluted and this decreases their effectiveness.

At a recent meeting of the American Chemical Society in Boston, however, researchers reported that using silver nanoparticles can amplify the fungal-killing power of certain wavelengths of light, thus overcoming the dilution problem. Indeed, the researchers suggest that these silver-based formulations were 10,000 to 1 million times more efficient than using naked photosensitizers.

One material that worked well was a silica-coated, silver nanoparticle-based hybrid photosensitizer. "To the best of our knowledge, this is the first report of PDI (photodynamic inactivation) against *T. rubrum* [the most common cause of nail fungus and athlete's foot] using nanoparticle-based hybrid photosensitizers," said the researchers in their paper. The team was led by Niranga Wijesiri of the Department of Chemistry, University of Cincinnati in Ohio. The work was done in the laboratory of Peng Zhang, who noted that the technique is noninvasive and user-friendly for the treatment of fungal infections. The goal is to produce a gel or a spray that can be activated under a handheld light.



PENG ZHANG]

Nanoparticles with a silver core (yellow) and a silica matrix (blue) enhanced the ability of photosensitizers (red) to generate reactive oxygen species which kill fungi.

# China to Continue Driving Global Silver Market

China will continue to be a major driver in the global silver market for the foreseeable future, fueled by continued industrial demand and silver mining activity, according to *Prospects for the Chinese Silver Market,* a report recently published by The Silver Institute.

China is not only the largest consumer of silver globally but the world's third largest mine producer, the report noted. "Starting with supply, Chinese mine production has averaged 110 Moz over 2010-17… This puts China in a position to also be a key supplier of metal to a number of silver-hungry nations, most notably India. China is also a leading fabricator. During 2010-17, total Chinese fabrication averaged 153 Moz accounting for 18% of the global total."

Examining specific demand sectors, the report noted:

Photovoltaic: China's consumption of silver for solar applications has been rising in recent years to an estimated 65 million ounces (Moz) in 2017. More than 70 percent of global solar panel production takes place in China, and local powder fabricators are only able to supply a portion of the essential powder and paste needed for manufacturing before relying on imported silver to fulfil the requirements. Although policy changes will most likely see volumes decline modestly this year, the long-term uptrend is expected to resume in 2019, assisted by still sizable local installations and strong sales abroad.

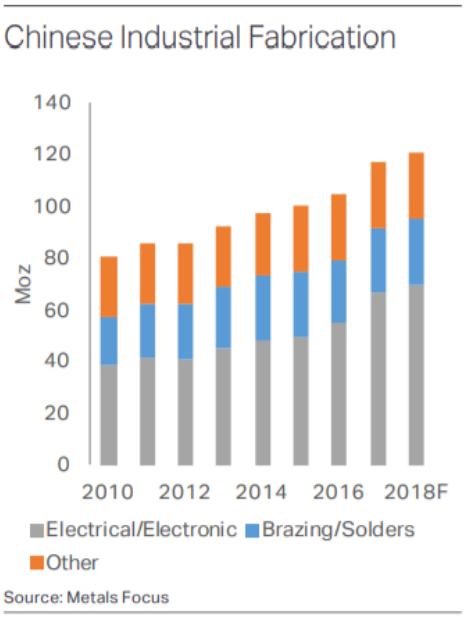
Electronic and Electrical: Growth across a wide range of end-use applications has and will continue to fortify demand. Significant areas of growth include touch panels, light emitting diodes (LEDs) and equipment used in electricity generation. Chinese consumption of silver for electronic and electrical uses was estimated at 78 Moz in 2017 and is forecast to grow modestly this year.

Brazing Alloys & Solder: Brazing applications that rely on silver should experience further gains as China continues to focus on infrastructure development. Brazing alloys and solders accounted for 24 Moz in 2017. A wide range of end-use applications, including railway infrastructure development, increasing car sales, refrigeration and air conditioning should fuel this growth.

Jewelry & Silverware: These areas have suffered declines in China in recent years, with combined fabrication reaching 29 Moz in 2017. The main drivers of this have been changing consumer appetites and the impact of anti-corruption legislation on the gifting market. The report authors, however, believe the end of this downtrend is near. In fact, silverware has already turned a corner, while silver jewelry in China is expected to return to positive growth from 2020 onwards.

The report was researched and produced by Metals Focus, a precious metals consultancy based in London.

The report can be downloaded free from the Silver Institute's website: *Prospects for the Chinese Silver Market.*




# More Vivid Light Emitting Diodes (LED) With No Toxicity

Everyone wants brighter, more vivid colors in their light displays, but this comes at a steep environmental price.

Currently, the best LED displays use the metal cadmium, which is highly toxic. This not only limits their use in some medical research and consumer applications, for fear that users may be exposed to the substance, but some countries are beginning to outright ban these LEDs.

One solution comes from Japanese researchers who have shown that a non-toxic version using silver indium disulfide coated in a shell consisting of gallium and sulfur may be the answer.

"We synthesized non-toxic nanoparticles in the normal way: mixed all ingredients together and heated them up. By tweaking the synthesis conditions and modifying the nanoparticle cores and the shells, we were able to achieve fantastic efficiencies and very pure colors," said study coauthor Professor Susumu Kuwabata of Osaka University, Japan, quoted in Asian Scientist.

One of their challenges was to produce semiconductor shells that were not as rigid as traditional shells. "The silver indium disulfide particles emitted purer colors after the coating with gallium sulfide. We think the less rigid nature of the shell material played an important part in making the nanoparticles more adaptable, and therefore able to take on more energetically-favorable conformations," said first author Assistant Professor Taro Uematsu.

# Silver Helps Break Down Toxic Methanol

Methanol, also known as methyl alcohol, is found in the chemical and gas industry, and as an additive to fuel cells to produce biodiesel. It is also used as a paint solvent and in the production of formaldehyde and antifreeze.

However, with more than 20 million tons of the gas produced annually, leaking of this highly toxic gas can be dangerous to those near it. Finding a simple, environmentally-friendly way to decompose it has been a goal of scientists and engineers, and now a team from Russia, Australia and Japan has developed a catalyst composed of boron nitrate nanoparticles and silver that can break down methanol into harmless carbon dioxide and water.

The catalyst could be used in protective filters and other devices for neutralizing methanol leaks. Currently, the researchers have been able to decompose methanol at temperatures of around 200 degrees centigrade – it takes 400 to 500 degrees without the catalyst. They hope to bring the reaction temperature to just under 100 degrees, which would open it up to more widespread use.

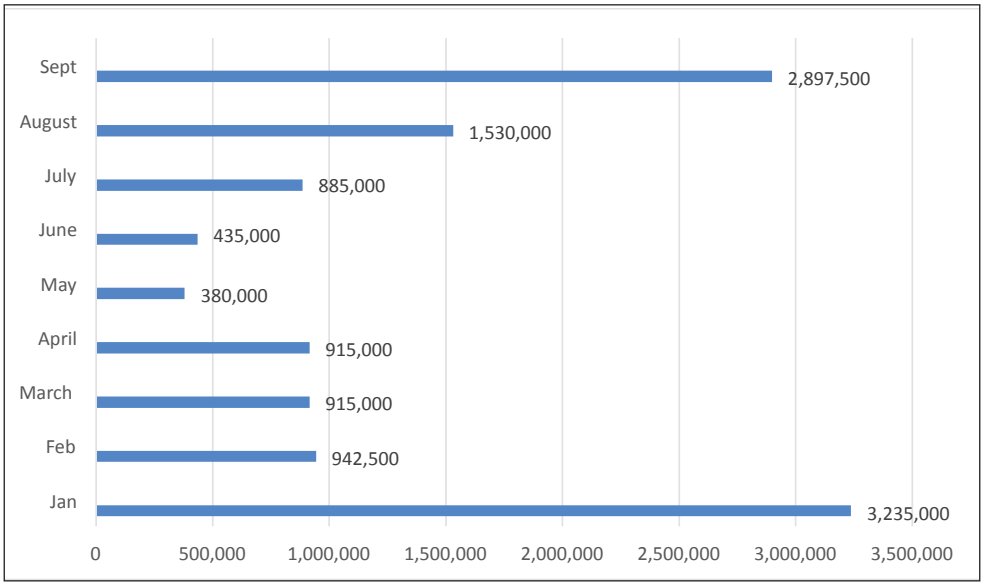
# Silver Eagles Soar in September

Sales of American Eagle Silver Bullion coins spiked in September pushing demand to nearly three million units. Paving the way, sales in August were about 1.5 million, which was up 73 percent from the month before. The jump in overall demand forced the Mint in early September to temporarily halt sales until they could secure more supply.

The September sales figures were in sharp contrast to May sales when the entire month, the lowest of the year, only saw 380,000 units sold. Sales have been on the upswing ever since with 435,000 in June, 885,000 in July, 1,530,000 in August and 2,897,500 in September.

From January through September, a total of 12,805,000 coins were sold.

American Eagle Silver Bullion Sales

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