THE SILVERINSTITUTE

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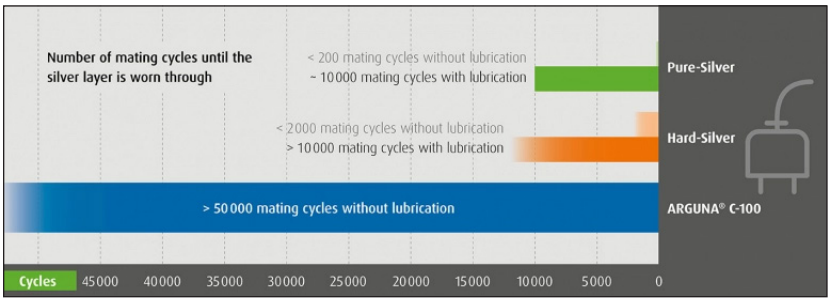
Silver News

New Silver Compound Moves Electric Car Sector Forward



UMICORE

Company tests show the increased wear resistance of the ARGUNA C-100 silver coating system in electric vehicle chargers.

Silver is at the heart of the global automotive industry. As the metal with the highest electrical conductivity, it is found in dozens of systems in modern-day vehicles. It is truly indispensable, and, as reported previously, demand for silver from this sector is growing rapidly and forecast to approach 88 Moz (2500t) by 2025.

However, there are certain applications in the sector where silver's other properties make it less than ideal. For instance, as a relatively soft metal, silver and silver alloys can wear quickly in certain applications. One example is in electric vehicle chargers. Repeatedly inserting and withdrawing (known as "mating") high-power industrial chargers can lead to wear of the silver surfaces and severely impact the durability of the device itself. This is why, typically, alternative coatings such as hard gold alloys and palladium-nickel alloys have been used in such environments. However, these materials are relatively high-cost, making silver-based alternatives with improved physical properties an attractive proposition.

ARGUNA C-100 from Umicore is one such option. According to Umicore officials, the silver-graphite combination offers the excellent electrical conductivity of silver while the lubrication of the graphite simultaneously increases abrasion resistance, thus reducing wear even with a high number of mating cycles.

Umicore carried out laboratory testing that involved repeatedly inserting and withdrawing samples into a test slot and then measuring the remaining coating thicknesses. After 50,000 mating cycles an intact silver graphite layer remained. In contrast, without lubrication a pure silver coating was completely removed after just 200 testing cycles.

Concluded Friedrich Talgner, head of technical applications at Umicore: "Under laboratory conditions, an end-of-life 'tribometer' test proves the low and stable coefficient of friction of the ARGUNA C-100 coating system."

Optimal Investment Portfolio Should Include 4-6 Percent Silver According to New Report

Significantly Higher than Current Allocations

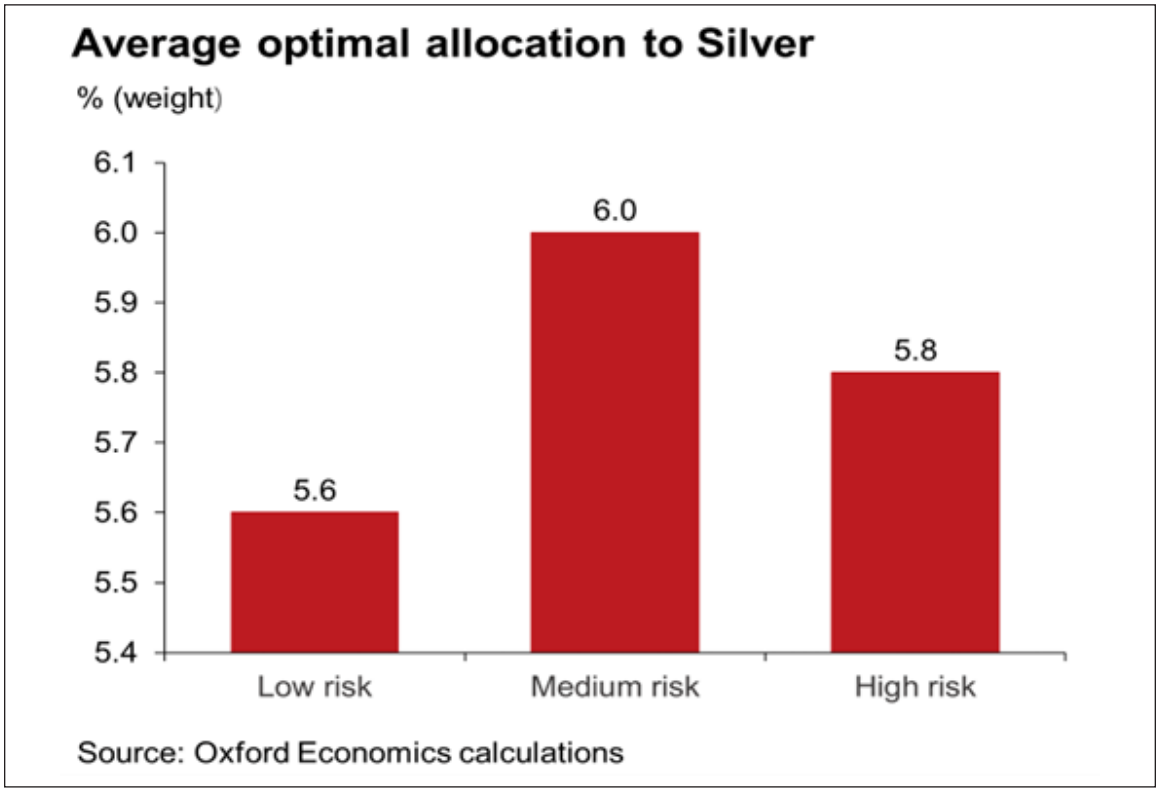
Multi-asset portfolios would benefit by adding a 4 to 6 percent silver allocation, according to new research by Oxford Economics, an independent economic advisory firm. This suggested allocation is significantly higher than current 0.2% holdings of silver by most institutional and individual investors.

The new report, *The Relevance of Silver in a Global Multi-Asset Portfolio,* was commissioned by the Silver Institute to explore the risk-adjusted returns of model portfolios with differing levels of silver exposure. The report noted: "Silver is often overlooked in these asset allocation decisions in favor of gold despite having its own unique return characteristics." Because more than half of silver is used in industrial applications, silver tends to be more sensitive than gold to trends in the global industrial cycle, contributing to its higher volatility, which is desirable in a diversified portfolio.

To examine the long-term benefits of holding silver in a portfolio, Oxford Economics compared silver's historical performance with a range of traditional asset classes, including stocks, bonds, gold, and other commodities, from January 1999 to June 2022. They found that silver was shown to have a relatively low historical correlation with asset classes other than gold, suggesting silver's valuable diversification potential in investment portfolios.

Forward-looking simulations also suggested optimal silver allocation based on an investor's risk tolerance, as shown in the following chart:

Optimal allocations to silver by risk threshold (2022 – 2032)



The study concluded: "Based on analysis of over 20 years of historic market data, our simulations indicate that an efficient investment portfolio would have had a 4.9% allocation to silver for a medium-risk investor. Moreover, looking forward to the next decade, our baseline economic projections and the strengthening structural demand outlook for silver indicates an even higher medium-risk optimal portfolio allocation to silver of 6%. With the average investment portfolio having only indirect exposure to silver of around 0.2% through a basket of commodities, this suggests that investment managers should consider the case for a more significant allocation to silver."

A complimentary copy of the report can be found here.

Biodegradable Printed Circuit Board Relies on Silver

Long-Term Goal to Cut E-Waste

Scientists at Lawrence Berkeley National Laboratory in California have developed a printed circuit board – the flat, rigid sheet that holds and connects electronic components in everyday items like smartphones, computers and TVs – that is fully recyclable and biodegradable. One of the features of the board is a printable conductive ink made of a polyester binder, which is biodegradable, and fillers such as silver flakes. The silver ensures that electricity is carried to all components on the board.

This development has come at an opportune time as United Nations officials noted that in 2021 alone global e-waste was 57.4 million tons and only about 17 percent of it was recycled. Only an infinitesimal fraction was biodegradable. Moreover, incinerating e-waste is not an option, because burning releases toxic gases into the atmosphere, and placing them in landfills puts heavy metals like mercury, lead, and beryllium into the environment.

"When it comes to plastic e-waste, it's easy to say it's impossible to solve and walk away," said Ting Xu, a faculty senior scientist in Berkeley Lab's Materials Sciences Division, and professor of chemistry and materials science and engineering at UC Berkeley. "But scientists are finding more evidence of significant health and environmental concerns caused by e-waste leaching into the soil and groundwater. With this study, we're showing that even though you can't solve the whole problem yet, you can at least tackle the problem of recovering heavy metals without polluting the environment," she said in a prepared statement.

To test the boards under real life conditions, researchers stored a printed circuit and mounted components without any humidity or temperature controls for seven months. After that time, they applied electricity to the device and it worked perfectly. To test its recyclability, they placed it in warm water and within 72 hours, the circuit board dissolved into its constituent parts: the silver particles separated from the polyester binders and the polymers themselves broke down, which allowed researchers to recover the metals without any further processing. About 94 percent of the silver particles were able to be recycled and reused with similar performance.

Xu and her team are now turning their attention to making biodegradable microchips, the most important component in modern devices. "Given how sophisticated chips are nowadays, this certainly won't be easy. But we have to try and give our level best," she said.

This work was mainly funded by the U.S. Department of Energy.

THOR SWIFT/BERKELEY LAB

Ting Xu

Silver Helps Detect Dangerous Foodborne Bacteria Quickly

New Method Does Not Require Time-Consuming Culturing

Testing foods for certain toxic bacteria can often take more than 48 hours, as it takes that long to grow or culture the microbes into a substance large enough to be detected. This time lag is an acute problem during food processing where facilities want to move food quickly into the supply chain but still make sure it is free of dangerous bacteria before it is shipped.

The need is great. Food poisoning affects 600 million people worldwide annually, about one in 10 people, and kills about 420,000 annually, according to the World Health Organization (WHO).

Now, a group of Japanese scientists at Osaka Metropolitan University have developed a simple and rapid method to detect dangerous bacteria based on how different colors of light bounce off silver, gold and copper nanoparticles, which are encapsulated in polymer compounds known as nanohybrid (NH) structures.

Their method relies on binding these metal nanoparticles with antibodies present in the bacteria and detecting the colors that are reflected. Each metal gives off a different color when bombarded with a full spectrum of light. For example, silver nanoparticles encased in NH structures look red when in the presence of food poisoning bacteria such as *E. Coli* and *Staphylococcus.* Gold looks white and copper, blue.

Because the sample does not need culturing, bacteria can be detected within one hour.

In a prepared statement, Professor Hiroshi Shiigi at the Graduate School of Engineering, Osaka Metropolitan University, who heads the research team said: "We aim to establish new detection principles and testing methods through the development of unique nano-biomaterials. Through this development, we hope to contribute not only to food safety and security, but also to the formation of a safe and affluent society in terms of stable supply and quality control of functional foods, medical care, drug discovery, and public health."

Kodak Hiring New Workers to Keep up with Demand for Silver-Based Film

Since 2021, Eastman Kodak has hired about 350 workers to help manufacture silver-based film in its Rochester, New York, facility to keep up with growing demand for 35mm film. The company has openings for 75 more workers, according to Nagraj Bokinkere, Vice President of Industrial Films and Chemicals.

Despite inroads by digital imaging, silver's use in traditional photography grew by 3 percent last year, according to the World Silver Survey 2022 published by the Silver Institute. In much the same manner that many audiophiles prefer the sound of vinyl records, some photographers, especially newer aficionados, prefer silver-based film and prints. (See *Silver News*, August 2022; *Silver's Use in Photography Continues*.)

"A few short years ago the film finishing operation was a 40 hours-a-week type operation; that was the capacity we had, and it was adequate to meet the demand," Bokinkere told a local Rochester radio station. "But now we're at 24/7. That's a four times increase in capacity, which is still not enough to catch up with the demand."

Kodak is struggling to keep up with demand for silver-based 35 mm film.

Race Car Champ and Salvor May Keep Over US$36 million in Silver Recovered from Sunken Vessel, South African Court Rules

A South African court has ruled that a British race car champion may keep 2,364 silver bars, worth about US$36.3 million, that he and his team salvaged from a steamer sunk off the coast of the Maldives in the Indian Ocean by Japanese torpedoes during World War II.

Salvor Ross Hyett, a former executive director of the British Racing Drivers' Club, led the team that recovered the silver in 2017 from the merchant ship SS Tilawa. The ship was transporting Indian nationals and the silver on a trip from Bombay, India, to Durban, South Africa, when it was hit by a torpedo. Before it was hit by another torpedo and sunk, 673 of the 954 people on board were brought back to Bombay on another vessel, but 281 people perished.

The South African government had ordered Hyett to turn the bars over, arguing that they were state property. Hyett's lawyers claimed that the ship was not on a government mission, but instead was acting as a merchant vessel at the time and, under the rules of salvage, the wreck belonged to those who recovered it, namely Hyett's salvage company Argentum Exploration Ltd. Although the silver was slated to be turned into coins by the South African government, the appeals court still ruled that it was legally in commercial use because it was being carried on a merchant ship. Had the silver been transported on a South African-owned vessel the ruling probably would have gone in the government's favor.

The South African government may appeal the case to the Supreme Court.

Silver-Based Sensor Takes New Approach to Infection Detection

Not Only Detects Presence of Disease but also its Severity

Most sensors used to detect diseases such as COVID-19 or Lyme disease rely on sending light through a medium – like a special glass or liquid – and then detecting the different light spectra that are reflected, or oppositely, are let through and seen either by eye or by using measurement equipment. An example is the familiar 15-minute COVID-19 test that shows a colored bar when the disease is present in a sample.

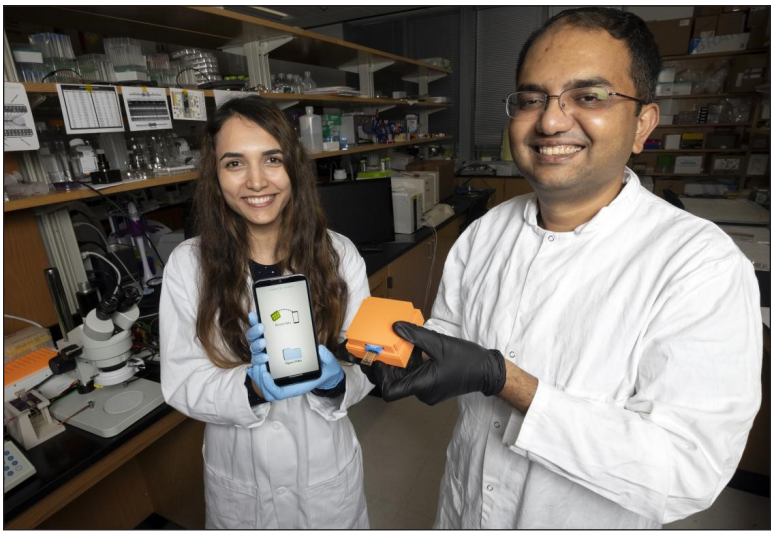
However, there's another way to detect diseases that relies on measuring electricity through the sample instead of optics, and silver plays a large role. This method has the advantage of measuring the severity of the disease (how many antibodies are present), which is an advantage over 'present/not-present' optical sensors, likes those used to detect COVID.

"At the heart of many diagnostics, something binds to something, and a signal is produced. That's where the optics interact and generate a light signal," said Aniruddh Sarkar, a faculty member in the Wallace H. Coulter Department of Biomedical Engineering at Georgia Tech and Emory, in a prepared statement. "[We've] figured out a way of making that binding event happen between a patient sample and [silver] from the sensor itself, so that signal will be electronic."

Small silver deposits in a specially-made microchip complete an electrical circuit that can be measured with a simple meter and indicates an infection when a sample is placed inside the chip. The chip can detect several different infections and the level of antibodies. The team's microchip invention was also able to differentiate in COVID-19 samples which antibodies were produced by a COVID infection and which were the result of vaccines.

"Let's say that we are detecting COVID-19 antibodies," said postdoctoral fellow Neda Rafat, who worked on the project. "The more antibodies we have, the more silver is deposited, and it's more conductive and has lower resistance. This way, by relating the conductivity or resistance to the [substance under test], we can also quantify the [disease's] concentration."

The chip can test for four different antibodies at the same time using just one drop of blood, but the team hopes to develop chips that are able to test for 60 or more infections in a single sample.



GEORGIA TECH

Postdoctoral fellow Neda Rafat and Assistant Professor Aniruddh Sarkar

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