

NanoInnovation 2025

Antibacterial SilverSil Sol-Gel Coating: From Design to Functionalization of Textiles

Giovanna Li Petri, Serena Facchiano, Valentina Trovato, Claudia Vineis, Giuseppe Rosace, Mario Pagliaro, and Rosaria Ciriminna

*Istituto per lo Studio dei Materiali Nanostrutturati, CNR, via U. La Malfa 153, 90146 Palermo, Italy
giovanna.lipetri@cnr.it*

ORganically MODified SILicas (ORMOSILs) are a class of hybrid materials obtained through the sol-gel hydrolytic polycondensation of silanes functionalized with organic groups, often in combination with conventional alkoxides.¹ Thanks to the flexibility of the sol-gel process, ORMOSILs offer a high degree of tunability, which has led to their widespread use in a variety of sectors, such as optics, electronics, energy technology, environmental remediation, and biomedical devices.²

One of the most promising approaches in the field of nanostructured materials involves the synthesis and incorporation of metal nanoparticles (NPs) into ORMOSIL matrices during the sol-gel process. This technique enhances nanoparticle stability and enables the creation of multifunctional materials in a range of forms, including powders, films, coatings, or monoliths.³

A notable example is SilverSil, a hybrid sol-gel xerogel material first introduced in 2020, which embeds silver nanoparticles (Ag NPs) within an ORMOSIL matrix and exhibits strong antibacterial performance across various bacterial strains.⁴ In this presentation, I will describe recent advancements in the synthesis and characterization of novel SilverSil xerogel, developed through a two-step sol-gel process involving tetraethyl orthosilicate (TEOS) and organically modified silanes such as methyltriethoxysilane (MTES) and (3-aminopropyl)trimethoxysilane (APTMS), with and without silver nitrate (AgNO₃) as the NPs precursor. A systematic study of parameters, such as the water-to-alkoxide ratio, ethanol-free conditions, gelation time, and drying methods, was carried out to optimize material performance.⁵

These newly developed SilverSil xerogel powders, dispersed in eco-friendly commercial biobased resins, along with their respective crosslinking agents and an acrylic-based thickener, were successfully applied to cotton fabrics via the rod-coating method, a scalable and environmental safety process. Antibacterial tests revealed a greater than 90% reduction of gram-positive (*Staphylococcus aureus*) and gram-negative (*Escherichia coli*) bacteria,⁶ confirming SilverSil's promise for high-performance antimicrobial textiles, including those intended for medical, protective, and other hygiene-sensitive applications.

Acknowledgements

This study was carried out within the MICS (Made in Italy – Circular and Sustainable) Extended Partnership and received funding from the European Union Next-GenerationEU – Piano Nazionale di ripresa e resilienza (PNRR) – Mission 4 Component 2, Investment 1.3 – D.D. 1551.11-10-2022

References

- 1 S. Dash, S. Mishra, S. Patel, B. K. Mishra, Adv. Coll. Interf. Sci. **2008**, 140, 77-94,
- 2 D. Avnir Acc. Chem. Res. **1995**, 28, 328-334.
- 3 K.H. Wu, C.I. Liu, C.C. Yang, G.P. Wang, C.M. Chao Mater. Chem. Phys. **2011**, 125, 802 – 806
- 4 K. Trabelsi, R. Ciriminna, Y. Albo, M. Pagliaro. ChemistryOpen **2020**, 9, 459 – 463
- 5 G. Li Petri, R. Ciriminna, M. Pagliaro. ChemistrySelect **2025**, 10 (4), e202404287
- 6 G. Li Petri, S. Facchiano, V. Trovato, C. Vineis, G. Rosace, M. Pagliaro, R. Ciriminna. ChemNanoMat **2025**, e202500132