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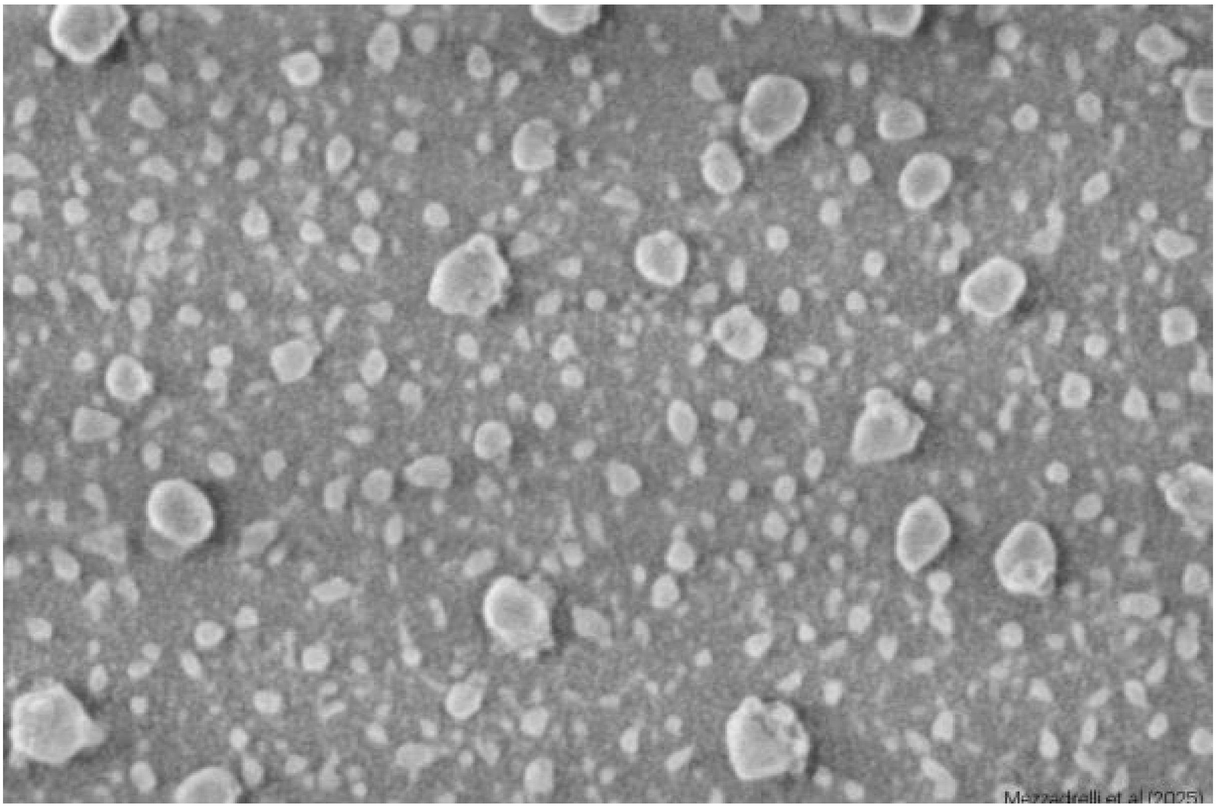

New alloys and embedded nanostructures for durable, color-neutral antimicrobial touchscreens

A team led by ICFO researchers has reported two new strategies in antimicrobial glass technology for touchscreens, utilizing a novel copper-zinc alloy for color neutrality and a "shielded" nanohole architecture to ensure mechanical durability of antimicrobial surfaces.

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Touchscreens are everywhere in our daily life, from smartphones and tablets to ATMs, but they also act as reservoirs for harmful microorganisms and hotspots for infectious diseases transmission. There is an increasing demand for antimicrobial transparent surfaces and coatings that inhibit the microbial growth on touchable screens.

While copper is a well-known antimicrobial agent, its implementation in interactive displays has been hindered by its distinctive reddish color, opaqueness, and its susceptibility to being

worn away by constant physical contact if integrated directly on the device surface. Its good electrical conduction is also a limitation for its implementation in touch-enabled devices, as they required complete insulation to preserve its touch sensitivity.
Now, in two recently published studies in Scientific Reports and APL Materials, a team of researchers from ICFO has reported two new approaches to overcome these challenges.

Copper-Zinc alloy for color neutrality

The first approach has been reported in an article published in Scientific Reports by ICFO researchers Alessia Mezzadrelli, Rubaiya Hussain and ICREA Professor at ICFO Valerio Pruneri in collaboration with researchers Wageesha Senaratne and Prantik Mazumder. The study introduced the use of a copper-zinc (Cu-Zn) alloy instead of pure copper as antimicrobial agent for developing transparent and color-neutral glass surfaces tailored for its use in touchscreen display applications.
While previous research on nanostructured copper achieved high antimicrobial efficacy figures, it often resulted in a slight reddish tint that affected the transparency of the screen. By mixing copper with zinc, the researchers successfully "dampened" the intrinsic copper color offering a significantly improved chromatic neutrality.
In their work, the researchers deposited nanostructured copper-zinc (Cu-Zn) ultra-thin film on existing glass surface samples and processed using a simple, scalable, and lithography-free technique.
The resulting optimized surface samples achieved a high level of transparency, with an average visible light transmission exceeding 80%, and a true color neutrality (no color tint), that is a color difference (?E) of 2.77, meeting the required industry standards for displays. The researchers tested also the antimicrobial performance of the surface samples. The biological testing confirmed that the coating showed rapid and high bactericidal efficacy with a 99.9% reduction of bacteria like Staphylococcus Aureus and Escherichia Coli.
ï¿½These findings open the path to have a scalable and effective solution for next-generati n high hygienic interactive display technologies based on Cu-Zn, also thanks to t e lithography-free fabrication processï¿½, said Alessia Mezzadrelli, early stage researcher (SR) of the Nano-Glass project at ICFO and first author of the st

Copper nanodisks shielded in nanoholes

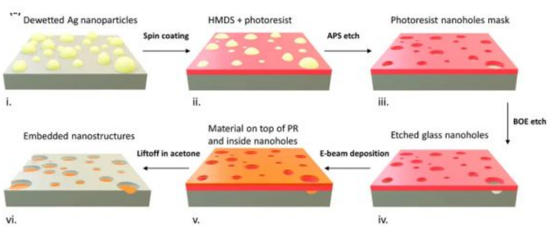
In a second study published in APL Materials, the ICFO researchers Iliyan Karadzhov, Rubaiya Hussain, Alessia Mezzadrelli, and ICREA Prof. Valerio Pruneri at ICFO collaborated with researchers Wageesha Senaratne and Prantik Mazumder to develop a transparent and robust glass surface designed to keep antimicrobial copper working even after repeated finger swipes and cleaning. The key idea is to place the antimicrobial material just below the surface ï¿½wear planeï¿½, where it is protected from abrasion while still able to release ions that can kill bacte

ia. Using a scalable, lithography-free six-step process compatible with wafer-s
ale manufacturing, the team created millions of nanoholes (around 80-100 nm deep) in
lass samples and deposited copper nanodisks at the bottom of each hole. The engi
eered surface acts like a protective armor: swipes from fingers or cleaning cloths pass over th
 top, while the copper remains sheltered under
eath. In abrasion tests simulating thousands of swipes, the embedded copper remained i
tact, with no loss of optical or antimicrobial performance. The surfaces showed 80%-85% a
erage transmission in the visible range and only minimal color shift compared to uncoated gla
s. In lab tests, the surfaces also achieved a 99% reduction of *E. coli* after one hour of contact.
i¿½These results demonstrate a scalable route to mechanically durable, optically cle
r antimicrobial surfaces for touch-based devices and everyday transparent materials,i¿½
aid Iliyan Karadzhov, first author of the study and NANO-GLASS project
SR. Both studies rely on thermal dewetting, in which a thin metal film breaks into nanos
ale structures when heated, enabling complex designs without expensive lithography. i¿
?With these two studies, we have shown that it is possible to enhance the antimic
obial performance and durability of touch-enabled display surfaces using cost-eff
ctive approachesi¿½, said Valerio Pruneri, ICREA Professor at ICFO and NANO-GLASS
project coor

Original Papers:

Mezzadrelli, A., Hussain, R., Senaratne, W., et al. (2025). Color-neutral, transparent, antimicrobial glass surface based on nanostructured Cu-Zn. Scientific Reports, 15, 43298. https://doi.org/10.1038/s41598-025-27050-5

Karadzhov, I., Hussain, R., Mezzadrelli, A., Senaratne, W., Mazumder, P., & Pruneri, V. (2025). Lithography-free fabrication of transparent, durable surfaces with embedded functional materials in glass nanoholes. APL Materials, 13(12), 121112. https://doi.org/10.1063/5.0304861



The developed fabrication process for embedding nanostructures in the glass (Credit: Karadzhov et al).