Anti-COVID-19 high-touch surfaces using photocatalytic transparent films

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The goal of this collaboration between the laboratories of Professors Kimberly Gray at Northwestern University and Hadas Mamane at Tel Aviv University was to develop biocidal thin films that disrupt the transmission of coronavirus and other pathogens on high- touch surfaces (e.g. instrument touch-screens) common in clinical or commercial settings. Antimicrobial and self-cleaning surface coatings offer broad utility in healthcare settings, reducing the spread of infectious diseases in environments where they are most common. While many existing coating technologies offer antibacterial performance, antiviral capabilities were comparatively unexplored. In the midst of the COVID-19 pandemic, this team sought to develop a coating that would prove effective in curtailing the virus's spread via touch.

Each half of the team offered a particular skillset vital to the development of the overall project. In Professor Gray's lab, photocatalytic nanocomposite thin films were synthesized and characterized for robust and durable disinfection. In Professor Mamane's lab, the performance of select thin films were then tested for viral and bacterial inactivation under a variety of conditions. Building from existing studies, the project focused on TiO2-based materials, with a particular emphasis on preserving the transparency of the coating while evaluating different material compositions for performance in a number of key areas.

This resulted in the fabrication of a variety of nanoscale TiO2-based transparent thin films (anatase TiO2, mixed phase anatase/rutile TiO2, silver-anatase TiO2 composite, and carbon nanotube-anatase TiO2 composite) via dipping and spraying coating technologies, and the evaluation of their antiviral performance (Bacteriophage MS2 as the model) under dark and illuminated conditions. The thin films showed high surface coverage (ranging from 40-85%), low surface roughness (maximum average roughness 70 nm), super-hydrophilicity (water contact angle 6-38.4o), and high transparency (70-80% transmittance under visible light). Antiviral performance of the coatings revealed that the nAg/nTiO2 coated samples achieved the highest antiviral efficacy (5-6 log reduction) while other nTiO2 coated samples showed fair antiviral results (1.5-3.5 log reduction) after 90 minutes LED radiation. Those findings indicate that TiO2-based composite coatings are effective in creating antiviral high touch surfaces with the potential to control infectious diseases and HAIs. These results are currently being compiled into a manuscript.

Over the course of the study, members of the two labs worked closely together. Han Fu, a Ph.D. candidate in Professor Gray's lab, was particularly involved, and was credited as first author of the resulting article. The project provided valuable experience interfacing with a lab on another continent, particularly during lockdown, and Fu mentioned the experience as a highlight of his academic career at Northwestern in an **interview last year** with the International Institute for Nanotechnology. While the two teams are continuing to refine their joint paper, the funding provided through the Catalyst program was sufficient to fulfill the terms of the project.

Publications:

Han Fu, Vered Yaniv, Yifaat Betzalel, Hadas Mamane, and Kimberly A. Gray, **"Creating anti-viral high-touch surfaces using photocatalytic transparent films,"** Chemosphere 323 (2023) 138280.

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