**Large area deposition technologies of multifunctional antibacterial and antiviral nanocoatings**



Project No: 1.1.1.1/21/A/050

Duration: 01.01.2022. - 30.11.2023.

Project Leader: Institute of Solid State Physics, University of Latvia, Dr. habil. Phys. Juris Purans.

Project partners: Sidrabe Vacuum SIA, Dr.Phys. Andris Fedotovs

 Latvian Biomedical Research and Study Centre (LBMC)

30.11.2023.

About project implementation (01.10.2023 - 30.11.2023)

During the past research period of the project ISSP did research about:

* New photochromic YHO coatings were produced, and YHO was deposited on various substrates, including glass, amorphous quartz, c-sapphire, Si, ITO, FTO, glass/SiO2, and glass/Si3N4, to assess adhesion. The samples were examined using an optical microscope, revealing that the coating adheres well to glass, amorphous quartz, and glass/SiO2. Additionally, FTO was found to be a more suitable transparent electrode as a substrate compared to ITO due to better adhesion.
* The oxidation conditions of YH2 (YHO intermediate) were varied: (i) air immediately after fabrication, (ii) air after 2 days, and (iii) pure oxygen (99.999%) immediately after fabrication to evaluate their impact on photochromic properties. Observations indicate that oxidation (i) provides better adhesion, although substrate material and cleanliness are more critical.
* YHO coatings were heated in air for 20 minutes at three different temperatures (50, 100, and 150°C) to assess their thermal stability and the effect of temperature on photochromic properties.
* XRD, UV-Vis-NIR transmittance/reflectance, and photochromic property measurements were conducted on the YHO samples.
* A popular scientific article titled "[*Latvian Scientists Research and Patent Surface Coatings to Combat Disease Agents*](https://www.lsm.lv/raksts/dzive--stils/tehnologijas-un-zinatne/27.11.2023-latvijas-zinatnieki-peta-un-patente-virsmu-parklajumus-cinai-pret-slimibu-ierosinatajiem.a533180/)" was published on the lsm.lv portal.

SIDRABE performed activities on:

* Two additional series of large-area YHO samples at different pressures were produced. The samples were handed over to the project partners for analysis of physical and antimicrobial parameters.
* A description of the roll-to-roll manufacturing technology of large-area YHO coatings has been created.
* A technical specification for sample series YH01 and YH04/Cu has been prepared.

LBMC research:

* Within the final reporting period, we tested the antibacterial activity YHO/Cu and MoO3/Cu/MoO3, which revealed a very high >5 Log reduction rate against *E. coli*, *S. aureus*.  Nevertheless, the reproducibility of the results varied significantly for some samples, demonstrating no optimal stability and homogeneity of the samples. In addition, we finished the assessment of nanocoatings with the wild-type SARS-CoV2 virus. A very high anti-SARS-CoV-2 effect was demonstrated for YHO/Cu (YHO4PO2 and YHO4PO4, large area deposited series) samples with TCID50 reduction rate > 5.7 Log.
* In summary, the data obtained in this project demonstrate the high potential of transparent conducting WO3/Cu/WO3 and MoO3/Cu/MoO3, and photochromic YHO/Cu coatings as novel biocidal materials for various applications.
* Scientific article “*Analysis of Antibacterial and Antiviral Properties of ZnO and Cu Coatings Deposited by Magnetron Sputtering: Evaluation of Cell Viability and ROS Production”* submitted in *Coatings* (IF=3,4).

The project was successfully completed with a total of one submission and publication of three scientific articles and one popular scientific article, as well as the submission of two patents:

* K. Korotkaja and A. Zajakina, Recombinant Virus Quantification Using Single-Cell Droplet Digital PCR: A Method for Infectious Titer Quantification, Viruses 15 (2023) 1060, <https://doi.org/10.3390/v15051060>, **IF=4.7**
* V. Vibornijs *et al.*, Analysis of Antibacterial and Antiviral Properties of ZnO and Cu Coatings Deposited by Magnetron Sputtering: Evaluation of Cell Viability and ROS Production. *Coatings*, **IF=3.4**,ID 2752374 (2023) (under review)
* M. Zubkins *et al.*, A stability study of transparent conducting WO3/Cu/WO3 coatings with antimicrobial properties, *Surfaces and Interfaces* 41 (2023) 103259, <https://doi.org/10.1016/j.surfin.2023.103259>, **IF=6.2**
* H. Arslan *et al.*, Reactive pulsed direct current magnetron sputtering deposition of semiconducting yttrium oxide thin film in ultralow oxygen atmosphere: A spectroscopic and structural investigation of growth dynamics, *Vacuum* 211 (2023) 111942, <https://doi.org/10.1016/j.vacuum.2023.111942>, **IF=4.0**
* V. Vibornijs, [Latvijas zinātnieki pēta un patentē virsmu pārklājumus cīņai pret slimību ierosinātājiem](file:///C%3A%5CUsers%5CKristine%5CDownloads%5Clsm.lv%5Craksts%5Cdzive--stils%5Ctehnologijas-un-zinatne%5C27.11.2023-latvijas-zinatnieki-peta-un-patente-virsmu-parklajumus-cinai-pret-slimibu-ierosinatajiem.a533180%5C), Tehnoloģijas un zinātne, LSM.LV, 27/11/2023
* EU patent application EP23158463.2: V. Skvorcova *et al.*, An antimicrobial multilayer thin-film materials coating
* EU patent application EP23210104.8: V. Vibornijs et al., An apparatus and a process for testing of anti‐microbial properties of a surface

The project resulted in one prototype and one new technology. Thanks to the productive and constructive cooperation between LU CFI, SIDRABE and LBMC, the results obtained in the framework of the project were presented as LZA Achievements in Applied Science for 2023.