Copper and copper alloys for the healthcare sector

By E Swanepoel, Copper Development Association Africa

Today, designers and architects have a key role to play in designing infection out of our hospitals and public spaces, and now they have a new ally: Copper. Healthcare facilities are high traffic environments, as they not only house patients, doctors, nurses and administration staff, but they also host patients' families and many visitors. This number of people can pose a significant risk of cross contamination and infections. However, any antimicrobial copper items will continuously reduce surface contamination, 24/7 and in-between cleans, essentially augmenting existing sanitation procedures.

Copper is inherently antimicrobial with proven rapid, broad spectrum efficacy against pathogens threatening public health in both hospitals and the wider community. Recent clinical trials around the world have confirmed the benefit of deploying touch surfaces made from antimicrobial copper to reduce microbial contamination and lower the risk of acquiring infections, as well as improving patient outcomes and saving costs. A new cost benefit model developed by the York Health Economics Consortium allows hospital managers to assess the return on investment of a copper installation, based on the cost difference between copper and standard components, and the savings from reduced infection rates. For example, on a new build, 20-bed intensive care unit in the United Kingdom (UK), payback was yielded in less than two months.

Copper and more than 450 copper alloys that benefit from copper's inherent antimicrobial efficacy, collectively referred to as antimicrobial copper, have been granted a registration by the US Environmental Protection Agency (EPA), permitting them to be marketed in the United States (US) with public health claims. The resultant use of antimicrobial copper surfaces in hospitals has become a global phenomenon, with manufacturers responding to demand by offering a wide range of antimicrobial copper products, taking advantage of the versatility of copper alloys to provide different colours and finishes.

Antimicrobial copper applications

Antimicrobial copper can be harnessed in a wide range of applications where hygiene is important, such as touch surfaces, food preparation areas, heating, ventilation and air-conditioning (HVAC) systems, and lighting.

Touch surfaces

In recent years, it has been reported that 80% of all infections are spread by touch, and a contaminated hand can infect the next seven surfaces it touches. Hospitals, in particular, faced with the problem of healthcare-associated infections (HCAIs), are looking more closely at the role of the facility's environment in the spread of these infections as hand washing campaigns alone have failed to control the problem. With antimicrobial surfaces, disease causing pathogens such as Methicillin-resistant Staphylococcus Aureus (MRSA), Clostridium difficile or C difficile (a bacterium that can cause symptoms ranging from diarrhoea to life-threatening inflammation of the colon), Influenza A (H1N1 or Swine 'Flu) and Norovirus (highly contagious stomach bug), are rapidly and continuously eliminated, as research has shown that antimicrobial copper surfaces harbour 95 to 99% less microbial contamination than equivalent non-copper surfaces.

Antimicrobial copper offers a new approach, a new way of thinking: employing an engineering material with intrinsic antimicrobial properties to help protect public health.

When used to supplement standard hygiene practices, such as hand washing, cleaning and disinfection, copper reduces contamination and the risk of infection dramatically. In hospitals, clinicians have identified medical equipment (such as taps, bed rails, drip poles and stethoscopes), furniture (including chairs, overbed tables, bedside cabinets) and fixtures and fittings (for example taps, door handles and light switches) as high risk touch surfaces.

Additionally, a recent study has shown that copper surfaces in an intensive care unit (ICU) have also lowered contamination on adjacent surfaces due to a 'halo effect'. Results from a clinical trial at the Aghia Sofia Children's Hospital in Greece showed that, in addition to contamination being 90% lower on the copper surfaces, they exerted a halo effect whereby non-copper surfaces up to 50 cm away exhibited a more than 70% reduction in contamination, as compared to surfaces not in the copper's proximity.

Food processing and preparation

The incidence of food-borne infections and high spoilage rates suggests that current measures are not always effective in minimising contamination of the world's food supplies. Hygienic surfaces, made

with copper and copper alloys, can be used in food processing areas to help reduce the risk of cross-contamination of moulds and even dangerous food-borne pathogens. Suggested applications include dry food contact surfaces (such as mixers, transfer chutes, conveyors and work tables) and touch surfaces (for instance door fittings and taps).

Heating, ventilation and air-conditioning

Heating, ventilation and air-conditioning (HVAC) systems are believed to be factors in over 60% of all 'sick building' situations and can also benefit from antimicrobial copper components, such as filters, cooling fins, drip pans and tubes, which eliminate bacterial and fungal growths that typically thrive on damp internal surfaces. This can potentially improve the resultant air quality. Apart from commercial and public buildings, controlled air spaces such as operating theatres and food preparation areas may especially benefit.

Lighting

Perhaps no area of the medical facility has greater need for precise lighting levels than the surgical suite. Controllable light levels in these areas are critical. They require high light levels to prepare the room and equipment for medical procedures, while lower light levels are needed when video screens, computers, and microscopes are used to clearly view the images. Doctors need lower perimeter lighting to reduce eye fatigue and remain focused during long procedures. Also, during procedures where the patient is awake, lower ambient light levels help the patient relax.

Recently, the world's first antimicrobial copper surgical lights, aimed at reducing the spread of infection in operating theatres, were debuted. These lights combined the necessary lighting control features along with the broad-spectrum antimicrobial efficacy of copper, thus offering an additional line of defence against infection, which could be critical to post-surgical patient outcomes.

Copper and copper alloys

Copper is well known for excellent thermal and electrical properties, as well as high ductility. However, copper also forms alloys with a wide range of elements to produce the following cast and wrought alloy families:

Copper with:

- Tin makes bronze
- Tin and phosphorus makes phosphor bronze
- Aluminium makes aluminium bronze
- Zinc makes brass
- Nickel makes copper-nickel.

One of the key requirements of an approved antimicrobial copper alloy is that there must be a minimum copper content of 60%. As a general rule, efficacy increases with copper content.

Abbreviations

AMC – Antimicrobial Copper
EPA - Environmental Protection Agency (United States of America)
HVAC - Heating, Ventilation and Air-conditioning
HCAI - Healthcare-associated Infection
MRSA - Methicillin-resistant Staphylococcus Aureus
ICU - Intensive Care Unit

Alloying provides improvements to strength, hardness, ductility, machining and joining properties, and castability and corrosion resistance, but results in lower electrical and thermal conductivities.

Designers and manufacturers who wish to use copper alloys for the production of antimicrobial components will find that they are easy to fabricate by machining, hot or cold working or casting. There should be no problem with existing tooling and fabrication equipment used for other materials.

With over 450 approved alloys to choose from, offering a wide range of properties and attributes, it is easy to select an appropriate alloy for the application and fabrication route required. In fact, there will usually be several that meet particular design requirements.

Alloy selection criteria

Product design must encompass many factors including aesthetics, economics, ergonomics and engineering. Together, these inform the choice of material and manufacturing route to achieve the most suitable design solution. Copper alloys continue to be widely specified because they are the most suitable material for those applications where they excel. However, the use of copper alloys for key touch surfaces is a relatively new field of design and requires consideration.

Alloy selection will often be a balance between aesthetics and antimicrobial efficacy. In long term clinical trials, where copper and alloys have been used in a busy hospital environment, no significant difference in performance has been detected between alloys. This is probably because other factors such as recontamination and

cleaning frequency influence the efficacy more than the differences between alloys. This is important as it allows choice to be made on the basis of other factors such as strength, form and colour: copper alloys are stronger and generally easier to fabricate or machine than pure copper.

In cool or refrigerated spaces, copper has been shown to be the most active surface and should be considered first. In such environments, often in pathology departments or food preparation areas, regular cleaning is the norm, so undue tarnishing should not become an issue. Many copper alloys will perform in the same way as, or better than, steel when fabricated into complex shapes by deep drawing or stamping. Many common components use copper alloys specifically because they are easier to work than other materials and offer both technical and economic advantages.

For antimicrobial touch surfaces, often colour will be a primary factor in alloy choice, confining the designer to a small family of alloys; whereas for components where colour may not be important, normal design criteria can be accommodated by one or more of the alloy families.

Cost-effectiveness

Copper alloys continue to be major industrial metals because they are both technically and economically most suited to their chosen application. There are many factors, sometimes overlooked, that contribute to the low costs of copper alloy components:

- Close tolerance manufacturing techniques can be employed so that finishing costs are minimal
- Tooling costs may be significantly lower than for other materials or processes
- Ease of machining means that production costs can be minimised
- In addition to these benefits, the high value of any process scrap can be used to reduce production costs significantly
- The long service life normally expected of well-designed components means that the costs of service failures are minimal
- Copper alloys are easy to work with and can reduce overall manufacturing costs.

Hygienic product design

When designing functional products with hygiene in mind, selecting an antimicrobial copper alloy is the first step, but consideration also needs to be given to optimising design for the following:

- Avoidance of crevices, rough surfaces, joins and hard-to-reach contours, which could trap dirt
- Surface finish - generally the smoother the finish, the easier it will be to keep clean, although a satin or brushed finish will retain its appearance for longer
- Ease of cleaning and decontamination
- Encouraging touch in specific areas so cleaning staff know where to focus their efforts
- Compatibility with different design schemes
- Importance of colour-matching with other components in a suite of antimicrobial copper products (including non-touch surfaces)
- Compliance with local disability laws, which may require colour or shade contrast
- Compliance with relevant product standards, especially in healthcare settings where additional requirements may have to be considered

Conclusion

Copper is a powerful antimicrobial with proven rapid, broad spectrum efficacy against pathogens threatening public health. Touch surfaces, food preparation areas and ventilation systems, in particular, have been identified as major contributors to cross contamination and infection and present opportunities for incorporating copper alloys.

Copper and its alloys can be used to upgrade or enhance existing designs of equipment. The alloys are strong and amenable to common fabrication techniques without expensive tool changes and present a new colour palette to designers. In the factory, antimicrobial copper alloys are easy to work and there is a well-developed infrastructure to take advantage of copper's excellent recyclability. In the field, copper alloys are durable, will not lose their intrinsic antimicrobial efficacy over time and are safe to use.

The Copper Development Association Africa is engaging with healthcare facilities in South Africa and the rest of Africa to promote this life saving metal and reduce the rate of infections in hospitals and clinics.

AMC products are manufactured and available in South Africa.
Cu+ mark is the only recognised mark for AMC.
When purchasing a product, insist on the supplier being Cu+ registered.

Copper Development Association Africa

The Copper Development Association Africa (CDAA) has represented the local copper industry in southern Africa since 1962 and now promotes copper usage throughout Africa. The CDAA's head office is based in Johannesburg and, on behalf of its members, the organisation is committed to promoting and expanding the use of copper and copper alloys throughout Africa.

Enquiries: Tel. 011 824 3916 or email evert.swanepoel@copperalliance.org.za. Visit www.copperalliance.org.za.

Evert Swanepoel is centre director for the Copper Development Association Africa (CDAA) - responsible for promoting and expanding the use of copper in Africa. His vast experience in managing large businesses has provided him with the skill and knowledge to promote both current and new copper projects that are positioned to increase the demand and utilisation of this ductile metal throughout Africa. He aims to expand the CDAA membership in South Africa and the rest of Africa to include the complete spectrum of the copper industry, from primary through to downstream companies and service organisations. Enquiries: Tel. 011 824 3916 or email evert.swanepoel@copperalliance.org.za. Visit www.copper.co.za.

About the author