SYNOPSIS

KEY POINT SUMMARY

OBJECTIVES

The objective of this study was to determine why discoloring occurs in some copper alloys after extended exposure to hand contact.

DESIGN IMPLICATIONS

The study found that cupronickel (C752) and nickel-silver (C706) retained their shine on being exposed to human sweat better than as compared to other antimicrobial copper alloys. Existing literature, according to the authors, indicates that many people have a contact-allergy to nickel. Cupronickel (C752) may thus be a more suitable antimicrobial material for various surfaces in hospitals.

Study of relative color stability and corrosion resistance of commercial copper alloys exposed to hand contact and synthetic hand sweat

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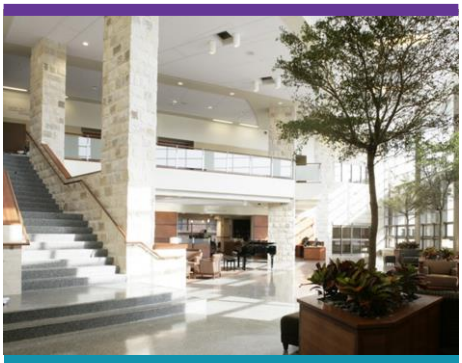
Key Concepts/Context

The authors acknowledge that the U.S. Environmental Protection Agency (EPA) recognizes more than 300 copper alloys to have antibacterial properties. They refer to different studies that have demonstrated substantial decreases in bacterial and fungal colonies on various hospital surfaces that are made of copper alloys versus plastic and stainless steel. Although these studies strongly recommend the use of antimicrobial copper alloys in hospitals, the authors indicate that the tendency of the copper surfaces to become discolored after continuous hand contact make it a less attractive option in healthcare facilities. In this study the authors conduct a hand baton test and analyze (synthetic) human palm sweat and its impact on copper and four of its alloys to understand why such discoloring occurs. The study found that the copper alloys with high nickel content were less prone to becoming tarnished.

Methods

The authors performed natural hand contact and electrochemical tests with commercial purity copper (C110) and four copper alloys (cupronickel (C752), nickel-silver (C706), brass (C260), and bronze (C510) to study their color stability. Hand batons were built with the above metal and alloys and exposed discontinuously to palm sweat of different people and to indoor air for varying time periods over a total period of two years. The batons were then subjected to various tests – scanning electron microscopy, glancing angle X-ray diffraction, and chronopotentiometry to determine what contributed to the discoloring of the batons. Due to varying reports in literature about the composition of palm sweat, synthetic palm sweat was created in the laboratory after the palm sweat of 21 people (of varying ages, genders, and ethnicities) was analyzed. Sample wires of the



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above metal and alloys were immersed in flasks containing 250 ml of the artificial sweat for one month. These wires were analyzed via electrochemical impedance spectroscopy (EIS) and scanning electron microscopy.

Findings

The study yielded the following findings:

Discoloring:

- The hand contact test revealed that copper (C110), brass (C260), and bronze (C510) became dark and dull; cupronickel (C752) and nickel-silver (C706) retained their shine.
- Scanning electron microscopy tests revealed that the surfaces of the copper (C110), brass (C260), and bronze (C510) batons had become rough and had multiple continuous pits; the cupronickel (C752) and nickel-silver (C706) batons revealed micro pits on the surface under higher magnification.
- The glancing angle X-ray diffraction tests revealed the presence of oxide deposits on the surface of all batons. The chronopotentiometry tests found that brass (C260) and cupronickel (C752) had thinner oxide deposits than the other three batons. This, however, did not affect the brightness of the batons.

Corrosion resistance:

- The EIS revealed that copper (C110) had the highest corrosion resistance, then brass (C260), followed by bronze (C510). Cupronickel (C752) and nickel-silver (C706) had the lowest corrosion resistance.
- Scanning electron microscopy tests revealed that the surfaces of nickel-silver (C706) wire had a thick green precipitate and had a rough porous surface, whereas copper (C110) had a much smoother surface. This finding was contrary to the findings pertaining to the baton.

Limitations

The authors do not identify limitations to their study, but mention making improvements to their study protocols. The literature reviewed and summarized by the authors indicate that sweat rates of people vary. The authors do not mention if they recorded the sweat rates of the people who touched the batons, how many times each baton was touched, and if the same people touched each baton.

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