The UIB and Inca Hospital work together to improve personal protection equipment for SARS-CoV-19

Researchers are analysing how they can use 3D printing technology to provide reusable PPE and respond quickly and effectively to a pandemic such as COVID-19.

The study intends to determine the viability of a procedure to optimise available certified protection material at the start of an outbreak and make improvements to increase the bioactive filtering capacity for virus particles.

The current COVID-19 pandemic has underscored just how important it is for health centres to have their own resources to create personal protection equipment (PPE) in scenarios where respiratory illnesses are spreading rapidly. These resources need to ensure health staff have access to suitable PPE, either by optimising the already available material at health centres or by introducing effective recycling solutions that provide protection capacity in an initial quick response until final PPE supplies can be brought in.

The rapid availability of respiratory protection equipment for all health staff is a critical area to provide an effective response and reduce the risk of infection amongst health workers. These types of critical clinical scenarios require each health centre to have a plan to independently provide certain protection elements so as to ensure staff safety (or at least on a temporary basis until normal supplies of PPE material can arrive).

A team of researchers from the University of the Balearic Islands has been working with clinical researchers from Inca Hospital to analyse the viability of a procedure to improve production of certified PPE by favouring the reuse of certified material whilst, in turn, improving filtering and viricidal capacity. This improvement means masks could have higher filtration of virus particles and create a barrier to inactivate the virus in the filter itself. In this sense, health workers and patients would have greater protection against possible infections such as the SARS-CoV-19 virus, responsible for COVID-19.

The theoretical basis behind this procedure has been previously published by university researchers in Korea and Canada (Quan FS, et al. *Scientific Reports*, 2017). The UIB and Inca Hospital are now attempting to demonstrate the viability of the procedure's practical application for the first time by using 3D printing technology. The process comprises designing a mask that covers the mouth, nose and eyes, and incorporating a bioactive filter consisting of a membrane covered in highly concentrated saline solution which would increase the capacity to inactivate viruses and, therefore, improve filtering capacity.

The work is being jointly undertaken by researchers in the Translational Oncology Multidisciplinary Group (GMOT) at the University of the Balearic Islands led by Dr Pilar Roca Salom, professor of biochemistry and molecular biology; clinical researchers at Inca Hospital, led by Dr Josep Reyes Moreno, head of gastroenterology at the hospital and associate lecture in the UIB Faculty of Medicine; and by Drs Yolanda González Cid and Bartomeu Alorda Ladaria, both senior lecturers at the UIB and members of the e-Health and Multidisciplinary Telemedicine via Smart Cyber-Physical Systems research group at the IdisBA.

In addition, with regard to 3D printing technology manufacturing, they are supported by the Flow Injection and Trace Analysis research group (FI-TRACE) led by Dr Manuel Miró Lladó, professor of analytical chemistry at the UIB; the Analytical Chemistry, Automation and Environment group led by Dr Víctor Cerdà Martín, emeritus professor in analytical chemistry at the UIB; and the Materials Chemistry group led by Dr Gemma Isabel Turnes Palomino, professor of inorganic chemistry at the UIB.

Validation phase

The results obtained by the UIB and Inca Hospital teams are currently in validation phase. This is an essential process so that the innovation can be applied clinically and will likely run for several weeks. Once the mask improvement mechanism is validated, it can be implemented at hospital centres.

The team of researchers has submitted the bioactive filter initiative, alongside the 3D printing mask design, to the call for expressions of interest for innovative project funding to minimise the transmission of COVID-19 in the health area of the Balearic Islands.

UIB-Inca Hospital collaboration

This project has been made possible thanks to the close collaboration between the GMOT and clinical researchers at Inca Hospital. This partnership has emerged in the last few years from the **CINUIB project** that aims to design new non-invasive diagnosis equipment for the screening and early detection of colorectal cancer.

Bibliography

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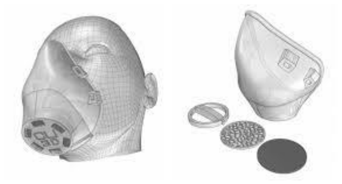
 copper3d.com/hackthepandemic/ Nanohack	 copper3d.com/hackthepandemic/ Nanohack 2.0	 makermask.com

Figure 1: examples of mask models available for 3D printing

The work the initial hypothesis is based on

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Universal and reusable virus deactivation system for respiratory protection

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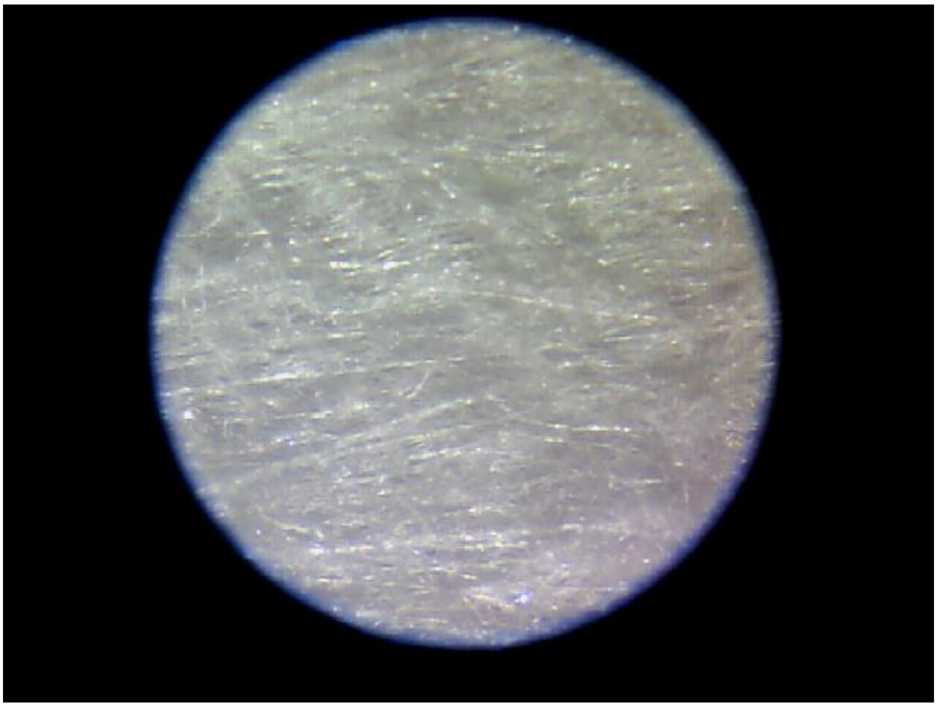
Aerosolized pathogens are a leading cause of respiratory infection and transmission. Currently used protective measures pose potential risk of primary/secondary infection and transmission. Here, we report the development of a universal, reusable virus deactivation system by functionalization of the main fibrous filtration unit of surgical mask with sodium chloride salt. The salt coating on the fiber surface dissolves upon exposure to virus aerosols and recrystallizes during drying, destroying the pathogens. When tested with tightly sealed sides, salt-coated filters showed remarkably higher filtration efficiency than conventional mask filtration layer, and 100% survival rate was observed in mice infected with virus penetrated through salt-coated filters. Viruses captured on salt-coated filters exhibited rapid infectivity loss compared to gradual decrease on bare filters. Salt-coated filters proved highly effective in deactivating influenza viruses regardless of subtypes and following storage in harsh environmental conditions. Our results can be applied in obtaining a broad-spectrum, airborne pathogen prevention device in preparation for epidemic and pandemic of respiratory diseases.

Microscopic image of the mask filter after the procedure



Archive image of a conventional surgical mask