Natural polymer-graphene-TiO_2 hybrid coatings with enhanced biocidal and self-renewal properties

Evangelia Vasilaki [1]
Eleftherios Koufakis [2]
Theodore Manouras [2]
Ioanna Peraki [3,4]
Maria Vamvakaki [2, 5]

[1] *Department of Chemistry, University of Crete, 700 13, Heraklion, Crete, Greece,* [2] *Department of Materials Science and Technology, University of Crete, 700 13, Heraklion, Crete, Greece,* [3]*Department of Medicine, University of Crete, 700 13 Heraklion, Crete, Greece,* [4] *Institute of Molecular Biology and Biotechnology, FORTH-Hellas, 700 13 Heraklion, Crete, Greece,* [5]*Institute of Electronic Structure & Laser, FORTH-Hellas, 700 13, Heraklion, Crete, Greece*

evasilaki@iesl.forth.gr

The bacterial contamination of surfaces is one of the most alarming and ever-growing threats for human health. As the conventional approaches have been proven inadequate to address this problem, the development of more effective biocidal materials is imperative.
The aim of this work is to synthesize hybrid materials comprising quaternized chitosan-graphene-TiO_2, for the development of novel coatings exhibiting enhanced properties and synergistic biocidal mechanisms.
Towards this direction, we first investigated the enhancement of the water solubility and the biocidal properties of chitosan, an abundant natural polymer, via its modification with an alkyl halide. Next, graphene oxide was prepared by a modified Hummers method and was used for the synthesis of hydrothermally reduced graphene oxide (rGO)-TiO_2 hybrids. The graphene modified titania particles were added into quaternized chitosan solutions containing a water-soluble and acid-degradable cross-linker. Polymer films were prepared by deposition of the solution onto solid substrates, followed by cross-linking.

The antibacterial properties of the hybrid films were evaluated without irradiation, as well as under visible light, using two representative gram-positive and gram-negative bacteria strains. The regeneration of the antimicrobial activity of the hybrid films was also assessed, upon the gradual scission of the acid-degradable cross-linker.
The novel quaternized chitosan-graphene-TiO_2 hybrids coatings presented herein were shown to exhibit enhanced antibacterial efficiency and are highly attractive for numerous applications.

Figures

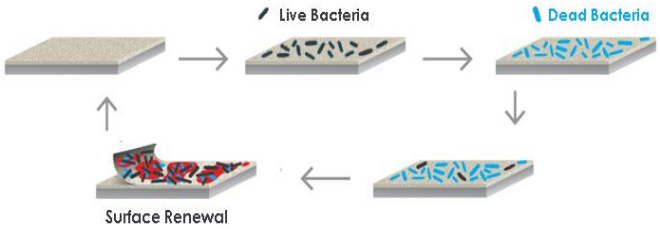

Figure 1: Schematic illustration of the bacterial death on the biocidal surfaces and the surface regeneration.

Acknowledgements

The project "Novel hybrid biocidal surfaces with self-renewal properties and direct detection of their antimicrobial activity" is implemented through the Operational Program "Human Resources Development, Education and Lifelong Learning" and is co-financed by the European Union (European Social Fund) and Greek national funds.