Smart nanomaterials with potential antibiofilm activity for medical devices

Francesca Mancusi,[a] Stefano Cicchi, [a] Costanza Montis, [a] Barbara Richichi [a], and Francesca Bugli [b]

[a] *Dipartimento di Chimica "Ugo Schiff", Università degli Studi di Firenze, Via della lastruccia 3-13, 50019, Sesto Fiorentino, Italy*
[b] *Dipartimento di Scienze biotecnologiche di base, cliniche intensivologiche e perioperatorie, Università Cattolica del Sacro Cuore, Largo A. Gemelli, 00168, Roma, Italy*
E-mail: francesca.mancusi@unifi.it

Antibiotic resistance is a serious public health problem. Bacteria can self-produce a polymeric complex architectural structure called *biofilm*. Wrapped by this structure they become much more resistant to antimicrobial treatments, harsh environmental conditions, and the host immune system. Conventional antibiotic drugs are unfortunately inadequate to eradicate biofilm-mediated infections. In addition, biofilm infections on medical implants such as valves, stents and catheters require their surgical removal and replacement, and recurrences of infection are very high. [1] There is therefore an urgent need for materials that prevent bacterial biofilm formation to make medical devices for hospital use. Simultaneously with this, the world is facing another serious environmental and ecological problem resulting from the overuse of chemicals and petroleum-based materials. [2] Our goal is to make a smart multilayer material to cover biliary catheters, often obstructed by biofilm-type infections, based on nanocellulose, a nanomaterial extracted from renewable biomasses. On a plastic surface we laid two layers of nanocellulose on top of each other. The first was cationic nanocellulose functionalized with quaternary ammonium groups, and the second was anionic decorated with Ag Nps, known in their literature for their anti-biofilm properties. A fluorescent marker was added to the various layers to allow them to be characterized by confocal microscopy. Our future goal the selection of other layers of nanocellulose further decorated with agents with known anti-biofilm activity and to produce a three-dimensional model to better verify the antimicrobial activity of the material and its resistance to bile flow.

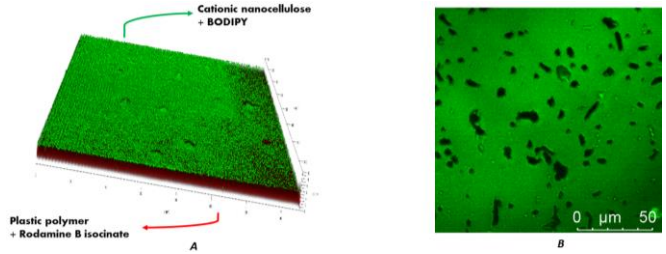

Figure 1: Confocal Microscope Images. ***A*** Double layer: labeled plastic polymer and positive labeled nanocellulose layer. ***B*** Triple layer: unlabeled plastic polymer, unlabeled positive cellulose, and labeled negative cellulose decorated with Ag Nps evident in the image.

[1] Li, X. H., & Lee, J. H. *Journal of Microbiology* (2017),55, 753–766
[2] Lin, N. ; Dufresne, A. *Eur. Polym. J.* (2014), *59*, 302–325.

Funder: Project funded under the National Recovery and Resilience Plan (NRRP), Mission 4 Component 2 Investment 1.4 - Call for tender No. 3277 of 30 December 2021 of Italian Ministry of University and Research funded by the European Union – NextGenerationEU.
Award Number: Project code ECS_00000017, Concession Decree No. 1055 of 23 June 2022 adopted by the Italian Ministry of University and Research, CUP: B83C22003920001, project title "Tuscany Health Ecosystem – THE"- SPOKE4_Nanotechnologies for diagnosis and therapy.