THE SILVERINSTITUTE

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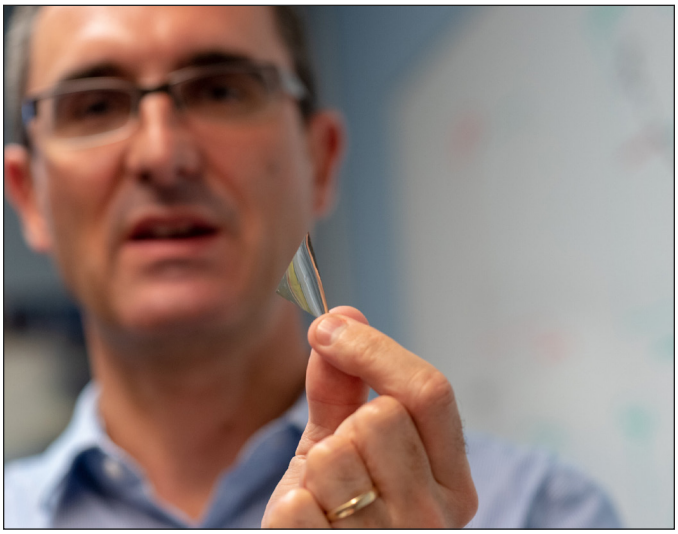
Silver News

Scientists Produce the World's Strongest Silver Alloy;

Metal's High Electrical Conductivity Remains Intact



JOSHUA BROWN

"We've discovered a new mechanism at work at the nanoscale that allows us to make metals that are much stronger than anything ever made before while not losing any electrical conductivity."

-- Frederic Sansoz, materials scientist and mechanical engineering professor.

University of Vermont scientists claim to have produced the strongest silver ever -- 42 percent stronger than the previous record -- without losing silver's high electrical conductivity.

Usually, the harder the metal conductor the more electrical resistance it has. This is particularly the case with alloys, which are combinations of metals with the goal of producing a stronger material (and other properties, too). However, as they gain strength these alloys lose conductivity.

Research team co-leader Frederic Sansoz, a materials scientist and mechanical engineering professor at the University of Vermont, Burlington, said in a prepared statement: "We've discovered a new mechanism at work at the nanoscale that allows us to make metals that are much stronger than anything ever made before while not losing any electrical conductivity."

The researchers mixed in trace amounts of copper to the silver, much the way that materials like silicon are 'doped' with tiny amounts of other elements like gallium (to produce semiconductors, for example) to change their properties. Because of the small amount of added material, the essential properties of the original material remain intact. By adding copper on a nanoscale, the researchers were able to more tightly control the end product. Silver is generally considered a softer metal, but in this case the silver got harder as copper was mixed in but the silver's ability to conduct electricity remained intact.

Materials are strong when, on an atomic level, the atoms are close together and producing a stable structure. In this case, copper atoms are placed in the empty spaces between silver atoms to shore up the structure. In essence, it acts as a filler material that makes silver's atomic structure more rigid without interfering with the free movement of electrons that gives the metal its high electrical conductivity.

Sansoz's goal is to transfer the team's understanding of producing strong and conductive silver to other metals. "This is a new class of materials and we're just beginning to understand how they work," he said. He adds that this basic understanding could lead to many different uses, including more efficient solar cells, lighter airplanes and safer nuclear power plants: "When you can make material stronger, you can use less of it, it lasts longer, and being electrically conductive is crucial to many applications."

Rising Silver Investment Detailed in Report

The main categories of global silver investment have increased appreciably this year, according to a report released in October from the Silver Institute, including:

- All-time highs for silver in exchange-traded products (ETPs) where 736.9 million ounces (Moz) were held by ETPs year-on-year through mid-August;
- Global mint bullion coin sales rising by 30 percent year-on-year through July;
- Strong net-long positioning on COMEX (with net money-managed longs up over 60% since the start of this year).

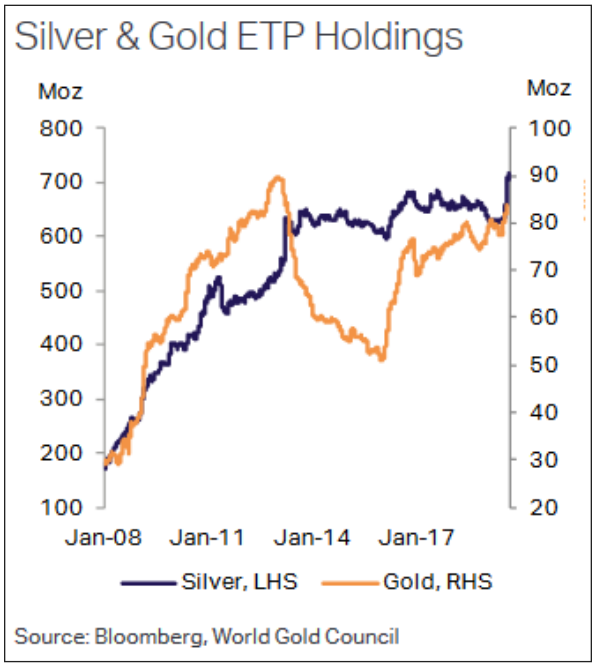
This, and other investment data, is in a report titled *Global Silver Investment*, prepared by Metals Focus, a global precious metals consultancy, on behalf of the Silver Institute. The report examines current silver investment trends, as well as highlighting opportunities and identifying potential challenges for the metal.

The report looks at the various influences on the silver price, its correlation to other commodities, macroeconomic variables, and the silver supply and demand balance.

The report also explores the main areas of silver investment demand, including:

- Commodity exchanges: A segment which is arguably the most sensitive to changes in investor sentiment, and the most volatile area of silver investment, featuring standardized contract sizes, delivery dates, and settlement locations;
- Exchange-traded products: These instruments are traded like stocks and track the spot price of silver with stored metal backing the shares. ETPs are a convenient way to invest in physical silver and have become popular amongst retail investors;
- Physical investment: Notably silver bars and coins;
- Mining equities: These offer investors the potential to benefit from stock appreciation and, in some instances, dividend streams; and
- Over-the-counter: This is a market for silver investment with 'off-exchange' transactions between investors and dealer/brokers that offer greater flexibility for investors than futures exchanges in terms of quantities, qualities, form of metal, and delivery locations.

A complimentary copy of the report can be downloaded here Global Silver Investment Report.



Total ETP holdings surpassed the previous peak of 686.6Moz (July 18, 2017) during July 2019 and have since reached successive all-time highs.

Digital Spy Messages That Dissolve in Water

For centuries, spies have written secret messages on slips of paper that they burned or sometimes swallowed to keep information from getting into enemy hands.

Now, scientists at Xidian University in Xi'an, China, offer a digital version in the form of a memristor -- a device that stores information much like a human neural network -- that can be dissolved by throwing it into water and erasing all the information it contains.

The researchers transferred layers of silver and magnesium oxide, using a water-based printing method, onto a substrate holding tungsten electrodes. By controlling electricity flowing through the memristor, they varied the flow of silver ions, which set up the memory network similar to how memory works in the human brain. Information is then stored in the network by changing the applied voltage. (See: *Artificial Nerve Cell Using Silver Moves Artificial Intelligence (AI) Forward;* December, 2018 *Silver News*.)

The memristor's components dissolve after 30 minutes of being immersed in deionized water.

"Combining transient materials that can physically disappear on demand within a memristor device can be an effective way to achieve secure storage applications," said Hong Wang, a researcher at Xidian's School of Advanced Materials and Nanotechnology. "For example, it can be more convenient for us to throw a transient storage device in water when information security is under serious threat," he told a recent edition of *IEEE Electron Device Letters*. "This especially [holds] great value for military applications."

Science-Challenge Student Invents Spray-On Nanosilver Bandage

A 14-year old student at San Diego's (California) Mesa Verde Middle School is a finalist in the *3M Young Scientist Challenge* with her invention of a spray-on bandage that uses silver particles instead of antibiotics.

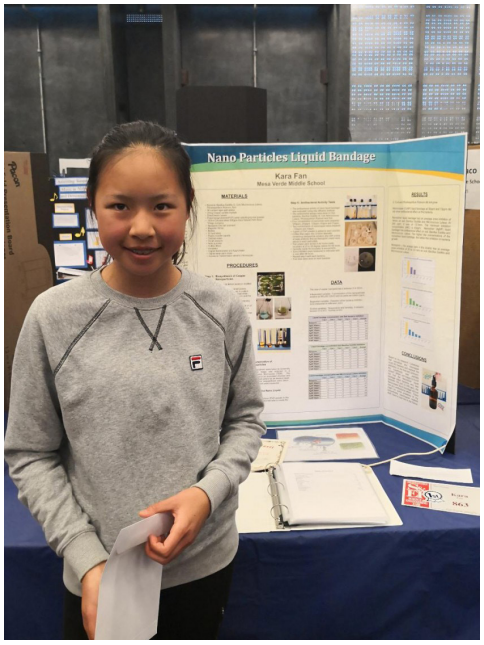
"I chose nanosilver," Kara Fan told the *San Diego Union-Tribune* newspaper, "because silver is a very effective anti-bacterial agent."

She said that several years ago she got interested in antibiotics when her grandmother was in the hospital for treatment of a serious infection. "She was saved by antibiotics," Fan said. "Since then, I got interested in this." Her curiosity led her to an article in *Scientific American* magazine noting that 2 million people annually in the U.S. contract antibiotic-resistant infections and 23,000 die. She also learned that some ancient civilizations used tiny amounts of silver or copper to help heal wounds.

Her nanosilver bandage comes in a spray bottle and dries on the wound creating a protective film.

Sara Hemmer, scientist mentor working at US multinational conglomerate 3M Company, said: "There are only a couple of products on the market today that are being advertised as a liquid bandage with the use of silver nanoparticles. Most of these products seem to do more preventing of infections and not necessarily treating the infection or bacteria. Kara's solution actually reduces the growth of the bacteria. I think her project will help bring awareness to the problem and also point to a potential solution."

Fan says she would like to become a microbiologist.



3M

14-year-old Kara Fan and her Spray-On Nanosilver Bandage Science Project.

Silicone Food Containers with Nanosilver Go from Oven to Table to Freezer

Food storage containers with nanosilver bacterial protection imbedded into the material are not new, but a nanosilver-protected storage container made of food-grade silicone that can be heated in an oven, microwaved and stored in a freezer is new and is the focus of crowdfunder Kickstarter that has so far garnered more than a quarter million dollars (US) in funding.

Taiwan-based BesoVida claims that food can be prepared, cooked and served all in one container – and that the container is recyclable. The company says that "once the product reaches the end of its life cycle, the US Food and Drug Administration-approved silicone can be incinerated and converted into harmless ingredients like silica, carbon dioxide, and water vapor." This ability, company officials say, will help ameliorate the 100 million tons of container and packaging waste that are generated in the US alone.

The container comes in several colors and sizes with lids, and a thickened-wall design that allows users to consume food or drink directly from the bowl without burning their hands. It also is dishwasher safe. Spoons and forks made from the same material are also available. The retail price for bowls ranges from US$11 to US$66 depending upon sets (which comprise multiple containers) and sizes. Pre-order Kickstarter prices are lower. Shipments are expected in January, 2020.

Click the image to watch a video of how BesoVida works.

Special Silver Catalyst Increases Carbon Monoxide Yield from Carbon Dioxide;

Could Produce More Synthetic Fuels, Other Chemicals

Using a silver catalyst to convert carbon dioxide, a byproduct of fossil-fuel combustion engines, is an effective method for producing carbon monoxide, which is a feedstock for useful chemicals such as synthetic fuels and pharmaceuticals. Increasing the yield has been a longtime quest for researchers and has led to experiments with different catalyst materials including silver and copper (See *Silver Beats Copper as Catalyst to Transform Greenhouse Gas;* June, 2019 *Silver News*).

How high can yield reach? A research team at the University of Delaware, Newark, reports that they can produce carbon monoxide from carbon dioxide with 92 percent efficiency. This is accomplished by employing a nanoporous silver electrocatalyst which they say is 3,000 times more active than polycrystalline silver, the catalyst commonly used in converting carbon dioxide to chemical precursors. (Other researchers have reached similar efficiencies using nickel and other metals but the method is not as straightforward as a nanoporous silver electrocatalyst.)

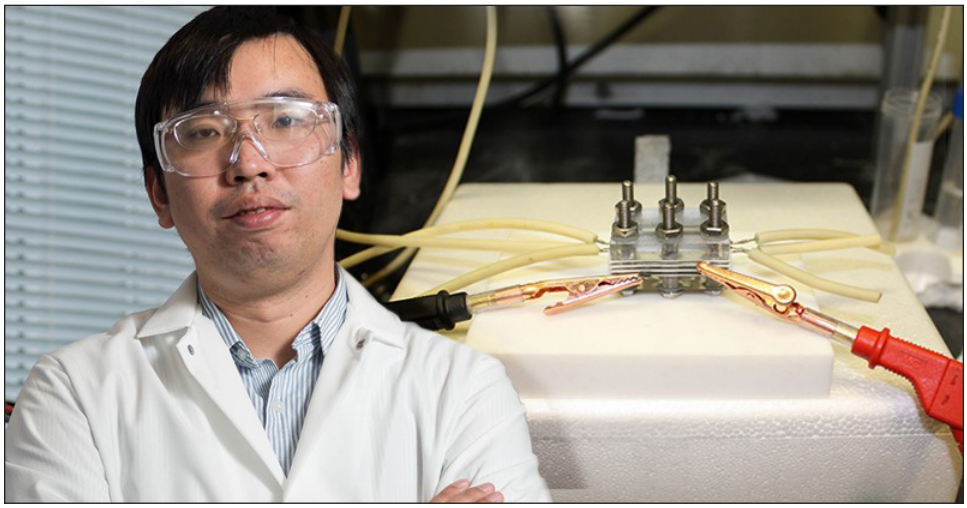
“Converting carbon dioxide to useful chemicals in a selective and efficient way remains a major challenge in renewable and sustainable energy research,” said Feng Jiao, assistant professor of chemical and biomolecular engineering and the project’s lead researcher, in a prepared statement. He noted that carbon dioxide is a major contributor to greenhouse gases and converting it to carbon monoxide and then to useful chemicals also helps to clean the environment.

Silver offers many advantages over other catalysts, according to Jiao. It cost less than other precious metals catalysts, such as platinum, and it remains stable under harsh conditions. He explained that nanoporous silver, in particular, offers more ‘active sites’ on its surface, allowing it to react more easily to carbon dioxide thus making the transition to carbon monoxide more efficient.

To doublecheck their findings, the team compared the nonporous silver that they developed in their laboratory not only to polycrystalline silver, but also to other silver nanostructures such as nanowires and nanoparticles. In each case, the nanoporous silver gave significant yields compared to other silver structures.

“Selective conversion of carbon dioxide to carbon monoxide is a promising route for clean energy, but it is a technically difficult process to accomplish,” Jiao said. “We’re hopeful that the catalyst we’ve developed can pave the way toward future advances in this area.”

The research team’s work was supported through funding from the American Chemical Society Petroleum Research Fund and University of Delaware Research Foundation. Jiao has patented this application technique in collaboration with the University of Delaware’s Office of Economic Innovation and Partnerships.



EVAN KRAPE/UNIVERSITY OF DELAWARE

A University of Delaware research team headed by Prof. Feng Jiao has developed a catalyst capable of electrochemically converting carbon dioxide to carbon monoxide with 92 percent efficiency.

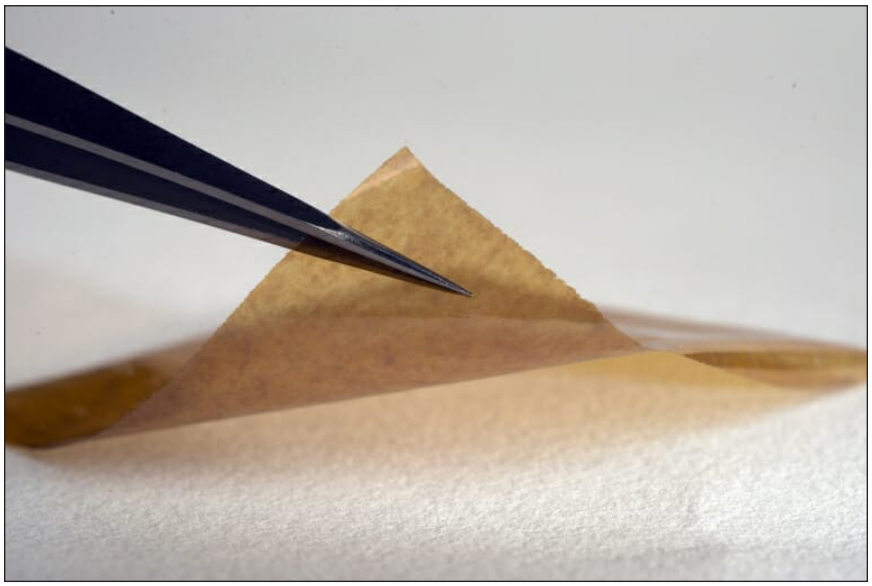
Medical Researchers Test Silver/Gallium Bandage to Heal Chronic Skin Ulcers

Silver-coated bandages are an often-used method to help heal difficult wounds such as diabetic skin ulcers. Scientists at Imbed Biosciences, the University of Wisconsin-Madison spinoff that makes and sells a silver-imbedded bandage known as *MicroLyte*, is taking it a step further by adding gallium, a chemical element, atomic symbol Ga, which they say enhances the covering's ability to reduce biofilms on the wound that shield it from antibiotics including the silver itself.

Ankit Agarwal, founder and CEO of Fitchburg, Wisconsin-based Imbed says that chronic ulcers affect more than 6 million people in the US and the number is growing because of increasing elderly and diabetic populations. In many cases, a chronic wound could remain open for months keeping silver and other antibacterials from reaching the wound. Silver's ability to kill microbes relies on it reaching the bacteria cell's wall and punching a hole in it. When biofilms appear on the wound, it cuts down on silver's penetrating power.

Gallium is a soft metal used to make alloys with lower melting points. It is also used in semiconductors. Chemically, gallium ions resemble a form of iron that cells need to gain energy. "Bacteria inside the biofilm are looking for more iron, so they take up the gallium," Agarwal said. However, the gallium turns out to be worthless and adds no energy to the cell. "In return for accepting a worthless 'Trojan horse,' the bacteria are exposed to silver -- the second punch -- and they will die," Agarwal explains.

The research, funded by a $1.5 million, two-year US Small Business Innovation Research grant, will test the silver/gallium mixture on pigs in the UW–Madison School of Veterinary Medicine. Pig's skin is similar to human skin.



IMBED BIOSCIENCES

The silver-containing MicroLyte bandage is thinner than a human hair and able to be absorbed into the wound (shown here on a fabric background).

Larry Kahaner
Editor

www.silverinstitute.org
@SilverInstitute on Twitter

THE SILVERINSTITUTE
1400 I Street, NW, Suite 550
Washington, DC 20005
T 202.835 0185
F 202.835 0155