Non-Toxic Nucleation and Passivation of Silver Nanoparticles on Stainless Steel for Biofouling Control

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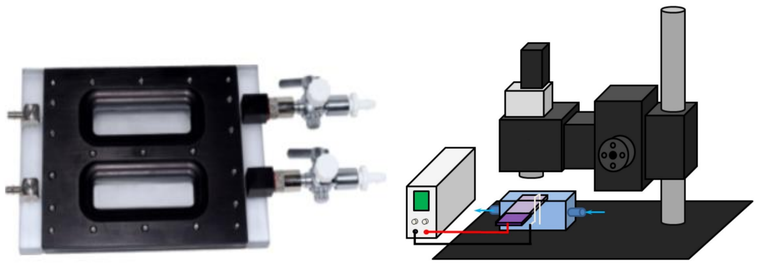
Introduction

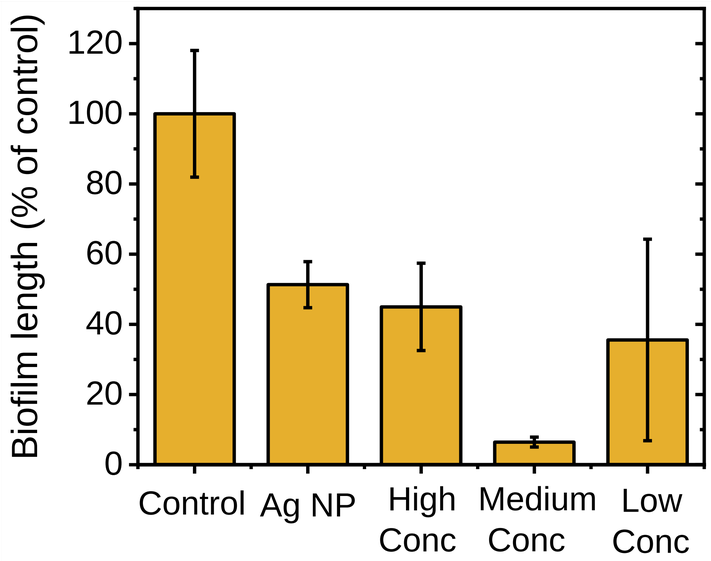
Currently, ionic silver (Ag^+) is used in water distribution systems of the International Space Station (ISS) to control the growth of microorganisms in the water. However, silver is highly soluble and is quickly removed from surface. By passivating the surface of stainless steel with formation of silver halide, the longevity of silver increased. The effect of this passivation on biofouling performance of functionalized silver was investigated by comparing them with control coupons. Fluorescence microscopy data confirmed the high antimicrobial activity of silver halides and ImageJ analysis showed reduction in biofilm formation rate. Future experiments are needed to monitor the surface properties of the coated surfaces.

Materials and Methodology

- Pristine and functionalized SS coupons were exposed to a suspension of *P. aeruginosa* solution for 3 hours.
- After 3h exposure, cells were stained with Syto9 and PI, for live and dead staining, and counted on a Leica DM6 epifluorescence microscope.
- Biofilm formation rate was quantified using Optical Coherence Tomography system and ImageJ analysis.
- Morphology and composition of the Ag NPs on SS was characterized by Scanning Electron Microscopy (SEM) and Energy Dispersive Spectroscopy (EDS).

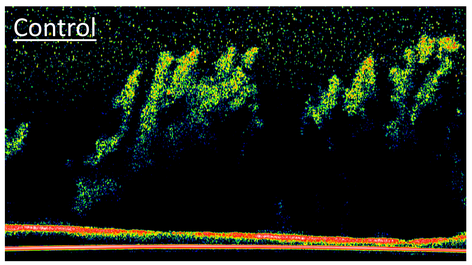


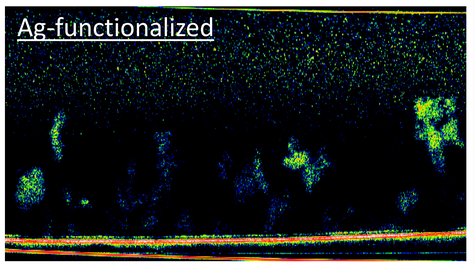
Results and Discussion



The thickness of biofilm on the surface of five different coupons is in millimeter with the pristine sample being the control coupon.

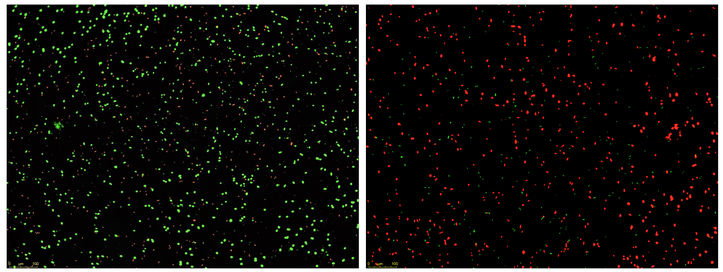
- ImageJ analysis suggests that after 5-day exposure to M9 minimal medium supplemented with *P. aeruginosa*, medium and low concentrations of silver halides formed less biofilm on the surface compared to other samples.





- In above images, the one on the left shows the thickness of biofilm on the surface of control coupon whereas image on the right shows the thickness of biofilm on Ag-functionalized coupon.

Antibacterial Properties



- Green dots represent live *P. aeruginosa* cells, whereas red dots represent dead *P. aeruginosa* cells.
- The number of live Bacteria cells (green dots) dramatically decreased moving from the control coupon to the silver functionalized samples.

Conclusions

- Results indicate that all Ag/ Ag-functionalized treated stainless-steel surfaces had an effective anti-biofouling and antibacterial performance while reducing the rate of silver release from the surface.
- Scanning electron microscopy data suggests that surface of stainless-steel was coated with silver nanoparticles, with a particular one exhibiting less agglomeration and more uniform distribution of Ag NPS compared to the others.

References

Rice, D, Westerhoff, P, Perreault, F & GARCIA SEGURA, S 2018, 'Electrochemical self-cleaning anodic surfaces for biofouling control during water treatment', *Electrochemistry Communications*, vol. 96, pp. 83-87.

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