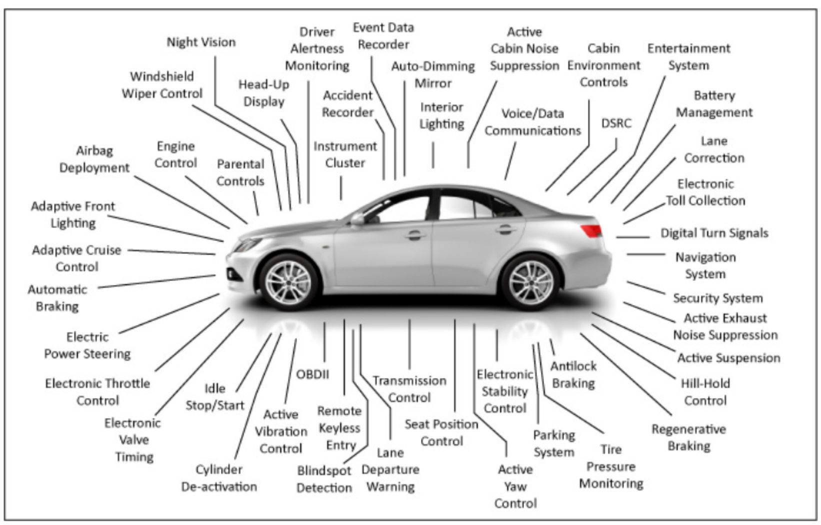
THE SILVERINSTITUTE

Silver News

February 2021

Silver Consumption in Global Automotive Sector to Approach 90 Million Ounces By 2025;

Should Challenge Silver Usage in Photovoltaic Industry



Source: The Clemson University Vehicular Electronics Laboratory

Silver is used in the vast majority of automobile devices like the ones shown here.

With modern cars using more silver than ever in their advanced technology components, the worldwide automotive sector could need nearly 90 million ounces (Moz) annually of the metal by 2025, according to a recently-published report by the Silver Institute.

In four years, silver consumption in the automotive sector should rival that of the photovoltaic industry, forecast to reach 98 Moz in 2025, and currently the largest application of global industrial silver demand, according to the report *Silver's Growing Role in the Automotive Industry*, produced on behalf of the Silver Institute by Metals Focus, an independent precious metals consultancy.

The report, part of the Silver Institute's series of *Market Trend Reports*, examines trends in automotive production, including the growth and evolution of hybrid and battery electric vehicles. It also addresses transportation policies that favor vehicle electrification in some of the world's most important vehicle markets.

Highlights of the report include:

- Silver's widespread use in automobiles reflects its superior electrical properties, as well as its excellent oxide resistance and durability under harsh operating environments;
- Silver is used extensively in vehicle electrical control units that manage a wide range of functions in the engine and main cabin. These functions include infotainment systems, navigation systems, electric power steering, and safety features, such as airbag deployment systems, automatic braking, security and driver alertness systems;
- Average vehicle silver usage, which is currently estimated at 15-28 grams (g) per internal combustion engine (ICE) light vehicle, has been rising over the past few decades. In hybrid vehicles, silver use

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is higher at around 18-34g per light vehicle, while battery electric vehicles (BEVs) consume about 25-50g of silver per vehicle.

- The move to autonomous driving should lead to an escalation of vehicle complexity, requiring even more silver consumption. Silver automotive demand this year is projected to be 61 million ounces.
- Ancillary services that require silver are also increasing, including charging stations and charging points for electric vehicles; and
- The acceptance of BEVs is gaining momentum as an increasing number of countries adopt policies that support the BEV industry.

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

SoCal's Metrolink Trains Keep Passengers and Crew Safe with New Silver/Copper Air Filter

Metrolink -- Southern California's regional passenger train service -- has added silver and copper-based antimicrobial filters to its train cars to keep passengers and train employees safe from airborne germs.

The PuraShield air filters from Purafil not only capture the microbes, but the company's proprietary antimicrobial technology employs silver and copper ions to attack and destroy the bacteria. The company claims that the filters screen out 99.99% of the *staphylococcus* bacteria, 99.91% of the H1N1 virus, 99.96% of *E. Coli* bacteria and 99.58% of the SARS virus.

"With every passing day, we learn more about ways to prevent the spread of COVID-19 and take necessary steps to keep our riders and employees safe aboard our trains," said Metrolink Board Chair Brian Humphrey in a prepared statement. "Understanding the airborne nature of COVID-19, we installed new state-of-the-art air filters that improve the air flow aboard our trains and destroy 99.9% of impurities. Together with enhanced cleaning, physical distancing and our face mask requirement, this new step reduces the exposure risk of infection."

The new filters are part of Metrolink's Heating, Ventilation, and Air Conditioning (HVAC) system, which is itself another protective layer. Intake vents draw in outside air, send it through the HVAC system, then distribute the filtered and cleaned air into the cars. Through this process, the filters screen out and kill not only viral and bacterial particles, but biological and atmosphere odors, providing a safer experience for riders.

METROLINK

Southern California Metrolink train riders are being protected from airborne bacteria and viruses by silver/copper-based filters in the ventilation systems.

Silver Demand Forecast to Rise 11 Percent in 2021;

Expected to Reach Six-Year High of 1.025 Billion Ounces

Led by industrial use and physical silver investment, global silver demand is projected to achieve a six-year high of 1.025 billion ounces in 2021, according to an analysis published by the Silver Institute on February 10.

Strong investment demand is expected to push silver prices higher in 2021. Physical investment, which covers silver bullion coin and bar purchases, is expected to achieve a six-year high in 2021 of 257 million ounces (Moz), as investors continue to add silver to their investment holdings. Already this year, holdings in exchange traded products reached a record level on February 3 of 1.18 billion ounces. One caveat: If the global economic recovery from the pandemic proves to be slower than expected, this could weigh on base metal prices, which could, in turn, encourage investors to reduce their exposure to silver.

Industrial demand is projected to post a four-year high in 2021 of 510 Moz, a 9 percent increase over 2020 figures. Demand from the electrical and electronics sector is poised to account for the bulk of these gains. With the growing penetration of 5G technology in consumer electronics this sector is expected to drive strong gains for silver offtake, with a 7 percent increase over 2020 to 300 Moz for silver's use in the sector.

The photovoltaic (PV) sector staged a strong recovery in the second half of 2020, and this momentum should carry through 2021. The global total for the sector is forecast at 105 Moz in 2021, overcoming the losses sustained last year. Although silver loadings continue to drift lower, the sector will benefit from a growing number of countries that are installing new PV capacity. Silver's use in the automotive market should also rebound strongly in 2021, to just over 60 Moz, benefiting from the growing electrification of vehicles.

Global jewelry demand is forecast to rebound to 174 Moz but remain below pre-COVID levels. To a large extent, this reflects only a modest recovery in India, where demand will be affected by high and volatile rupee silver prices. A similar outcome emerges in silverware, which is dominated by the Indian market. Even though total silverware fabrication is predicted to achieve a double-digit percentage gain this year, reaching 45 Moz, the global total will remain considerably short of 2019 levels because of the challenges in India.

Metals Focus, the respected global precious metals research consultancy, contributed to this analysis. The firm will research and produce the Silver Institute's annual report on the international silver market, *World Silver Survey 2021*, which will be released on April 22.

Recovering Silver from Industrial Waste Made Easier with Plant Material

Scientists at [Kanazawa University in Japan] have developed a method for extracting silver and other metals from acidic wastewater using an environmentally-friendly method that involves cellulose, the main building block of green plants.

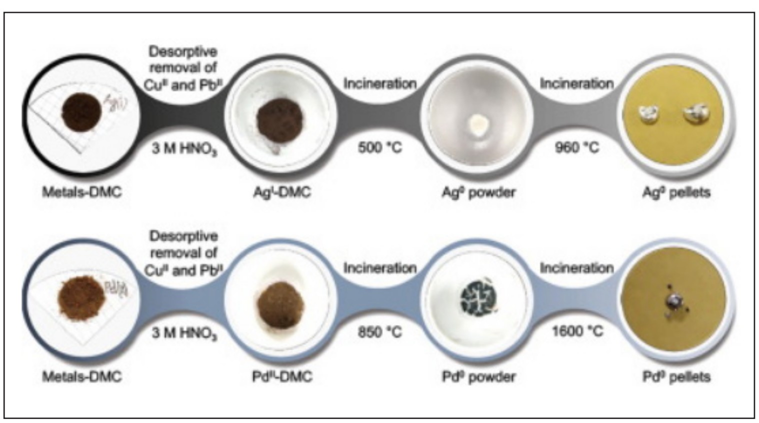
The technique involves letting extremely small particles of cellulose adsorb the acidic liquid waste -- at room temperature -- which is carrying the metals. Once adsorbed, the cellulose carrier is burned and the silver recovered. Not only is the adsorption process straightforward but it is relatively fast, about an hour at designated acidic levels, the researchers reported.

Once the cellulose-containing silver is incinerated, silver in powder form is left. By increasing the oven temperature, the powder then is converted into silver pellets. No other chemicals are needed. An analysis of the final metal pellets shows that they are pure silver and not silver-oxide.

“We removed nearly all of the silver … from real industrial waste samples,” said lead author of the [published study] Foni Biswas in a prepared statement. “Obtaining pure and elemental metals proceeded as smoothly as in our trial runs.”

Aside from silver, other metals from the industrial waste were extracted. Palladium, copper and lead were among the 11 metals recovered using this process with copper and lead removed with the most ease, according to the researchers.

The method can be scaled up for commercial applications. The study stated: “… the excellent performance (extraction rate of about 99%) of [specially-modified cellulose] towards the recovery of silver and palladium from actual waste solutions indicates the potential for the application of the process at a larger scale.”



CHEMICAL ENGINEERING JOURNAL

By using extremely small particles of cellulose in wastewater, scientists have extracted 11 different metals including silver, copper and lead, as well as palladium.

Are Battery-Free Wearables Possible?

What if wearables could be powered by electricity generated by the body’s own heat?

Researchers at the [Korea Institute of Science and Technology (KIST)] are studying whether an ordinary thermocouple -- two different pieces of metal that generate electricity when sandwiched together in the presence of heat -- could generate enough electrical energy to operate a wearable device like heart rate or blood pressure monitors without the need for batteries.

Thermocouples are common in devices like fire alarms or hot water pipe sensors, because they generate an electrical signal at dangerously high temperatures but not at lower temperatures.

That’s where silver comes in.

Because of silver’s high electrical conductivity, ability to transfer heat with low loss, and flexibility, the researchers are experimenting with connecting a high-performance thermoelectric device to a stretchable base composed of silver nanowires. The researchers showed that the device could be printed and placed onto the skin where its flexibility allowed maximum contact to body heat. When touching human skin, 7 microwatts per square centimeter of electricity was generated from body temperature only.

Seungjun Chung, one of the [study’s] authors, said: “Going forward, we will develop a flexible thermoelectric platform that can operate wearables with only body temperature… Our research findings are significant in that the functional composite material, thermoelectric device platform, and high-yield automated process developed in this study will be able to contribute to the commercialization of battery-free wearables in the future.”

A New Way to Harden Silver and Other Metals

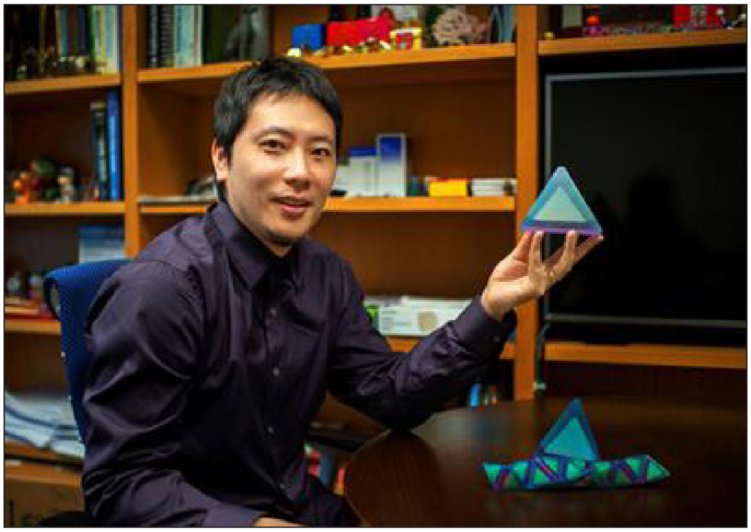
For centuries, metalworkers have hardened metals by bending, twisting, hammering and running them between rollers. These traditional methods work because they break the metal's microscopic grain structure and realign it with smaller grains that are inherently harder.

Now, scientists at Brown University in Providence, Rhode Island, have found a new way to harden metals, including silver, by smashing together nanoclusters of the metal. Nanoclusters are groups of a small number of atoms, in the tens at most, that have the same properties as their larger counterparts. When the Brown team impacted together individual metal nanoclusters to form solid, larger hunks they found that the resulting metal was up to four times harder than the naturally-occurring metal.

"Hammering and other hardening methods are all top-down ways of altering grain structure, and it's very hard to control the grain size you end up with," said Ou Chen, an assistant professor of chemistry at Brown and corresponding author of the new research, in a public statement. "What we've done is create nanoparticle building blocks that fuse together when you squeeze them. This way we can have uniform grain sizes that can be precisely tuned for enhanced properties."

Not only were the metals harder, but in the case of silver, in particular, the metal's exceptional reflective and electrical conductivity properties remained the same. This is especially important for silver, because it is too soft for some industrial applications where its other properties would be welcomed. These applications could include, for example, a silver switch that is subject to extreme wear and tear or high weight loads in industrial equipment.

Chen has patented the technique. "We think there's a lot of potential here, both for industry and the scientific research community," he said.



BROWN UNIVERSITY

Professor Ou Chen was awarded an Alfred P. Sloan Foundation Fellowship for 2020, an honor given to outstanding early-career researchers.

Silver Aids Faster and More Accurate Diagnosis of Tumors and Other Growths

Doctors are always seeking more effective and less invasive ways to identify tumors and other abnormalities inside patients. The most common method is through radiology, such as X-rays and Magnetic Resonance Imaging (MRI), after injecting dyes into the body that help illuminate a specific area. Some patients cannot tolerate the dyes, however, so radiologists resort to inserting non-toxic, semiconductor nanoparticles that glow under ultraviolet (UV) light, a property known as luminescence. Unfortunately, these nanoparticles suffer two drawbacks: they are not very bright nor does their luminescence last long enough for study.

Silver offers a solution. To make nanoparticles brighter and last longer, a team of scientists from the Tokyo Institute of Technology 'doped' a platinum thiolate complex (a type of metal complex that contains sulfur) with silver that increases photoluminescence by 18 times.

Why does it work?

The scientists found that when energized with UV light, the structure is kept stable and intact by the silver ions, thus leading to strong photoluminescence. "This could be because the size of the silver ion and the cavity of the platinum thiolate ring are a good match and the orbitals are in good alignment," said team leader Prof. Takane Imaoka. He added: "The silver ion acts as a template to maintain the highly-ordered structure of the tiara-like complex, thereby enormously enhancing its phosphorescence."

Also, the silver-doped structure stayed intact longer than the non-doped structure, the team noted in their study.

Further studies will explore how to produce even brighter nanoparticles which would enable doctors to identify smaller tumors and other abnormalities within the body sooner and with more accuracy.

Micromotors and Silver Join to Kill Bacteria

Micromotors -- corkscrew-shaped devices that are about a hundred micrometers long and propelled by nearby magnets -- show great promise in delivering drugs inside the body as well as scooping up pollutants in wastewater.

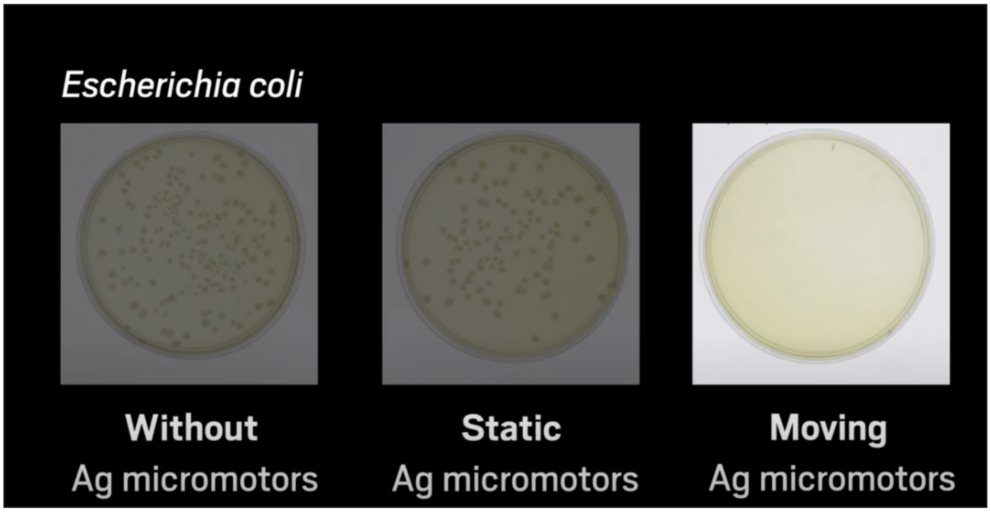
Although still in the trial phase, engineers from the [Chinese University of Hong Kong] and [Huazhong University of Science and Technology] have been able to produce these micromotors from graphene, a material that is derived from carbon atoms fashioned in a particular structure that makes it extremely light yet more than 200 times stronger than steel. For its weight, it is reportedly the strongest material ever invented.

These engineers have not only produced these motors from graphene but have done so in a cheap and easily scaled-up fashion able to make hundreds in minutes.

Because graphene easily attaches to other molecules -- aided by a high surface area -- it is ideal for collecting microscopic pollutants as well as bacteria that may be harmful to humans. (See *Micromotors Lure, Trap and Destroy Bacteria with Silver Ions*, February 2020 *Silver News*.)

To that end, the engineers have attached silver ions to the micromotors to test their ability to destroy bacteria. In the laboratory, stationary silver micromotors killed deadly *E. coli* bacteria in a petri dish. When the micromotors were moved around by magnetic fields, they were even more effective.

Although explored theoretically in 1947, graphene was first explicitly produced and identified in 2004 by the team of Andre Geim and Konstantin Novoselov who shared the 2010 Nobel Prize in Physics for their work.



Click the image to watch a video on micromotors in action.

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