



## Letter to the Editor

# Novel transparent copper film with antibacterial activity for environmental infection control

Dear Editor,

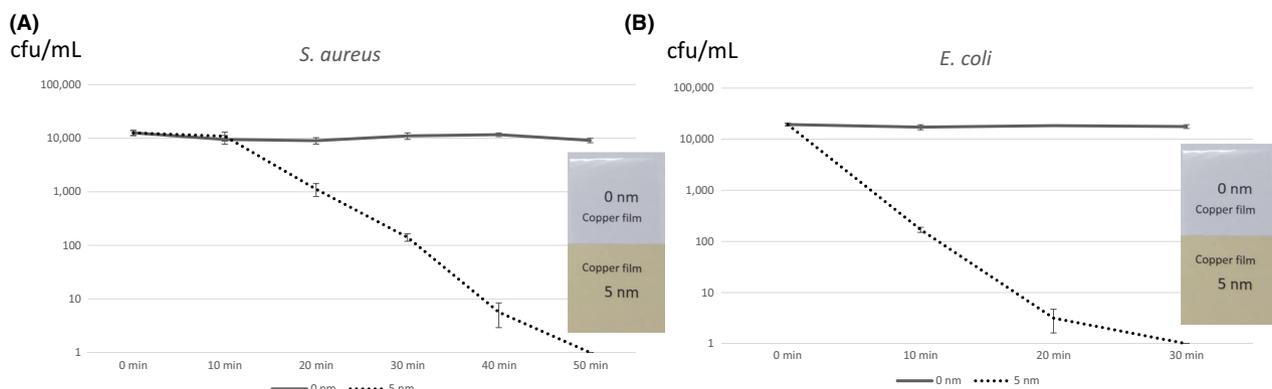
The wide distribution of severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) in the air and object surfaces in hospital wards, which indicates a potential risk of nosocomial infection for medical staff and other close contacts, was reported from Wuhan, China.<sup>1</sup> In another report, van Doremalen *et al.*<sup>2</sup> showed that SARS-CoV-2 was not detectable on copper after 4 h, although it was stable and viable on plastic and stainless steel up to 72 h. Their results indicated that some metals, such as copper, could become an antiviral material to protect against environmental contamination from SARS-CoV-2.

We recently developed a novel transparent copper film using a sputtering method (patent applied for; cooperative research with UACJ Corporation, Tokyo, Japan). According to the International Organization for Standardization (ISO) rules (available on line at the ISO website<sup>3</sup>), we proved the antibacterial effect of this new film against *Staphylococcus aureus* and *Escherichia coli*. The strains used in this study were *S. aureus* (ATCC6538P) and *E. coli* (ATCC8739). We incubated the copper film with *S. aureus* or *E. coli* at 37°C and more than 90% relative humidity.

We examined two experimental conditions for copper film coatings (0 and 5 nm), with 0 nm being the control. All experimental measurements are reported as means across

three replicates. With the 5-nm copper film, the bacterial colonies of *S. aureus* were exponentially reduced, and no viable bacteria were found after 50 min (Fig. 1A). The colonies of *E. coli* diminished even more quickly, and no colonies were present after 30 min (Fig. 1B). For the colonies of both bacterial species, no reduction in count was found on the 0-nm film.

The antimicrobial effect of soluble micro metal was first revealed 100 years ago. The antimicrobial effect of silver is the most well known in the medical field and is present in creams containing Ag<sup>+</sup> or medical equipment coated with Ag<sup>+</sup>. Copper, which has an antimicrobial effect more than 100 times stronger than that of silver, has been used in water pipes and as an industrial material, but it is not yet well known in the medical field. Recently, the strong antimicrobial effect of copper against methicillin-resistant *S. aureus*, multidrug-resistant *Pseudomonas aeruginosa*, and *E. coli* was revealed, which indicated the strong potential of copper for infection control including that of antimicrobial-resistant bacteria in the medical field.<sup>4</sup> Antiviral effect of copper was reported in norovirus, influenza virus, and SARS-CoV-2.<sup>2,5</sup> Infection control of these viruses with copper products is also expected in the future. However, copper itself is not transparent, which has made its antimicrobial effect difficult to introduce in the medical field. The novel transparent



**Fig. 1.** A, Number of bacterial colonies of *Escherichia coli* over time (solid line, transparent film with 0-nm copper coating; broken line, transparent copper film with 5-nm copper coating). B, Number of bacterial colonies of *Staphylococcus aureus* over time (solid line, transparent film with 0-nm copper coating; dotted line, transparent copper film with 5-nm copper coating). The pictures on the right side of each graph are transparent films with 0- and 5-nm copper coating. The plots show the means and error bars show the standard deviations across three replicates. cfu, colony forming unit.

copper film reported here can be used as a face shield, partition, keyboard cover, or control panel cover on medical equipment without disturbing its operation. Although we have not examined its antiviral effect yet, we think this novel film could help to prevent nosocomial infection not only in hospitals but also nursing homes and nursery schools in which environmental contamination could easily cause a disease outbreak.

## DISCLOSURE

Approval of the Research Protocol: N/A.

Informed Consent: N/A.

Registry and the Registration no. of the Study/trial: N/A.

Animal Studies: N/A.

Conflict of Interest: This work was undertaken as cooperative research with UACJ Corporation, Tokyo, Japan.

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