Biocidal surfaces based on silver and zinc compounds

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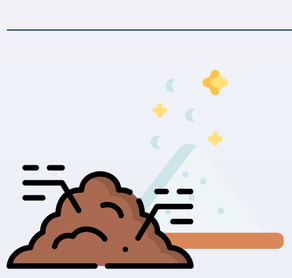
Introduction

Since the COVID'19 pandemic, there has been a great interest in surfaces cleaning, especially in enclosed areas where many people gather, such as workplaces, shopping centres, restaurants, etc., because virus can be spread if someone touches an infected surface or object. Moreover, without cleaning and disinfection, the COVID'19 virus can remain on surface object from hours to days.

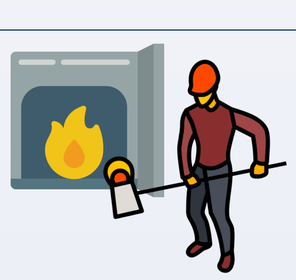
The main objective of this work was to obtain new antiseptic substances against bacteria and viruses, which are incorporated in different materials, such as ceramic tiles and coatings (varnishes or paints). For this purpose, some silicate glasses have been developed based on the system SiO_2-Al_2O_3-B_2O_3-RO_2-RO (R_2O corresponds to the combination of Na_2O, K_2O and Ag_2O, while RO corresponds to CaO, MgO, BaO and ZnO), which incorporate Ag_2O to partially replace Na_2O.

Experimental

Synthesis



Raw materials



Frit melting

Application

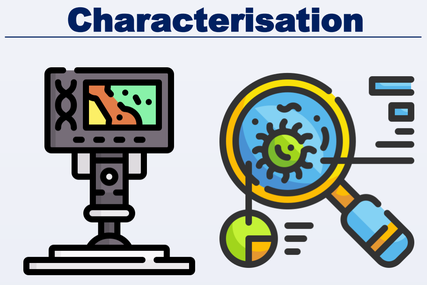
Dispersing / Milling

Air spraying / Mixing

Sintering

Firing
(only ceramic route)

Characterisation



Scanning electron microscopy
Bacteria and viruses test

Ceramic route

Synthesis: F1 glass (frit) was obtained in a melting kiln at a maximum temperature of 1500°C for 20 minutes, followed by quenching in cold water.

Composition	
(wt%)	**F1**
SiO_2	51.3
Al_2O_3	13.7
R_2O*	5.0
RO	30.0

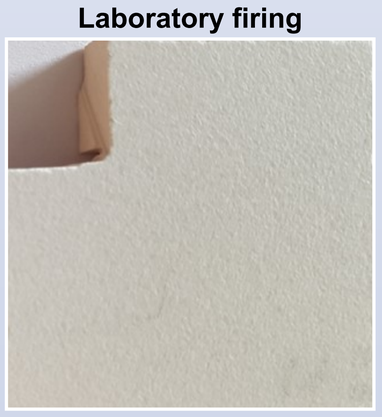
** ≈ 5 wt% Ag_2O*

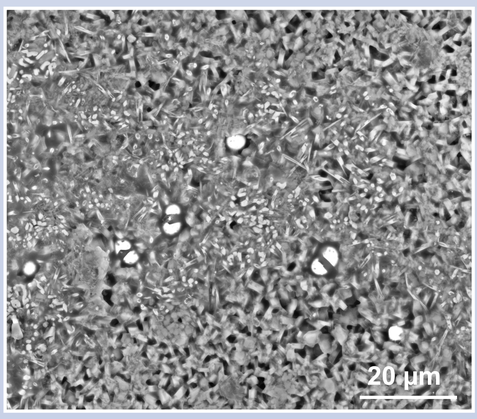
Glaze C1	
Oxides	(wt%)
F1	85.0
RO_2-R_2O_3	10.0
RO	5.0

Application: The preparation of the C1 glaze was carried out by traditional ceramic milling. Glaze C1 was applied by air spraying on the surface of wall tiles at a density of 1.4 g/cm^3 until a weight of 160 g/m^2 was reached.

Sintering: The glaze C1 was fired in laboratory (left) and industrial kilns (right), in order to compare the reproducibility and scalability of the process.

Laboratory firing

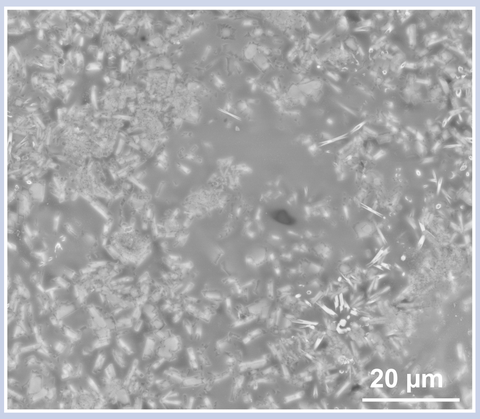




Bacterial and viruses test	
Laboratory fired glaze C1	
E. Coli	99.99
S. Aureus	99.81
TGEV	99.30

**Transmissible gastroenteritis virus*

Industrial firing



Bacterial and viruses test	
Industrially fired glaze C1	
E. Coli	99.99
S. Aureus	95.44
TGEV*	—

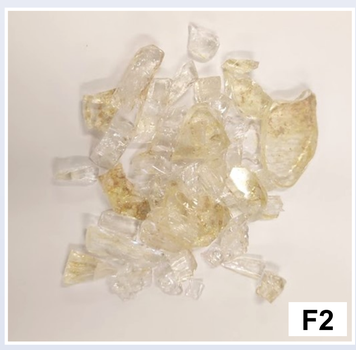
**Transmissible gastroenteritis virus*

Organic coatings route

Synthesis: Frits (F2 and F3 glasses) were obtained in a melting kiln at a maximum temperature of 1450°C, followed by quenching in cold water.

Composition		
(wt%)	**F2**	**F3**
SiO_2	59.2	46.7
R_2O_3	9.6	30.3
R_2O*	4.4	7.1
RO	27.2	15.9

** ≈ 4 wt% Ag_2O*



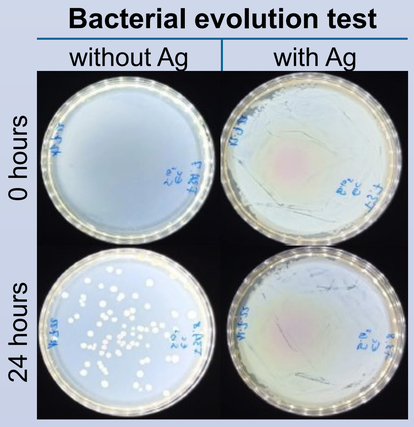
Coating		
(wt%)	**C2**	**C3**
F2	7	0
F3	0	10
Acrylic paint	93	0
Melamine paint	0	90

Application: Frits were finely milled to increase the surface area of the particles. The preparation of the coating C2 was carried out by mixing of components and then applying them as a homogeneus layer onto a wood surface. The coating C3 was prepared by air spraying onto a 100% melamine paint layer over a wood surface.

Sintering: The coatings were left to air dry for a few hours.

Coating C2

Bacterial evolution test

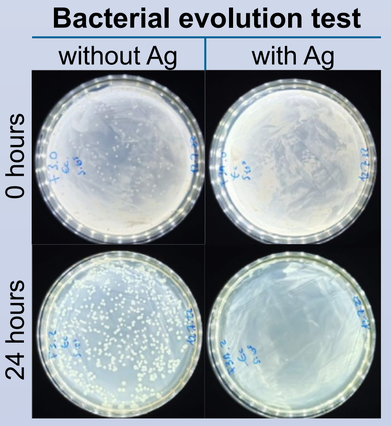


Bacterial and viruses test	
Coating C2	
E. Coli	99.95
S. Aureus	99.94
TGEV	83.90

**Transmissible gastroenteritis virus*

Coating C3

Bacterial evolution test



Bacterial and viruses test	
Coating C3	
E. Coli	99.99
S. Aureus	99.95
TGEV*	96.70

**Transmissible gastroenteritis virus*

Conclusions

- New antisepctic substances based on silver-doped glasses were successfully developed.
- The incorporation of the silver-doped glasses was carried out in a glaze (ceramic route) and a varnish (organic coating route). In all conditions, silver was detected when EDX análisis were carried out on the surface of the coatings. Moreover, coating C3 had a higher biocidal and viricidal capacity than coating C2.
- The bactericidal and virucidal effect was effectively developed in all samples. Futhermore, reproducibility at laboratory and industrial scale was quite acceptable.

Information

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Acknowledgements

The work has been supported by the Valencian Innovation Agency (AVI) under the grant nº. INNEST/2021/19.

Actuació cofinançada per la Unió Europea a través del Programa Operatiu del Fons Europeu de Desenvolupament Regional (FEDER) de la Comunitat Valenciana 2014-2020