Antiviral Copper Oxide Impregnated Face Masks Kill the SARS-CoV-2 Virus which causes the covid-19

Copper is a potent biocide

Exposure of microorganisms (viruses, bacteria and fungus) to a high concentration of copper results in their death within minutes. Copper toxicity to microorganisms is achieved through several parallel mechanisms. The first site that copper damages is the microorganisms' envelope, followed by alteration of proteins and inhibition of their biological activity, and denaturation of genetic materials.[1,2]

MedCu copper oxide impregnated fabrics possess potent biocidal properties

Impregnation of different fabrics with copper-oxide microparticles (Figure 1) endows the fabrics with wide spectrum potent biocidal properties.

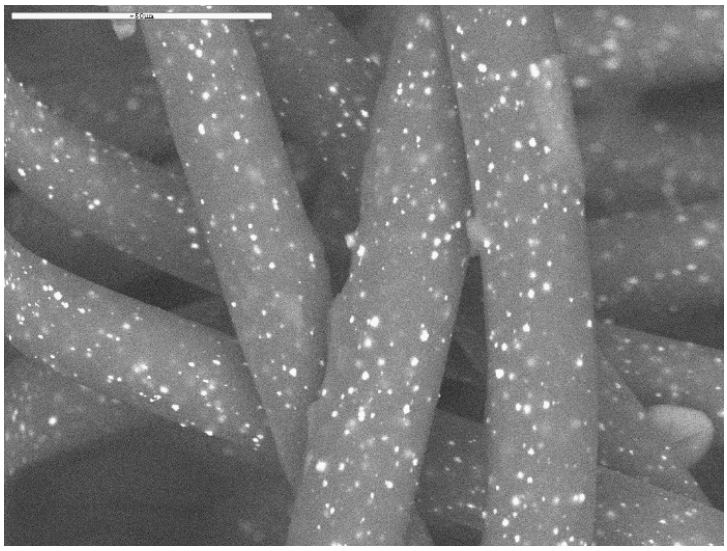

Figure 1. Scanning electronic microscope image of polypropylene fibers impregnated with copper oxide microparticles. The white dots are copper oxide microparticles. The particles are physically impregnated in the polymeric matrix.

The potent biocidal properties of textile products impregnated with copper oxide microparticles have been widely published in many peer-reviewed scientific articles.[3-9]

Copper, and copper-oxide, have potent virucidal properties.[2] The capacity of copper to readily neutralize corona viruses was demonstrated.[10] Respiratory face masks, in which the external nonwoven layers were impregnated with copper oxide microparticles, reduced the infectious titers of Human Influenza A (H1N1) and Avian Influenza Virus (H9N2) virions that remain on the mask, by more than 99.9% in 30 minutes of the viruses exposure to the mask.[7] The high capacity of the copper oxide impregnated nonwoven fabric to neutralize 12 additional different pathogenic viruses was demonstrated in separate studies.[5,6,11] Recently it was demonstrated that copper kills the SARS-CoV-2 virus.[12,13]

Face masks become contaminated with the SARS-CoV-2 virus

Surgical masks, N95 and other face masks are now being used widely not only by healthcare and first responders, but by most of the world population, in view of the current COVID-9 pandemic caused by SARS-CoV-2 virus. Face masks can become contaminated with viral pathogens following their prolonged use.[14-16] The SARS-CoV-2 virus is transmitted mainly through droplets and aerosol particles generated during coughing or sneezing by symptomatic patients and asymptomatic individuals even before the onset of symptoms. Thus, both internal and external mask surfaces can become contaminated with the virus. It has been demonstrated that the SARS-CoV-2 virus can survive and remain infectious on the surface of regular masks for up to 7 days.[17] Mask and face touching is a frequent habit,[18] and thus the handling, use and disposal of regular face masks can significantly increase cross-contamination, viral transmission and viral infection.

Copper Oxide Impregnated Masks readily kill the SARS-CoV-2 virus

As depicted in Figure 2, masks in which the external layers were made with MedCu copper oxide impregnated nonwoven fabrics (orange or salmon color) inactivated 100% of the SARS-CoV-2 virus exposed to the masks surface as compared with regular masks already after **10 minutes** of exposure.

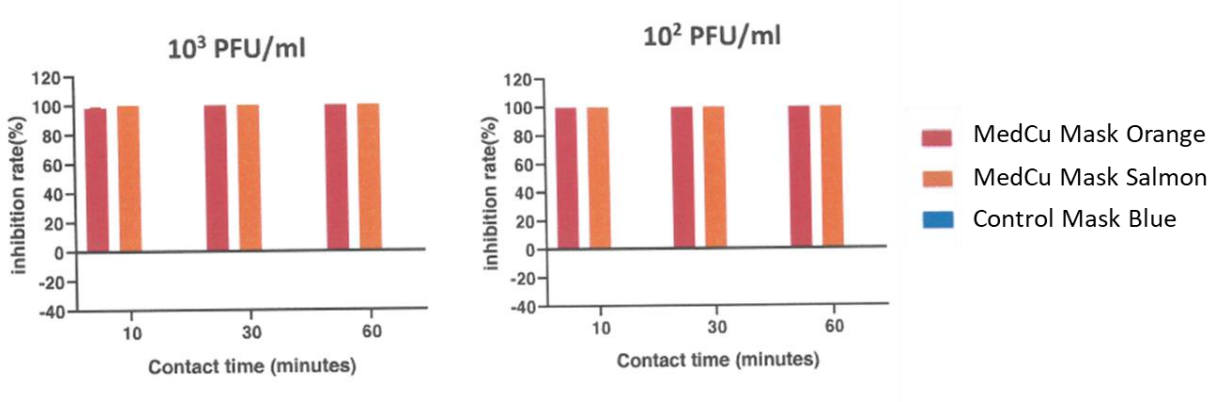

Figure 2: Inactivation of SARS-CoV-2 by masks in which the external layers are made with MedCu copper oxide impregnated nonwoven fabrics, as compared with masks in which the external layers are made with ordinary nonwoven fabrics (testing laboratory: State Key Laboratory of Emerging Infectious Diseases, University of Hong Kong)**.** Prof. Yi Guan, who is one of most famous virologists in the world, signs the report).

"PP Spun Bond Nonwoven Fabrics Containing Copper Oxide shown remarkable inactivation effects on SARS-CoV-2 at all titers."

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When the masks were exposed to 100 times higher titers (amounts) of SARS-CoV-2, more than 99% reduction of virus infectious titers was achieved within 30 minutes of the virus exposure to the masks (Figure 3).

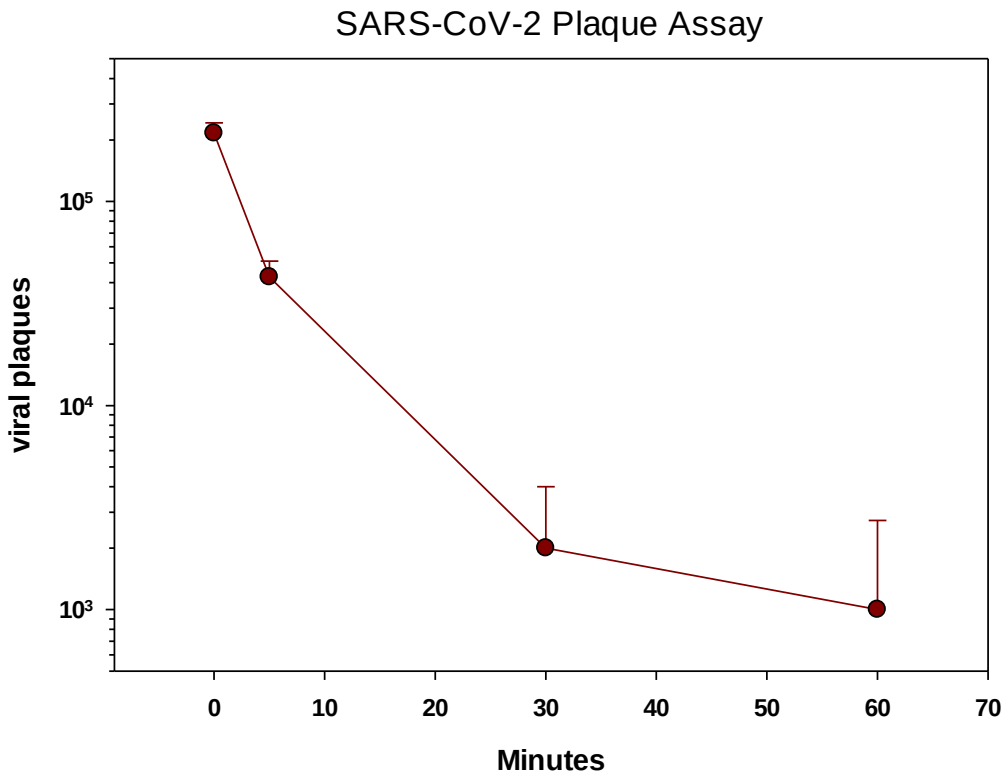

Figure 3. Copper oxide impregnated masks reduce high titers of the SARS-CoV-2 infectious virions by more than 99% within 30 minutes (P3 Lab of Fudan University, Shanghai, China)**.**

The capacity of MedCu copper oxide impregnated masks to neutralize and drastically reduce the infectious titers of the SARS-CoV-2 virus was confirmed by 3 separate labs.

The effect on the virus by the copper present in the MedCu masks external layers starts immediately when the viruses reach the mask. The presence of an antiviral nonwoven fabric, in both the layer in contact with the face and in the external layer of the mask, significantly reduces the risk of cross contamination during mask use, handling and disposal. The internal layer is especially relevant regarding asymptomatic individuals, who unknowingly contaminate their masks, making them a hazardous object. Following the mask handling and removal, they may contaminate their hands or gloves. Then unintentionally they contaminate other high touch surfaces, such as door handles and elevator buttons. Placing the contaminated masks in common areas can create cross

contamination. Taken together, these surfaces may be touched by unexposed individuals, who then can become infected.

Copper Oxide Impregnated Masks readily kill bacteria

Many of the face masks are used for hours, and thus exposed mainly, but not only, to the wearer's own bacteria. Masks are made from textile fabrics that can serve as a good substrate for bacteria, which in the presence of the breath moisture and warmth, proliferate and secrete unpleasant volatile molecules [19]. Recently, bacteria culture experiments were conducted with four types of masks. It was found that after using them for a day, bacteria, including antibiotic-resistant bacteria commonly found in the skin and mouth, were detected in all masks (https://news.v.daum.net/v/20200724210003573). Therefore, after not too prolonged use of the masks, the masks not only may emanate malodor but, more importantly, be a potential source of bacterial cross-contamination of the environment during handling and disposal of the masks.

As can be seen in the Figure 3 of a representative experiment, **the MedCu copper oxide impregnated external layers of the masks (MedCu NW Fabric) kill more than 99% of the bacteria exposed** to the fabrics within 15 minutes of exposure, and more than 99.9% of the bacteria after 1 hour. In contrast, the bacteria proliferates in the control nonwoven fabric regularly used in face masks.

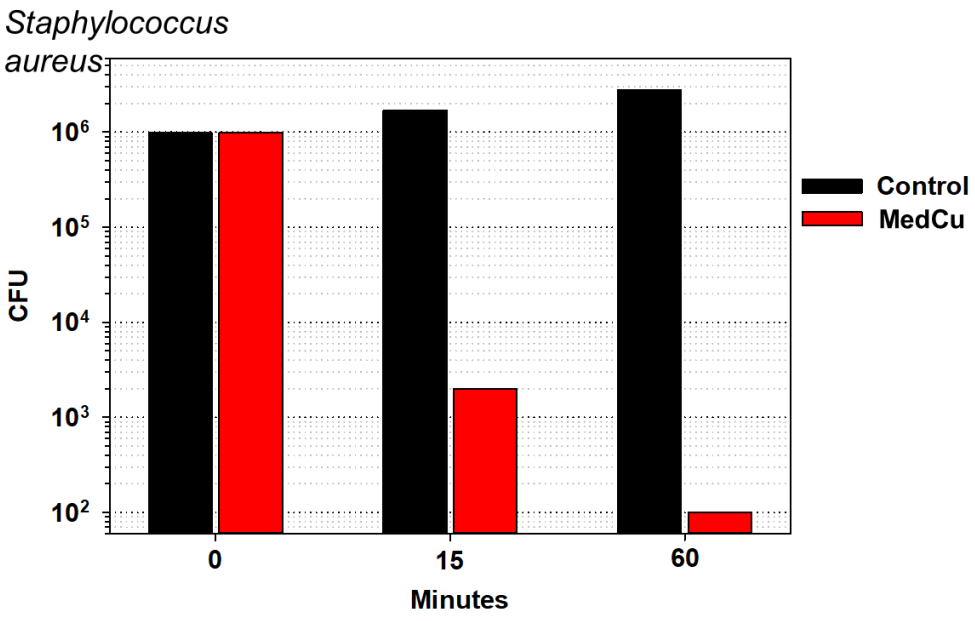

Figure 3. MedCu copper oxide impregnated fabrics kill more than 99% of the tested bacteria during 15 minutes of exposure of the bacteria to the mask surface.

Textiles in general are a good substrate for bacterial and fungal proliferation. Storage of textiles for prolonged periods of time may result in contamination of the textiles, especially by mold. For example, face masks distributed by the Swiss federal government at the beginning of the COVID-19 pandemic, taken from their emergency warehouses, smelled bad and were infested with fungus and had to be recalled from the public (https://www.world-today-news.com/fungus-infestation-millions-of-muffle-masks-are-recalled/). Importantly, **MedCu copper-oxide impregnated fabrics have also potent fungicidal properties**. As can be seen in the Figure 4, MedCu fabrics killed >99% of the mold spores added to the fabric within 18 hours of exposure, in contrast to the regular fabric, in which the mold grew on the fabric. Thus, **the shelf life expectancy during storage of masks made with the MedCu copper-oxide impregnated fabrics would be significantly longer.**

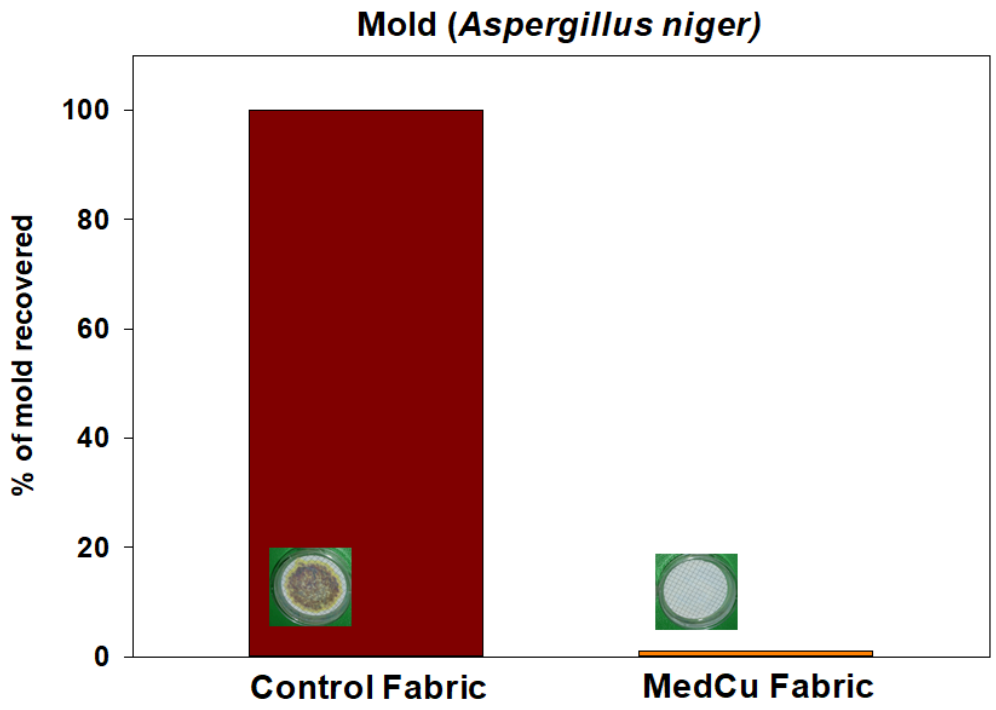

Figure 4: MedCu fabrics and Control Fabrics were inoculated with $2x10^6$ *Aspergillus niger* spores. After 24 hours of incubation, the mold spores were recovered and plated on petri dishes. While mold recovered from the Control fabric grew readily, no mold grew from the MedCu fabrics (example shown in inserts).

Filtration properties of the Copper Oxide Impregnated Masks

The physical properties of the face masks are not influenced by the presence of the MedCu copper oxide microparticles impregnated external fabric layers of the masks. For example, the table below shows that the filtration properties of masks produced with MedCu copper-oxide impregnated fabric, were not altered, as determined by an independent laboratory (Test Report 721653396-10, 15/4/2020, TUV SUD China Lab).

No.	Test Name	Test Standard	Judgement
1	Bacterial Filtration Efficiency (BFE)	EN 14683:2019+AC:2019(E) Annex B	Pass
2	Differential Pressure	EN 14683:2019+AC:2019(E) Annex C	Pass
3	Synthetic Blood Penetration	ISO 22609:2004	Pass
4	Microbial Cleanliness	EN 14683:2019+AC:2019(E) Annex D	Pass

Safety of MedCu Copper Oxide Impregnated Fabrics

The safety of the MedCu copper oxide impregnated external nonwoven fabric layers were tested according to the biocompatibility tests described in the table below. All tests were conducted in independent laboratories using Good Laboratory Practices (GLP) . All tests passed successfully, demonstrating the high safety of the masks.

TEST	Standard	RESULT	LABORATORY
Cytotoxicity	ISO 10993-5	No cytotoxicity	Namsa, USA
Skin Irritation	ISO 10993-10	No irritation	Namsa, USA
Intracutaneous reactivity	ISO 10993-10	No reactivity	Namsa, USA
Systemic Toxicity	ISO 10993-11	No toxicity	Namsa, USA
Maximization Sensitization	ISO 10993-10	No skin sensitization	Namsa, USA
Pyrogenicity	ISO 10993-11	No pyrogenicity	Namsa, USA
Particle Leaching	FDA Cleared Protocol	No leaching at all of copper microparticles	Scientific Solutions, Israel
Elution of copper during breathing	FDA Cleared Protocol	$>10^5$ fold below toxic threshold	Nelson Labs, USA
Elution to simulated saliva	FDA Cleared Protocol	>4 times lower than the minimal risk level (MRL) for oral exposure to copper	Nelson Labs, USA

MedCu copper-oxide impregnated nonwoven fabrics have been used safely for years in adult diapers[20] and antimicrobial wound dressings,[8] which have been cleared by the FDA and other regulatory bodies.

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