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New materials exhibiting antibacterial activity against antibiotic resistant bacterial strains

The bacteria, when present in the wound, begin to produce biofilm in response to reduction of nutrients, increased levels of reactive oxygen species, change in pH, and under influence of immune cells or antibiotics. Treatment of chronic wounds is a major problem, not only in medical but also economic terms. Lack of an effective method of the bacterial biofilm destroying leads to a significant prolongation and complication of the medical treatment. Literature data show that the killing dose for any given antibiotic is more than 1000 times higher for biofilm forming bacteria than for planktonic bacteria of the same strain. The poor efficacy of antibiotics against bacteria contained in the biofilm is associated with inefficient penetration of the antibiotic through the biofilm matrix either due to specific adsorption by matrix or to physical barriers. The aim of my research is focused on (*i*) preventing or reducing biofilm formation and (*ii*) destroying of the biofilm structure in order to facilitate biocidal agents penetration and their activity. Thus, the designed new compounds and materials should work on (*i*) the first stage of the biofilm formation (*i.e.* inhibitors of enzymes involved in biofilm synthesis) or (*ii*) the mature biofilm and destroy its structure (*e.g.* chitosan-based materials, metal nanoparticles, metal coordination complexes, *etc.*). In general, I concentrate on preparation and physicochemical characterization of stable and well-defined composite materials based on (bio)polymers and metals: (*i*) (bio)polymer-based M nanoparticles, (*ii*) (bio)polymer@M nanocomposites, (*iii*) (bio)polymer nanoparticles loaded with M ions, and (*iv*) other biomaterials, where biopolymer – *e.g.* chitosan, alginate, polycaprolactone, polycarbonate, polylactide, polyacrylic acid, polyvinylpyrrolidone, *etc.*; M – metal *e.g.* Au, Ag, Cu, *etc.*. Moreover, elucidation of the (bio)polymer role as a reducer and/or a stabilizer in chemical reduction of metal ions is the most important goal in this investigation. Results were published in the form of six papers and two are under preparation [1-7]. Within the scope of biocidal agents research, I collaborate with professor Olivier Martin from University of Orlean in France. Collaboration concerns synthesis of new potential inhibitors of enzymes (mutases and transferases) involved in bacterial biofilm formation. All new materials and compounds are tested against bacteria and fungi *in vitro* within collaboration with group of professor Piotr B. Heczko from Department of Microbiology of Jagiellonian University Medical College in Kraków.

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A. Regiel, S. Irusta, A. Kyzioł, M. Arruebo, J. Santamaria, "Preparation and characterization of chitosan-silver nanocomposite films and their antibacterial activity against *Staphylococcus aureus*", Nanotechnology, 2013, 24, 1, DOI: 10.1088/0957-4484/24/1/015101,

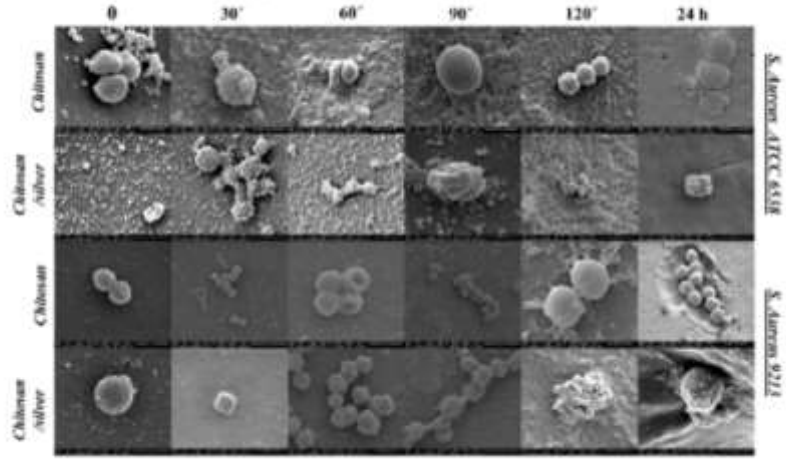

Figure 11. SEM photographs showing the morphology of the bacteria upon contact on chitosan or chitosan–silver films (medium MW and 52 mM silver nitrate as precursor) on *Staphylococcus aureus* strains ATCC 6538 and 9213.

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