THE SILVERINSTITUTE

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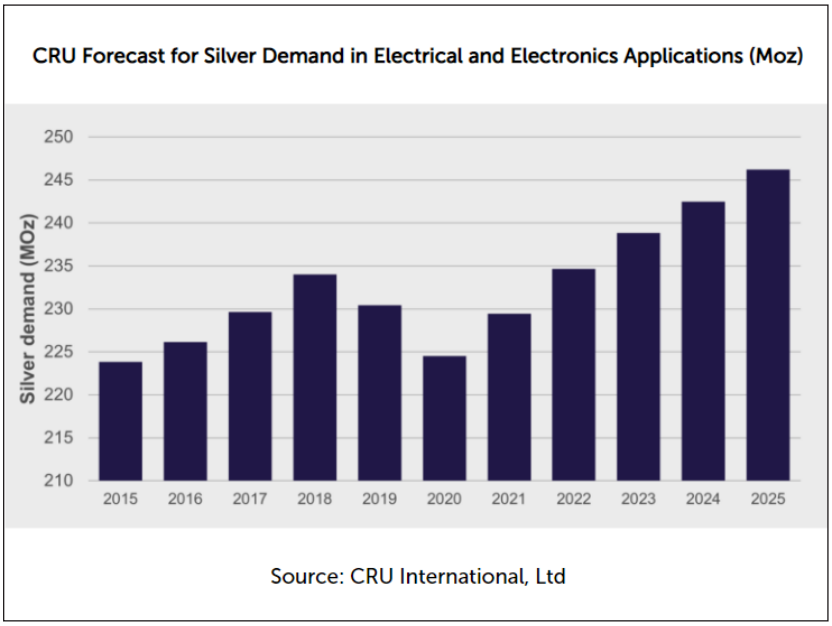
Silver News

Silver's Role in Global Connectivity Expected to Grow 10 Percent from 2020 to 2025



The use of silver in electronics and electrical applications (excluding photovoltaics) is forecast to rise from 224 million ounces (Moz) in 2020 to 246 Moz in 2025, reflecting a 10 percent increase, and underscoring silver's role in emerging technologies, according to a recent report published by the Silver Institute.

"Today, silver is found in nearly all electronic devices," the report noted. "With the greatest electrical conductivity of all metals, silver is playing a critical role in the latest technological advancements. Silver's inherent conductivity is an important asset in the miniaturization of electronics; allowing electrical currents to flow in even the smallest semiconductors and computer chips."

In the newest of the Silver Institute's series of *Market Trend Report*s, titled *Silver and Global Connectivity*, produced by CRU International Limited, the London-based consultancy, the findings highlighted that:

- Silver is playing an important part in providing increased access to information, global markets, and communication, and, as a result, boosting productivity, reducing waste and inefficiencies, strengthening supply chains, allowing greater automation, and spurring economic activity. This is especially notable today as the COVID-19 pandemic has caused a dramatic uptick in the number of employees working from home and students learning remotely.
- Radio-frequency identification devices (RFID) wirelessly connect objects for tracking, monitoring, and data collection. The logistics and supply chain industry have had high adoption of RFID tracking systems to monitor their assets through air, rail, road, or ship. Health care has also benefited by allowing workers to discover real-time location of life-saving medicines and equipment. Projected usage of silver for RFID's is expected to increase as much as 400 hundred percent through 2030.

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- Silver is integral to applications such as the expansion of 5G communications technology and the joining of once 'unintelligent' goods to a greater ecosystem through the 'Internet of Things' (IoT), the network of historically non-communicative physical objects that are now able to relay information. A common example is home thermostats and the ability to control them from a smartphone or other device.
- Silver offtake in electronics and electrical applications will benefit from the global green revolution's need for additional power distribution to connect renewable power, off-grid energy storage, and increasingly, the installation of electric vehicle charging stations.

To download a copy of the report, please click here.

Silver May Make Hydrogen Storage Safer

Holds Promise for Greenhouse Gas-Free Fuel

Hydrogen has been called the 'fuel of the future' by some energy experts because when burned in oxygen the gas does not produce carbon dioxide or other harmful greenhouse gases. It produces only water as a byproduct of combustion. Currently, many metropolitan buses and local trash-hauling trucks are hydrogen powered. Engineers also envision ships as well as airplanes that one day may run on hydrogen.

While hydrogen could solve a lot of environmental problems, it has a major drawback: storage. The lighter-than-air gas is highly volatile at ambient temperatures and must be stored at extremely low temperature or high pressure, which limits its widespread use.

Silver, gold and copper may offer an answer, according to Cristina Trujillo, PhD., Trinity College, Dublin Ireland, who, working with researchers from the Instituto de Química Médica in Spain, discovered that compounds of the three metals were able to react with hydrogen atoms during its production in a manner that kept the end product from being dangerously volatile.

In a prepared statement, Trujillo said: "For decades now many research groups across the world have put their efforts into this issue [lowering greenhouse gases]. One of the most studied alternatives has been hydrogen as a clean and carbon dioxide-free energy source, but it presents multiple problems due to its reactivity, low density and stability. Our contribution here -- made via quantum chemistry techniques -- has been to show that gold, silver and copper hydride complexes are very likely to effectively retain hydrogen in a stable manner. We hope that this work will have multiple applications in times to come."

Toyota is one of several truck makers developing hydrogen-powered long-haul trucks.

Silver Nudges Bacteria to Produce More Electricity

When certain bacteria break down organic wastes, like those found in wastewater, small amounts of electricity are produced. For example, the bacteria *Shewanella* decomposes organic matter into small molecules, and electrons are produced during this metabolic process. In essence, the sequence forms a microbial 'fuel cell' that generates electricity which can be captured as the bacteria grows as a film on electrodes.

However, the amount of electricity produced is not enough to make it a viable source of power -- until silver nanoparticles are brought into the picture.

A team of engineers and chemists from the University of California, Los Angeles, discovered that when they added silver nanoparticles to electrodes composed of a type of graphene oxide (a combination of carbon, oxygen and hydrogen), the nanoparticles released silver ions that traveled inside the bacteria's cells, capturing even more electrons produced by the bacteria.

"Living energy-recovery systems utilizing bacteria found in wastewater offer a one-two punch for environmental sustainability efforts," said co-corresponding author Yu Huang, a professor and chair of the Materials Science and Engineering Department at the UCLA Samueli School of Engineering, in a prepared statement. "The natural populations of bacteria can help decontaminate groundwater by breaking down harmful chemical compounds. Now, our research also shows a practical way to harness renewable energy from this process."

"Adding the silver nanoparticles into the bacteria is like creating a dedicated express lane for electrons, which enabled us to extract more electrons, and at faster speeds," said Xiangfeng Duan, the study's other corresponding author and UCLA professor of chemistry and biochemistry.

"The *Shewanella*-silver microbial fuel cells (MFCs) delivered a maximum current density of 3.85 milliamperes per square centimeter, and a power density of 0.66 milliwatts per square centimeter… which are all considerably higher than those of the best MFCs reported to date," the team wrote in the journal *Science*. "With the addition of silver nanoparticles, the *Shewanella* film increased electrical output more than 80 percent."

The study was supported by the U.S. Office of Naval Research, and further studies could lead to large-scale electrical generation from organic waste plants, the authors noted.

"Adding the silver nanoparticles into the bacteria is like creating a dedicated express lane for electrons, which enabled us to extract more electrons and at faster speeds" -- Xiangfeng Duan

Nanosilver Aids Treatment of 'Diabetic Foot'

Without Treatment, this Limb Complication Can Lead to Amputation

'Diabetic foot' is a common condition among those who suffer from the disease. More than being simply a chronic condition, diabetic foot -- caused by infections, foot ulcers, deep tissue damage, nerve damage, and vascular lesions -- leads to one person with diabetes in the world having their foot amputated every 20 seconds, according to studies including those from the Chinese Medical Association, Diabetes Branch. In addition, nearly 15 percent of diabetes patients are at risk of developing foot ulcers as their disease progresses, and this complication accounts for nearly one-third of all medical costs related to the disease.

Although nanosilver dressings have been found to improve many outcomes of body wounds and infections, studies have shown that it is particularly beneficial in the treatment of diabetic foot.

In a recent peer-reviewed study titled *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, the authors noted: "Nano-silver dressings are a novel form of long-spectrum, safe, antibacterial dressing... In addition to protecting the wound, facilitating better drainage, and improving safe broad-spectrum anti-infection role, related studies show that its application in the treatment of diabetic foot holds significant advantages; several comparative experiments with different dressings have shown that nanosilver dressings effectively improve the cure rate, the safety of diabetic foot patients, and alleviates pain to a certain level."

The main way in which nanosilver aids wound healing is that it breaks down the structure of bacteria cells, in effect causing their destruction, but there are other ways in which nanosilver, which breaks down to silver ions, the true destroyer of bacterial cells, helps to heal diabetic foot, the study's authors suggest. Silver ions also inhibit the growth of new bacteria cells by blocking DNA replication. Silver also promotes the growth of epithelial cells (in essence, 'new skin cells') that not only allow the wound to heal more quickly but reduce the likelihood of scarring.

"Considering the increasing number of diabetes patients in China, nanosilver dressings should be promoted and developed," the authors concluded. "… Appropriate utilization and development of nanosilver materials combined with continued research can improve the performance of nanosilver in terms of its physical, chemical, and biological aspects, thereby providing better medical conditions to the majority of diabetic foot patients."

Silver May Help Extraction of Lithium from Seawater

Lithium has become a highly sought-after element mainly because of its growing use in batteries that provide a lot of power for relatively little weight compared to traditional batteries usually made from lead and zinc. However, we are using lithium at a fast rate. U.S. Geological Survey (USGS) data indicated that more than 70 percent of lithium mined was used in batteries in 2020, up more than 23 percent from 2010 when the rare metal was mainly used in making glass and ceramics. Some analysts predict that manufacturers could consume about one-third of the lithium supply in just a few decades -- land-based lithium, at least.

Seawater also contains lithium, and silver is helping to extract it. Lithium may be thousands of times more plentiful in seawater than it is on land, according to the USGS, which estimates that there are 200 billion metric tons of lithium in oceans compared to about 21 million tons currently obtainable using standard land-based mining methods.

Several methods of seawater extraction are being tested, but one technique from Seoul National University (SNU), South Korea, holds promise, and silver is a component. The salt-enriched by-product of taking saltwater and turning it into potable water -- a method known as desalinization -- leaves behind a great deal of salt and small amounts of lithium. By using an electrolysis-type of system with pairs of silver and manganese oxide electrodes, scientists were able to raise the natural concentration of lithium in the mostly-salt piles.

"In this study," wrote lead author Hwajoo Joo, of the School of Chemical and Biological Engineering and Institute of Chemical Processes (ICP) at SNU, "using lithium-ion battery electrode materials [made from manganese oxide and silver electrodes] enabled lithium recovery from 6 tons of desalination concentrate per day (0.25 ton per hour) … with purity of 88 percent and enrichment factor of 1,800." And, while this method yields small absolute amounts of lithium, the United Nations estimated in 2019 that the world's 16,000 plants produced about 5 billion cubic meters of brine every day, of which 5 percent is salt and other chemicals including lithium, compared to seawater which contains about 3.5 percent salt and other chemicals depending upon the body of water.

The desalinization plant in Ras Al Khair, Saudi Arabia, produces more than a million cubic meters of fresh water a day.

Silver Wrapped in Gold Makes for Wearable Sensors

Medical sensors attached to a patient's skin offer the strongest and clearest signals for checking muscle activity which is vital for studying muscle fatigue and recovery from injuries. These signals are also used to diagnose and treat neuromuscular diseases such as multiple sclerosis and muscular dystrophy.

However, sensors on the skin can be uncomfortable, especially for prolonged periods, and doctors are always seeking alternatives.

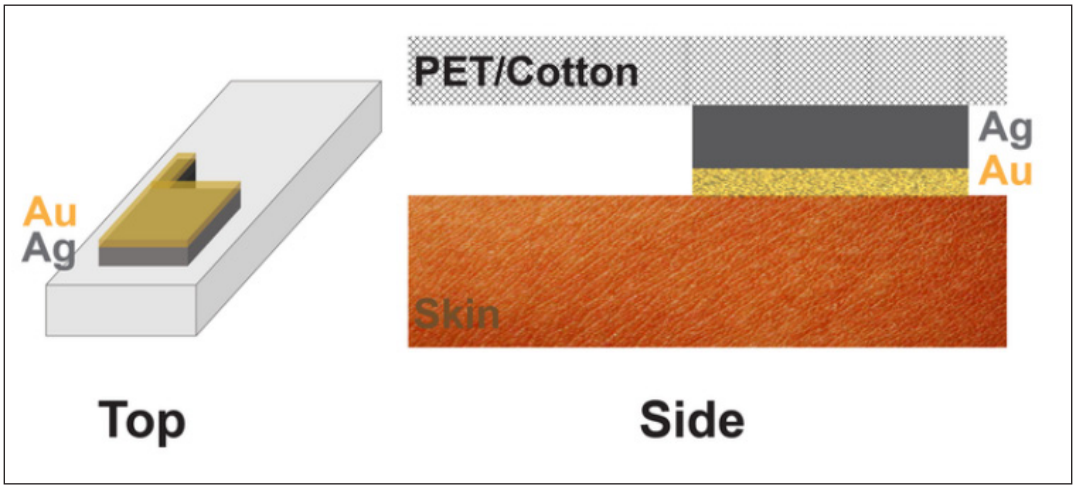
One idea is to place sensors on clothing, and researchers from the University of Utah and Gyeongsang National University in South Korea have developed a bioelectrical sensor that is silk-screened onto fabric. This not only gives doctors access to a patient's health during exams, but also can be accessed while the patient is outside a hospital or medical facility with information sent over the phone network or the internet.

"The signal we measure is a voltage over a time," said study author Huanan Zhang, in a prepared statement. "Every time your finger moves, the potential of the body, of the muscle, changes. So, we are able to detect that difference in potential."

During initial tests, researchers imbedded silver paste onto clothing because of silver's excellent electrical conductivity. However, some patients complained of minor skin irritations when the paste was left on for a prolonged period of time. The workaround was to encapsulate the silver in gold nanoparticles as gold is inert when exposed to bodily fluids like sweat.

The amounts of gold and silver are small enough to keep the price of the sensor low while silver's high conductivity assures continuous and solid signal generation. Performance was checked on fingers and the bicep, showing how they move and change during various exercises.

"[Our] work not only designs a wearable device, which has the convenience factor, but it also has great performance and is biocompatible," Zhang concluded.



TAEHWAN LIM

This silver and gold sensor attached to fabric can measure muscle movements and help diagnose neuromuscular diseases.

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