

# New Applications for Silver

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I would like to thank the LBMA for inviting me this afternoon. It has been a great conference so far and there is a little bit more to go. As you can see, I am speaking on new applications for silver. Silver's chemical and physical attributes, especially its antibacterial properties, make this particular metal a prime component in a growing list of applications, which include wound and burn care, drugs, consumer appliances, textiles and clothing, wood preservation, water purification, catalysts for industrial processes, commercial food and beverage preparation, furniture, building materials, and, of course, consumer electronics, for example mobile phones, DVDs, plasma televisions and computers. This presentation will highlight the latest worldwide uses of silver in various applications and everyday products.

The Silver Institute is 35 years old this year. Our members are primarily from leading silver mining houses, bullion banks, refineries, some end users of silver-based products, and wholesalers of silver investment products. We have a simple mandate: to create programmes that stimulate silver demand and to provide accurate information to our members, the media, the public, and government officials. Many of you will be familiar with our *World Silver Survey*. It is considered the bible of the silver industry and is produced on our behalf by GFMS Ltd. Our most recent edition was released in May this year. We also produce *Silver News*, which is a quarterly publication. It is available on our website each quarter for free. We also have three additional reports coming out this year. One is a comprehensive study of silver's end uses in its industrial applications and another is a more modest look at silver's biocide use. Later this year, we are producing an in-depth report on silver jewellery.

The phrase 'born with a silver spoon in one's mouth' is also a reference to how parents kept their children healthy by preventing mouth bacteria with silver spoons. Only rich families could do this, so the phrase came to mean being affluent.

Today, medical professionals and others are increasingly incorporating silver into a wide array of applications. This has not escaped the attention of the press, as evidenced by several articles that have appeared recently. A *Washington Post* article appeared earlier this year on nanotechnology and how silver will play a major role in this promising new field.

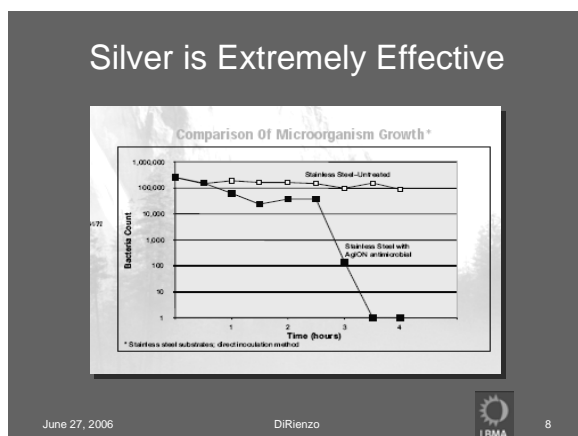
There was an article in the *Wall Street Journal* on how hospitals are taking further steps to stop bacteria. Silver will again play a prominent role in the eradication of these diseases.

People have known for centuries that silver kills germs, but scientists have only recently discovered how the white metal does its work. One question that has puzzled scientists is why silver is harmful to bacteria but does not hurt humans. Silver interrupts the ability of bacteria cells to form chemical bonds essential to bacteria's survival. These bonds produce the cell's physical structure, so bacteria essentially falls apart in the presence of silver.

Cells in humans and other animals have thick walls and are not disturbed by silver.



The picture on the left is a normal bacteria cell. The picture on the right shows cell walls being penetrated by silver ions, which will destroy the cell's structure. There are many examples of how silver kills germs, but this is typical.



In this case, it was tested on stainless steel using components manufactured by AgION Technologies, which likes to boast: 'If this is on it, then bacteria is not.' I will give you a brief explanation of how AgION's compound works. The silver ion delivery system is a zeolite carrier that allows a controlled and effective release of the silver ions on demand, thus inhibiting the growth of bacteria, mould and fungus for long periods of time.

Zeolites are minerals that have a porous structure and there are over 150 types. This stable ion-exchange process is non-reactive and allows the compound to be used in virtually every imaginable manufacturing process. The list of bacteria that silver can kill is growing. Common germs that silver has been clinically tested against and found to be effective include:

- Legionella
- E.coli
- Streptococcus
- MRSA

These microbes probably account for 95% of all germs that we encounter on a regular basis. Silver has also been shown to be effective against fungus and mildew too. The world's economic growth depends on keeping diseases isolated and not allowing them to spread through commerce. Due to the increasing use of antibiotics in the Western world, often unnecessarily for viral infections, some bacteria are becoming immune to antibiotics.

### Biocide Applications

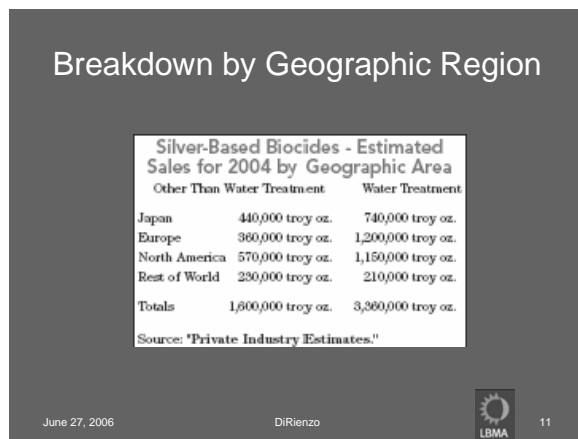


Data on biocide uses is difficult to acquire because the industry, except for water treatment, is so new. Anecdotally, we know that biocide use is increasing based on the large number of new products being introduced. The silver biocide segment is poised for growth for several main reasons:

- Global economic growth
- More acceptance of silver as a biocide, which has been backed by scientific research and testing
- The outright banning of some chemical biocides.

Europe and North America use more silver in biocide applications than Japan, but Japan uses more per capita. Japan has had a cultural tradition of fighting germs because of its dense population and it has always been at the forefront of new consumer applications such as

refrigerators, metal doorknobs, handles, and cell phones.



## Medical Applications

Calgary's Rockyview General Hospital has silver-copper ionisation water treatment facilities to prevent Legionnaires Disease. This is just one example. Hospitals in the US are also major users of silver biocides for their water systems. Silver is also used in instruments, catheters, furniture, and almost any service in the operating rooms. Hospitals are also major users of silver-embedded bandages. Water treatment is very important for hospitals because many patients have compromised immune systems. Health departments in New York State and Maryland have approved silver-copper ionisation as a primary treatment for long-term control of legionella.

The use of silver in **wound dressings** was first tried on burn victims, who were highly susceptible to infection without the protection of skin. Doctors found that not only did silver inhibit the growth of bacteria, but the wounds actually healed more quickly. Why they healed more quickly is not yet understood, but it is clear that they do. Some research has suggested that the reason is because the body is using resources for repairing cells and not to fight off infection.

The consumer can purchase Curad **silver bandages** in their local pharmacy. The word silver is being used on products with greater frequency these days, as more products hit the market and as the public gets a better understanding of silver's ability to kill bacteria. The company Biersdorf has a \$1 million advertising campaign featuring the animated cartoon character Plasterman to promote its Elastoplast SilverHealing bandages.

Innovative Medical Services (IMS) recently announced results showing that its silver-based

Axenoh product is 99% effective against **acne-causing bacteria**. Company officials report that this product was the most successful retail introduction in its 11-year history, and it is currently undergoing FDA approval in the US.

A **clotting powder** called QuikClot was developed for the US military and has been given to every marine in Iraq and Afghanistan to reduce the number of soldiers who bleed to death on the battlefield. Silver will play a major role as this technology is modified and used by paramedics and other first responders. Silver helps to mitigate the heat produced when the powder meets the wound and QuikClot speeds coagulation of blood, even in large wounds, through a very simple process. It physically absorbs the liquid from blood, thereby concentrating the clotting factors and encouraging rapid clotting to stop the bleeding.

## Industrial Applications

### Food Processing

The Netherlands-based Eriks group is introducing sealing rings containing a silver-based biocide aimed at the dairy industry to provide protection against bacteria that can build up on processing equipment. Making ice for restaurants, food shipments and industrial processes has always been plagued by bacteria in the hoses and fittings. Now, manufacturers of commercial ice machines are using silver-embedded hoses, clamps, pipe fittings, and other places where gunk can build up and harbour bacteria. Meat processors are also using silver-embedded tables, grinders, tools, refrigerators and hooks.

Silver simply offers greater hygiene, control of odour, prevention of discolouration and structural damage in processing areas than chemicals do. Use of silver-based biocides also offers reduced downtime, because there is less need to take processing equipment offline for cleaning. Additional uses are in specialty packaging, occupational clothing worn by food processing workers, prevention of pathogen build-up in climate control systems and on the floors, walls, and ceilings of food processing and storage facilities.

### Food Preservation

Silver is already used to keep fruit, vegetables and cut flowers fresh whilst in transit. The cut flowers industry is a huge industry – over \$50 billion in sales worldwide – and many companies use silver to keep their products fresh in transit to the US, Western Europe, Japan and

elsewhere. Citrus researchers are seeking funding to see if silver could be useful in combating the citrus canker, a bacterium-caused affliction that threatens many of the citrus crops produced in Florida.

### **Paper**

British papermaker James Cropper has introduced a line of silver-based paper products known as DocuGuard. The company says that the early applications will be in protecting hospital case notes and medical files against the proliferation of bacteria, but future applications will include business stationary, envelopes, brochures, book-binding materials, and food packaging.

### **Public Hygiene**

AmeriSwiss, a provider of public restroom equipment, is employing AgION-based silver ion antimicrobial products in a protective finish for door pulls and plates, which minimises bacterial growth on the surface of the finished product. Surveys have shown that over 55% of people fear touching door handles in public restrooms. In addition, the antimicrobial protective finish will remain effective for the useful life of the finish and does not cause any product discolouration.

### **Wood Preservation**

Wood preservation continues to be a major potential use for silver biocides. Research conducted at the US Forests product laboratory, which is part of the Department of Agriculture in Madison, Wisconsin, shows that silver chemicals are effective in improving the resistance of wood to termites. Research sponsored by the Silver Research Consortium and at Florida International University and Mississippi State University indicates that wood treated with liquid preservatives can withstand the South Florida soil environment and exposure to aggressive brown-rot fungus.

Continuing efforts are being made to obtain funding for further research, and these products are currently being looked at by the US Environmental Protection Agency. I can tell you that several major chemical manufacturers are looking to get into this market, because chromium, copper, and arsenic-based wood preservatives were phased out by the US government back in 2003.

### **Textiles**

With clothing, the main issue is smelly fabrics. Odour comes from bacteria, so if you eliminate the bacteria, then you eliminate the odour. This is a huge worldwide market that is just being tapped. It is especially popular in sports clothes. A special ion-laced compression fabric was originally designed for Israeli special forces, but the clothing is now available to everyone. X-Static is a popular silver-based fabric that is used in many garments. It is especially useful in hiking and camping clothes to prevent bacteria build-up and odour. It is a name, like Silverlon, which we will hear about shortly and one that you will see more and more often in advertisements.

Top cyclists are often plagued by skin wounds and other injuries. Rapid resolution of such problems is crucial to achieving maximum performance and winning races. Properly moistened Silverlon proved to be excellent for wraps for skin wounds. The US cycling team applies this product to open wounds, for example abrasions and road burn, which are common in bicycle racing. NASA crew members test their equipment and skills in underwater environments. The crew of Nemo 6 lived in the aquatic test facility off the coast of Florida to simulate life in the confined International Space Station. They all wore silver-based clothing to cut down on bacteria and odour.

### **Home Appliances**

Samsung Electronics has a washing machine that uses the antibiotic properties of silver instead of hot water and detergents to disinfect clothing. When the AG Plus washing machine is set on silver sterilisation, the system generates silver nano-particles that kill off most of the bacteria and mould in the laundry load without using hot water. Two major companies include silver antimicrobials in refrigerators, Samsung and BSH. BSH is based in Germany and is now use nano silver coatings in all its new refrigerator and air purifier product lines.

### **Playgrounds**

Due to its low toxicity, silver is approved for use in everyday items, including those used by children, for example composite plastic playground equipment.

## Consumer Electronics

Motorola is selling a cell phone which is housed in a case that is embedded with AgION's antimicrobial technology.

## Home Water Purification

Floatron is a small solar-powered ionisation product that sends silver and copper ions throughout your home pool to purify and soften the water. It is an example of an in-pool solution that reduces the need for chlorine powder.

## Silver-Based Solder

With the EU banning lead use in electronic equipment, mainly in solder for circuit connections, many manufacturers are switching to a combination of tin, copper and silver instead. The changeover could mean an increase in the amount of silver used in solder, although it is unclear how much because the appropriate ratio of tin, copper and silver is still being determined.

## Silver Inks

We all know that silver is an excellent electrical conductor. In this application, silver inks essentially act as flat wires that are placed on surfaces and used to connect electrical components. A major use is in printed circuit boards, where they replace wires. Dow Corning expects to see double-digit growth in this sector over the next several years, driven by demand from industries as diverse as healthcare, inventory control and logistics.

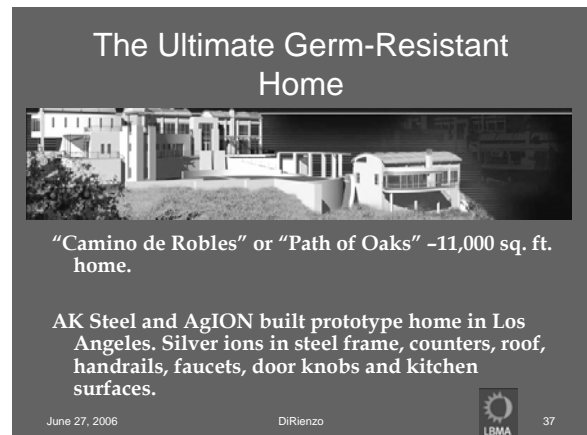
## RFID Chips

Silver printing is the prime technology used by the entire electronics market and it is especially suited to producing flat antennas for RFID chips. The market for these devices is limitless. In a warehouse situation, the tag tracks palette loads in and out, and can provide instantaneous inventory. As the price drops to around 5-cents per unit, it will begin to edge out bar codes on products.

## Building Materials

Protective coating maker EnviroCare has teamed up with PRIMETech, a company that produces machine-coated products to manufacture DOA, a factory finish system for silver ion embedded lumber that resists mildew and mould.

## The Ultimate Germ-Resistant Home



Finally, to tie most of these products into one single entity, this picture shows the ultimate germ-resistant home. AK Steel and AgION built an 11,000 square foot home called Camino de Robles, which means path of oaks, just outside of Los Angeles in California. The home was constructed of steel from frame to roof, which should make it resistant to fires and earthquakes. Silver-embedded areas include areas that are considered high touch, for example, hand rails, faucets, kitchen surfaces, and door knobs.

Heating, ventilation and air conditioning ducts were made of AgION's coated steel, as well as some non steel products such as refrigerator trays and counter tops. As with other silver based antibacterial products, silver ions will be released slower over a long period of time.

## Conclusions

As you can see, silver's use is growing day by day. The potential market for silver in biocide applications is significant. I look forward to answering any of your questions at the end of this panel or throughout the remainder of this conference. Be sure to look out for our reports, which will be released later this year. Thank you for your time and attention. ■

