Solid defence against harmful microbes.

ANTI-MICROBIAL COPPER.

"Hand hygiene cannot be replaced but more can be done in preventing the spread of harmful bacteria on touch surfaces."

COPPER Connects Life.

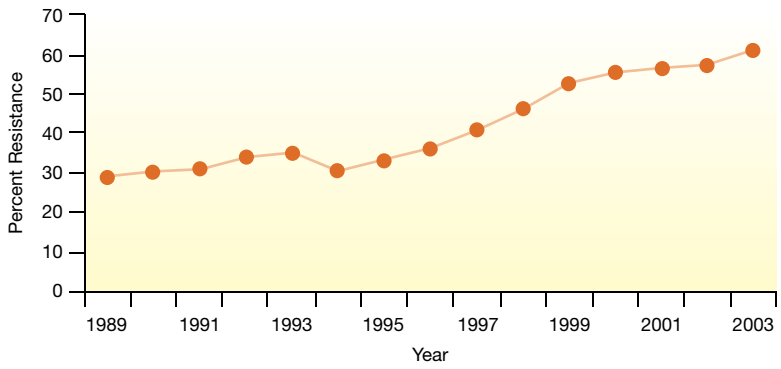
Invisible enemy, visible solution

Microbes, the tiniest form of life on earth, have a dubious record of invading our bodies, food and air, often with devastating results.

Hospital-acquired infections

In the United States, more than 2 million hospital-acquired infections such as MRSA are recorded per year. Among intensive care patients, there has been a steady rise in the proportion of S. aureus nosocomial infections resistant to Oxacillin (MRSA) as shown in Fig. 1. On the whole, hospital-acquired infections cause nearly 90,000 deaths annually [1].

Figure 1: Proportion of S. aureus Nosocomial Infections Resistant to Oxacillin (MRSA) Among Intensive Care Unit Patients, 1989-2003*



* Source: NNIS System, data for 2003 are incomplete

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In United Kingdom, at least 5,000 patients died of complications from infections they contracted in hospitals [2]. Each year, hospital-acquired infections cost the National Health Service in the region of 1 billion pounds [2].

SARS outbreak

Between November 2002 and July 2003, Severe Acute Respiratory Syndrome (SARS), which began in November 2002 in China's Guangdong Province, caused 8,096 known infection cases and 774 deaths worldwide. The SARS epidemic sent shock waves around the world as it quickly spread to Hong Kong, Singapore and Canada.

World Health Organisation (WHO) warned the outbreak highlighted how new deadly microbes could spread quickly around the world, and it was a wake-up call to the very real danger of emerging diseases.

Food contamination

In the U.S., there were 66 major recalls related to more than 60 million pounds of contaminated food products in 2002. Those numbers are a threefold increase from the preceding year. The U.S. Department of Agriculture cites more than 62,000 cases of infection from E. coli O157:H7 each year, incurring an annual cost impact of nearly $660 million. An estimated 1,600 cases of listeriosis cause more than 400 deaths annually.

The enemy is indeed too small to be visible, but the solution to the challenge posed by deadly pathogens, such as MRSA and E.coli, is highly visible: **Copper.**

[1] A 2000 Centre for Disease Control and Prevention report estimate. [2] Report by the National Audit Office.

Antimicrobial Copper

Several research studies have proven that copper and copper alloys are naturally antimicrobial materials. And this fact has now been recognised by the U.S. Environmental Protection Agency (EPA).

Scientific evidence

Paper title: Copper Alloys for Human Infectious Disease Control
(Presented at Materials Science and Technology Conference, September 25-28, 2005, Pittsburgh, PA)

Authors: **H.T. Michels**, Copper Development Association Inc., USA
S.A. Wilks, J.O. Noyce, C.W. Keevil
University of Southampton, School of Biological Sciences, Environmental Healthcare Unit, United Kingdom

Focus and methodology

The focus of this study was the inhibitory effects on bacteria of commercial wrought copper-base alloys, with stainless steel as an experimental control.

The tested organisms included E. coli O157:H7 and Listeria monocytogenes, which are food-borne pathogens associated with several large-scale food recalls, and Methicillin-Resistant Staphylococcus aureus (MRSA), a serious hospital-acquired, or nosocomial infection, which is now finding its way into our communities.

Findings

The pathogenic bacteria tested all died when placed on copper alloy surfaces. The concentration of live bacteria dropped from several orders of magnitude to zero on copper alloys in a few hours.

E. coli O157:H7

A semi-log plot of bacteria count vs time in minutes for C11000, a 99.90% copper alloy, is shown in *Figure 2*. At 20°C, the bacteria count decreases by about one order of magnitude (one log) over 75 minutes and then falls off rapidly and reaches zero at 90 minutes. The zero point, which corresponds to a 9-log drop, indicates the bacteria (E. coli O157:H7) are no longer viable and are dead.

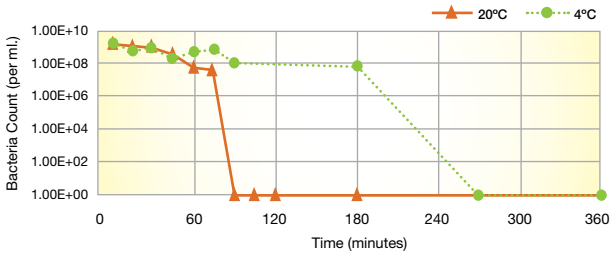
Listeria monocytogenes

The viability of L. monocytogenes was measured on the surfaces of seven alloys and the results at 20°C are presented in *Figure 3.*

Methicillin-Resistant *Staphylococcus aureus*

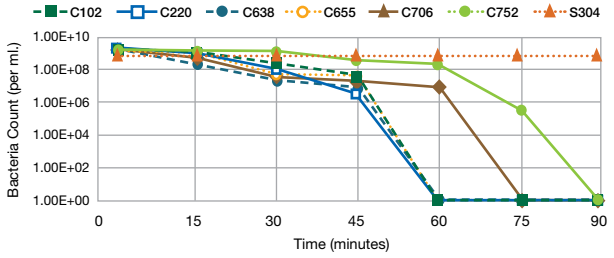
The viability of Methicillin-Resistant Staphylococcus aureus (MRSA) was measured on the surfaces of four alloys and the results at 20°C are presented in *Figure 4*.

Figure 2: *E. coli* O157:H7 Viability on Alloy C1100 Surfaces



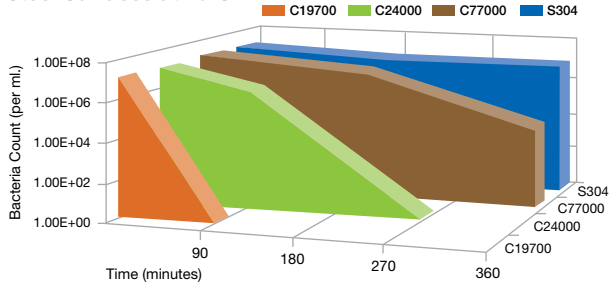
E. coli O 157:H7 Viability on Alloy UNS C10200 Surfaces at 20ºC and 4ºC.

Figure 3: L. monocytogenes Viability on Copper Alloy Surfaces at 20ºC



The Viability of Listeria monocytogenes on the Surfaces of Alloys UNS C10200, C22000, C63800, C70600, C75200 and S30400 at 20°C.

Figure 4: MRSA Viability on Copper Alloys and Stainless Steel Surfaces at 20ºC



MRSA bacteria thrive on stainless steel (blue) but die off quickly on copper (red) and copper alloy surfaces.

Summary

- In contrast to the copper alloys, stainless steel, UNS S30400, a popular material for food-processing equipment and healthcare applications, has little or no inhibitory effect on certain deadly human pathogens.
- The inhibitive effects of copper alloys decrease as copper content of the alloys decreases.
- Results from the study suggest selection of copper alloys for surfaces exposed to human touch or food contact. Using copper alloys can materially assist in reducing the transmission of potentially infectious organisms. The utilization of copper alloys for door handles, door push plates, faucets, bedrails, stair and corridor rails and other hardware, holds the promise of being an effective, passive approach to controlling MRSA in healthcare facilities, including hospitals, clinics, physician's examination rooms and nursing homes. And also, in public facilities such as gyms, spas and public transport systems.

Paper title: **Use of Copper and its Alloys to Reduce Bacterial Contamination in Hospitals**

Authors: **Takeshi Sasahara**, Assistant Professor, Department of Microbiology & Parasitology, Kitasato University School of Medicine
Nanako Niiyama, Medical Doctor, Department of Dermatology, Kitasato University School of Medicine
Miho Ueno, Head Nurse, Nursing Department, Kitasato University Hospital

Findings

The study was an investigation of bactericidal activity of copper and its alloys in the hospital environment.

When grown on the surface of copper alloys, Staphylococcus aureus, Escherichia coli and Pseudomonas aeruginosa were killed depending on the incubation period. Japanese coins made of nickel silver (a copper-nickel-zinc alloy), cupronickel, bronze and brass also inhibited the growth of these bacteria on nutrient agar.

On the basis of the results above, a clinical trial was started to monitor the level of contamination by nosocomial bacteria on the surface of copper alloys and on non-copper materials in the Dermatology Ward and Neonatal Intensive Care Unit (NICU) of Kitasato University Hospital from 2005. The researchers found copper alloys had a superior sanitising effect in the hospital environment. *(Figure 5)*

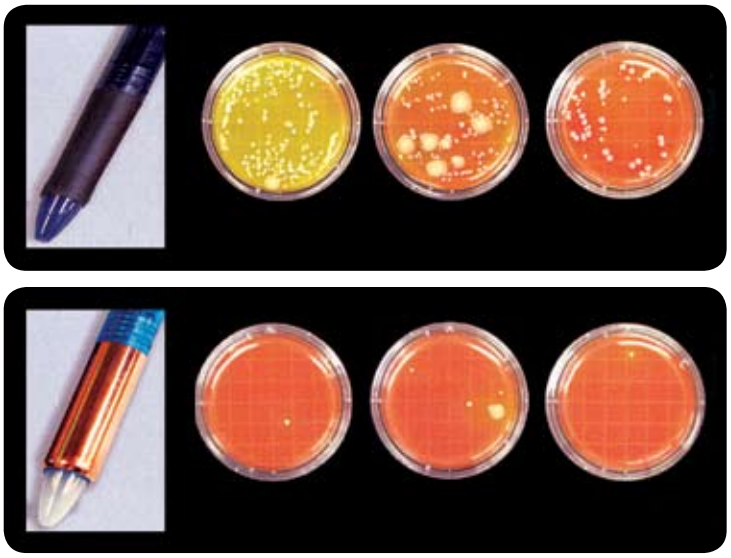


Figure 5

EPA registration

275 copper alloys, including brass and bronze, have been registered with the U.S. Environmental Protection Agency (EPA) as antimicrobial materials that kill these bacteria. The registration acknowledges claims that copper, brass and bronze are capable of killing harmful, potentially deadly bacteria. Copper is the first solid surface material to receive this type of EPA registration, which is supported by extensive antimicrobial efficacy testing.

The laboratory research performed under U.S. Environmental Protection Agency-approved protocols demonstrated that copper alloy surfaces kill more than 99.9% of several bacteria known to be human pathogens within two hours. The organisms tested were:

- **Staphylococcus aureus**
- **Enterobacter aerogenes**
- **Escherichia coli O157:H7**
- **Pseudomonas aeruginosa and**
- **Methicillin-resistant Staphylococcus aureus (MRSA)**

MRSA is one of the most virulent strains of antibiotic-resistant bacteria and a common cause of hospital- and community-acquired infections.

Copper is the first solid surface material to receive this type of EPA registration, which is supported by extensive antimicrobial efficacy testing.

Antimicrobial applications of copper

Copper and copper alloys, besides strong antimicrobial properties, offer a wide range of mechanical and aesthetic properties that make them ideal for use in the healthcare, heating ventilating and air-conditioning (HVAC) and food processing industries.

Touch surfaces in hospitals

In healthcare facilities, surfaces in proximity to patients are of the most concern. Eighty percent of infectious diseases are spread by touch. A hand contaminated with influenza A virus will contaminate the next seven surfaces that are touched.

Many of the commonly used materials in healthcare facilities such as stainless steel have proven to be significant source of cross contamination. Replacing frequently touched surfaces with copper or high-copper alloys such as brass and bronze, which are naturally antimicrobial, can potentially be an effective infection control measure by greatly reducing the microbial load.

Replacing frequently touched surfaces with copper or high-copper alloys such as brass and bronze, which are naturally antimicrobial, can potentially be an effective infection control measure.

Frequently touched surfaces in hospitals which could be made from copper or copper alloys include: door handles, push plates, light switches, bed rails, grab rails, intravenous (IV) stands, dispensers (alcohol gel, paper towel, soap), dressing trolleys, faucets, sinks, counter and table tops. These touch surfaces are all potential reservoirs of infection-causing bacteria. Reducing the number of live germs on these surfaces could help in controlling the spread of MRSA and other hospital-acquired infections.

Heating, Ventilating and Air Conditioning (HVAC)

In today's modern buildings, especially in hospitals, concerns about exposure to toxic microorganisms have created a dire need to improve the HVAC systems - believed to be responsible for over 60% of sick building situations.

Fungi and pathogenic bacteria that are grave threats to public health thrive in moist, dark HVAC environments. Studies have found high concentrations of different species on heat exchanger fins, cooling coils and evaporator pans.

Copper and copper alloys have an intrinsic ability to inhibit the growth of algae, fungi/moulds, viruses and bacteria. With superior thermal conductivity (compared to aluminium and steel) and proven antimicrobial properties, copper is an ideal material for heat exchanger fins, cooling coils and evaporator pans in the air handling units, fan coil units and other heat exchangers.

Food processing

CDA studies demonstrate the efficacy of copper and copper alloys to inactivate food-borne microbes at room and chill temperatures. The evidence suggests that stainless steel, the most common touch surface material in the food-processing industry, has little or no efficacy in combating contamination.

Copper's antimicrobial properties are a potential solution to help prevent cross-contamination and subsequent human infections emanating from the food-processing industry. Chief among the pathogens of concern are Listeria and E. coli, which affect beef, pork and poultry products.

Conclusion

Copper and copper alloys, backed up by EPA registration and scientific proof of its natural antimicrobial properties, can materially assist in protecting us against the menace of diseases caused by harmful microbes. These materials have a significant potential to make a difference to human health, cost of businesses and human survivability in healthcare, HVAC and food processing industries.

The use of a Copper Alloy surface is a supplement to and not a substitute for standard infection control practices; users must continue to follow all current infection control practices, including those practices related to cleaning and disinfection of environmental surfaces. The Copper Alloy surface material has been shown to reduce microbial contamination, but it does not necessarily prevent cross contamination.

COPPER Connects Life.

International Copper Association (ICA)
ICA is the leading organisation for the promotion of copper worldwide. The Association guides policy, strategy and funding of international initiatives and promotional activities. Headquartered in New York City, ICA operates in 30 worldwide locations through a network of regional offices, and copper development associations and centres to execute programmes and initiatives.

International Copper Asia, Ltd (ICAsia)
ICAsia is one of four world-wide operating arms of ICA; its regional head office is located in Singapore. It maintains a network of ten offices in Australia, China, India, Japan and South East Asia.

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