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ASSESSMENT OF PROPERTIES AND BIOLOGICAL IMPACT OF NEW TYPES OF NANOCOMPOSITE MATERIALS

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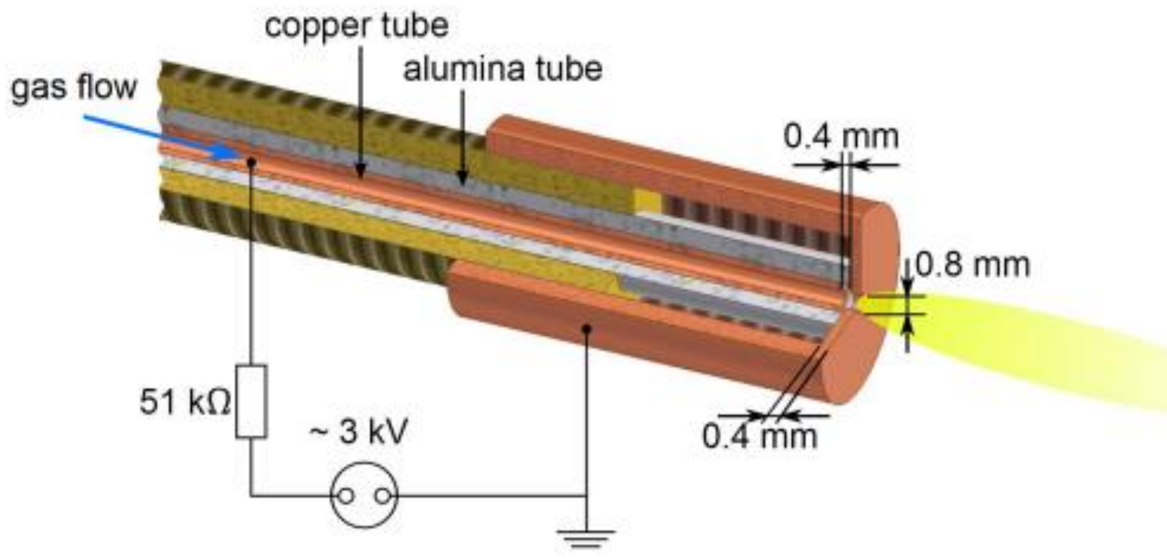
Introduction

Adhesion of microorganisms and organic matter (=fouling) to surfaces triggers the development of biofilms that cause various health, operating and technological problems, such as biofilm-related infections, lowered flux and filtration efficacy in piping/membrane units. . Therefore, biofouling control in industry is challenging. Depending on surface type and intended use, three anti-biofilm/antifouling case studies are presented.

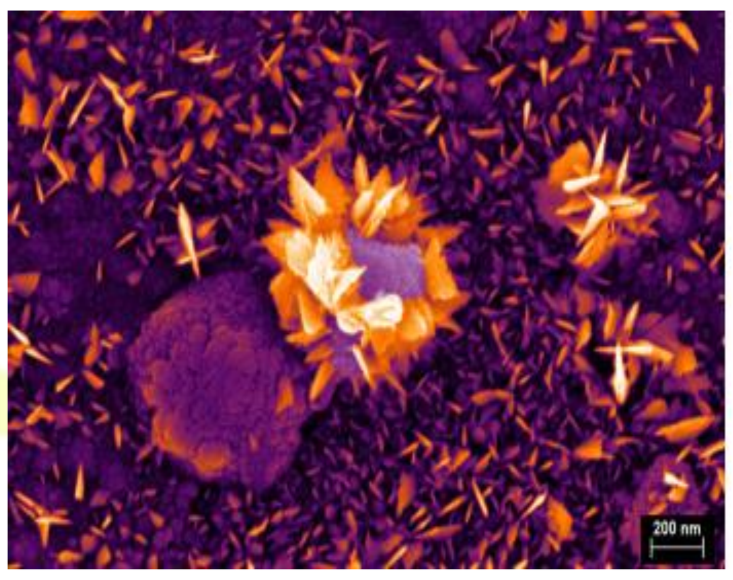
Case study n. 1: Antibacterial efficacy of atmospheric plasma-deposited copper oxide coatings

Nanostructured copper oxides are regarded as suitable antimicrobial agent in healthcare facilities. Especially the antimicrobial surfaces is the evolving area, since increasing presence of antibiotic-resistant microorganisms.

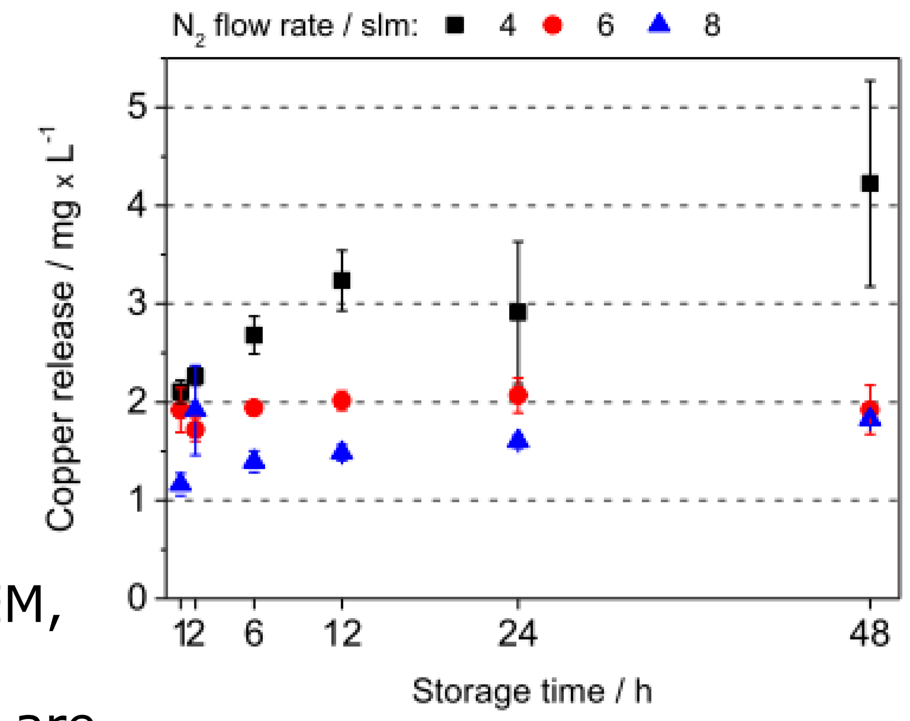


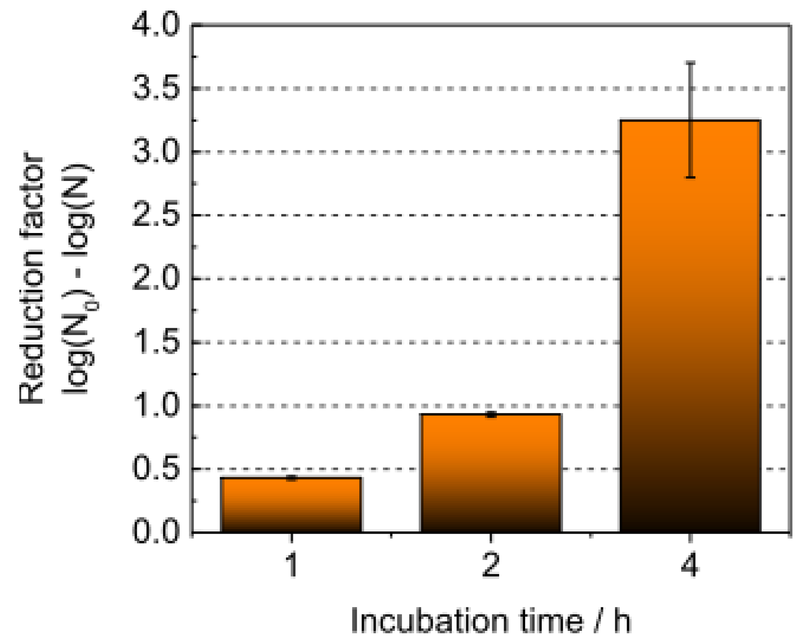
Scheme of the DC jet with the atmospheric pressure plasma protruding from the copper electrode.

- coatings deposited by DC jet
- 4, 6 and 8 l of N_2 per minute
- 5, 10, and 20 minutes of deposition



- coatings characterized by SEM, XPS, XRD, profilometry
- nanospheres and nanoflakes are presented
- XPS depth profile shows transition from $CuO/Cu(OH)_2$ to CU_2O

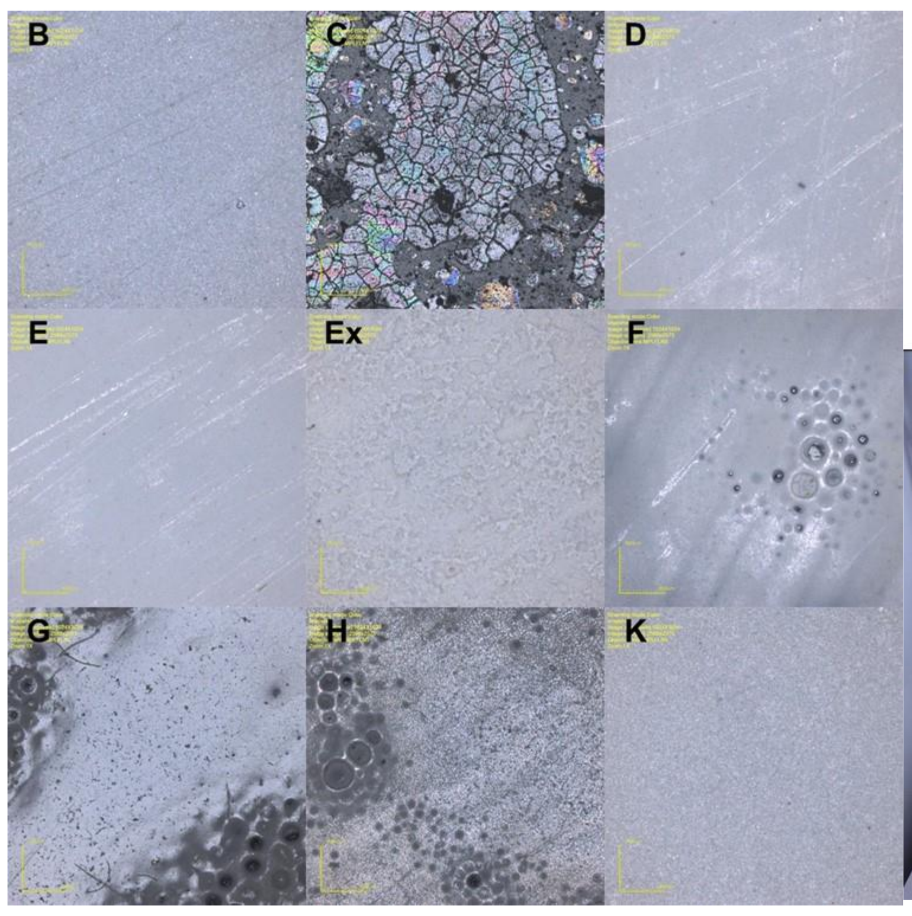


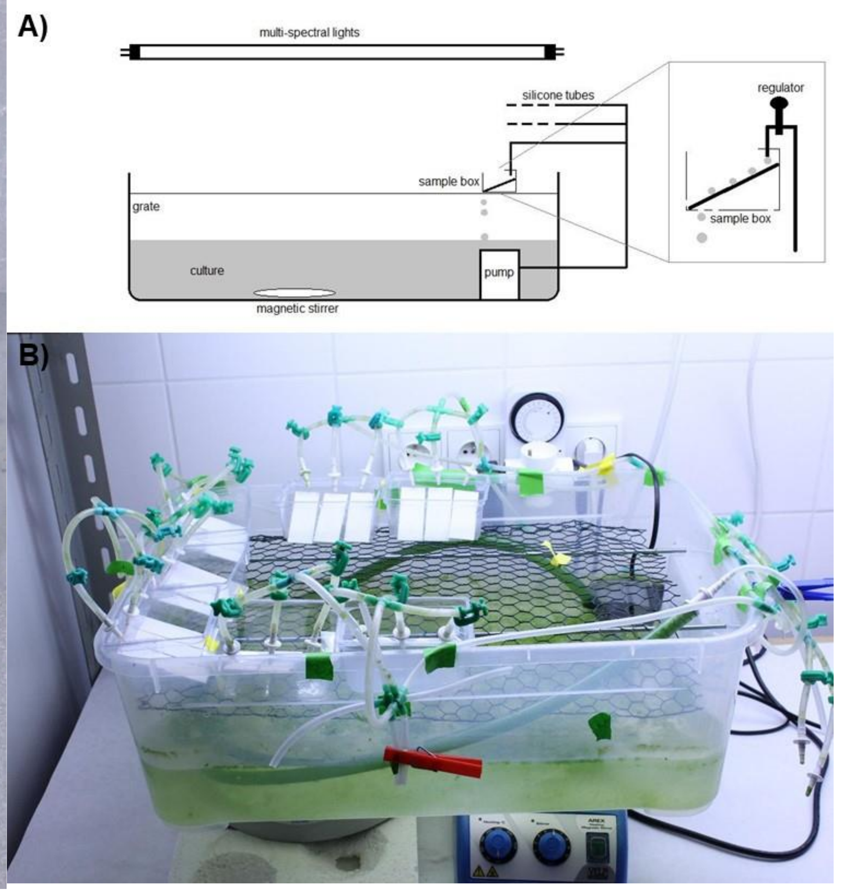


- Cu realease kinetics are dependent on N_2 flow rate and time of deposition, the highest release observed within first 12 h
- Bactericidal effect (on *Staph. aureus*) is significant after 4 h

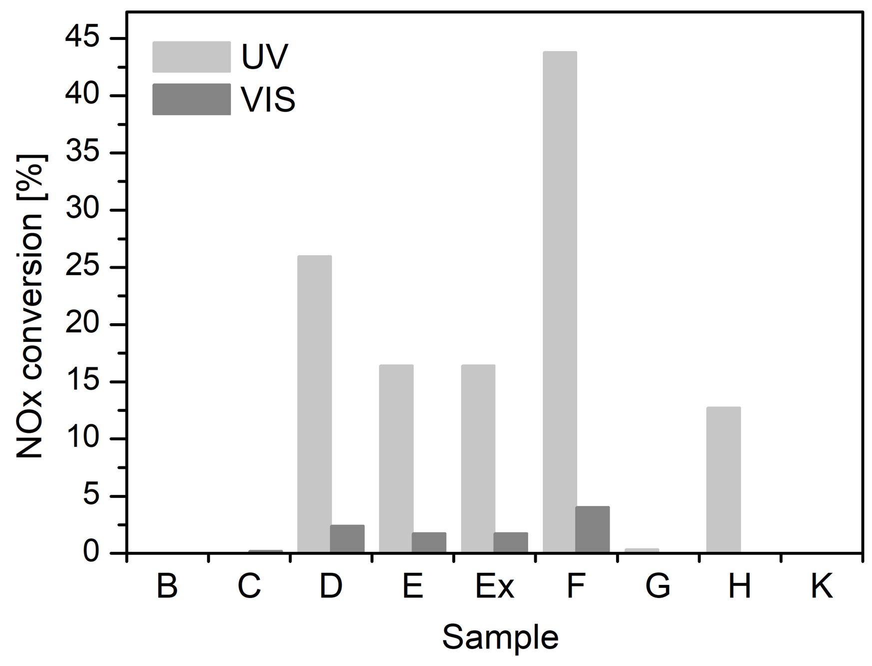
Case study n. 2: Antifouling performance of superhydrophobic photocatalytic coatings against algae

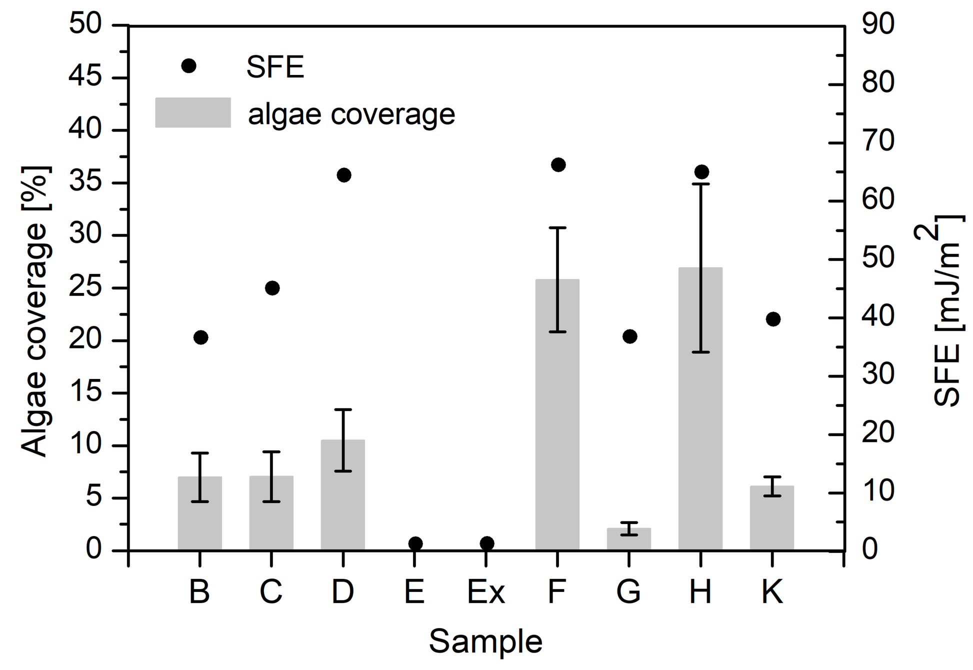
Superhydrophobic or photocatalytic coatings were used to combat algal fouling. Here, these two properties are combined to see which parameter is more benefitial for antifouling.





- TiO_2 of various particle size + hydrophobization agent + other co-formulants used for creating coatings
- characterized by SEM, hydrophobicity as surface free energy (SFE), NOx abatement, algal coverage, chlorophyll *a* content
- test performed in flow-through design, with *Klebsormidium* alga

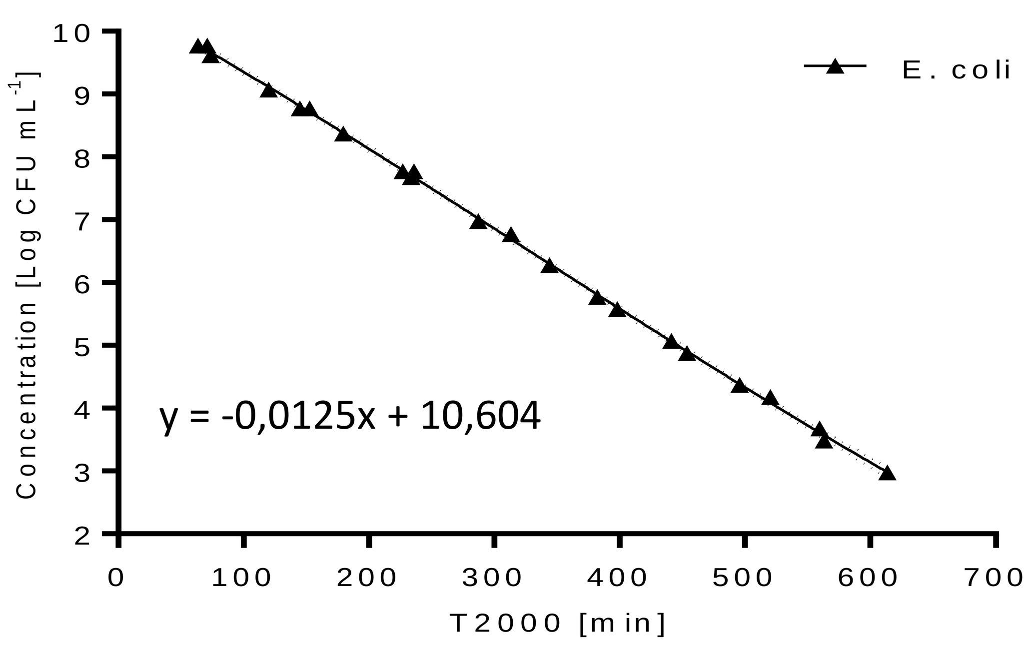




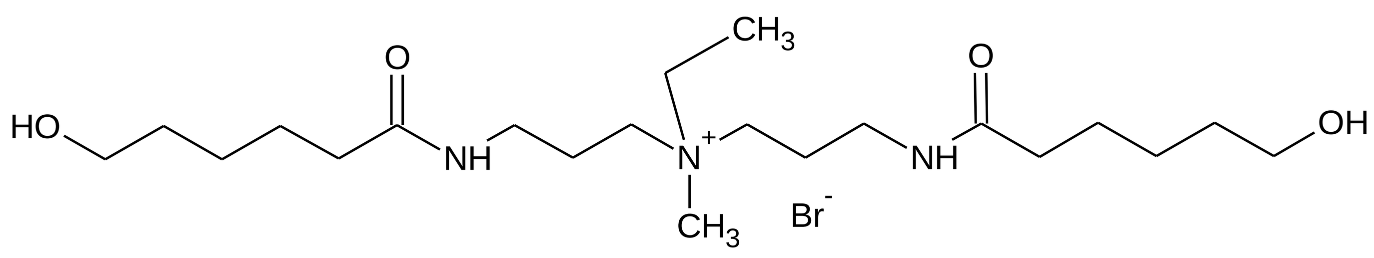
- particle size has no effect on photocatalytic efficiency (NOx abatement), some co-formulants have
- hydrophobicity (SFE) is the leading parameter to prevent fouling
- unchanged chlorophyll *a* content suggests that algae have mechanisms to quench reactive oxygen species generated by TiO_2, therefore photocatalysis have only supporting effect on antifouling

Case study n. 3: Development of high throughput test for screening antibacterial efficacy of nanofiber membranes

Development of antifouling/antibacterial membrane material requires high throughput screening test, as many samples could be inefficient and standard cultivation techniques are demanding and time-consuming. However, it is advantageous to have these tests correlated.

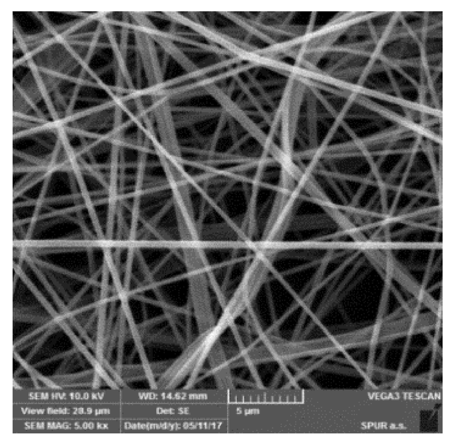


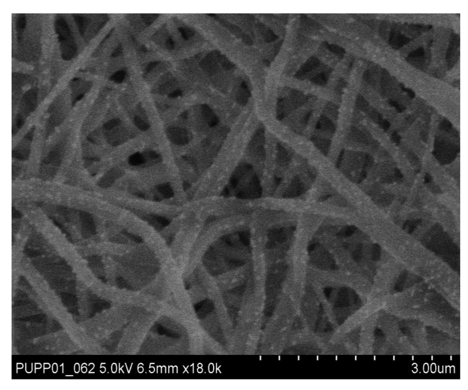
- method based on resazurin metabolization and fluorescence
- calibration curve: various exact bacterial (*E. coli* and *E. faecalis*) concentrations have different times to reach 2000 RFU (T2000), T2000 and concentrations are x and y values respectively
- membranes cultivated with bacteria reach RFU=2000 in different time, depending on antibacterial efficiency
- T2000 for membranes is put into calibration curve equation and CFUs is calculated
- *A* (antibacterial efficiecny, log reduction) is calculated from CFUs for treated membranes and control membrane

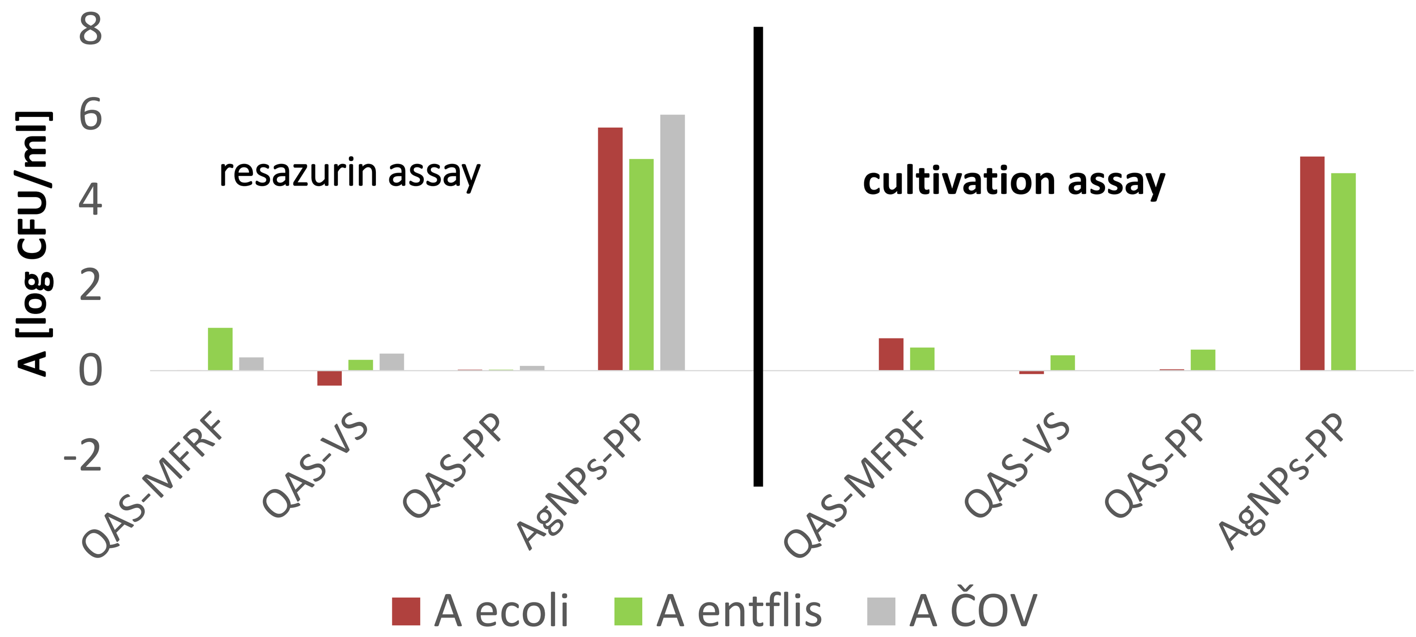


PU nanofiber membranes

- with embedded quarternary ammonium salt (QAS)
- with grafted Ag nanoparticles (AgNPs)







- the developed test has a good correlation with standard cultivation technique
- membranes with AgNPs are antibacterial, membranes with QAS are not efficient