Biofouling Control in Water systems using Nanoparticles

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Introduction

Biofilm is a deposit of microorganisms on a surface embedded in a matrix of protective and adhesive compounds and biofouling is commonly used to describe the negative effect of the biofilm on the performance of water systems.

Silver nano-particle is one of the most fast growing nano-materials. They exhibit antibacterial properties via bacterial inactivation and growth inhibition. New highly effective preparation methods have opened a window for new and wider applications including the method presented in this work.

Objectives

In this study we exposed planktonic bacterial cells to molecularly capped silver nano-particles (Ag-MCNPs) as a strategy to control biofilm formation .
The main aims were:

- **To study the ability of pre-exposed *P.aeruginosa* cells to form biofilm.**
- **To reduce the formation of biofouling in a dead-end UF membrane system, thus to improve its performance.**

Approach and Results

The synthesis of the **Ag-MCNPs** is based on reducing metal ions in solution in the presence of Tri-sodium Citrate as stabilizing agents.

MCNPs main Characteristics:

Size: relatively small (mean size of ~10nm)

size distribution: narrow

Stability: high zeta potential (~ -40mV)

Shape: roughly spherical

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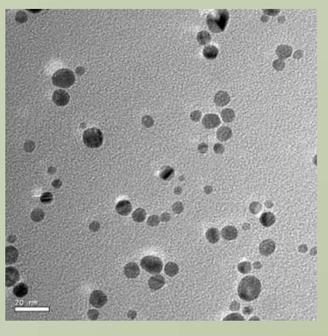
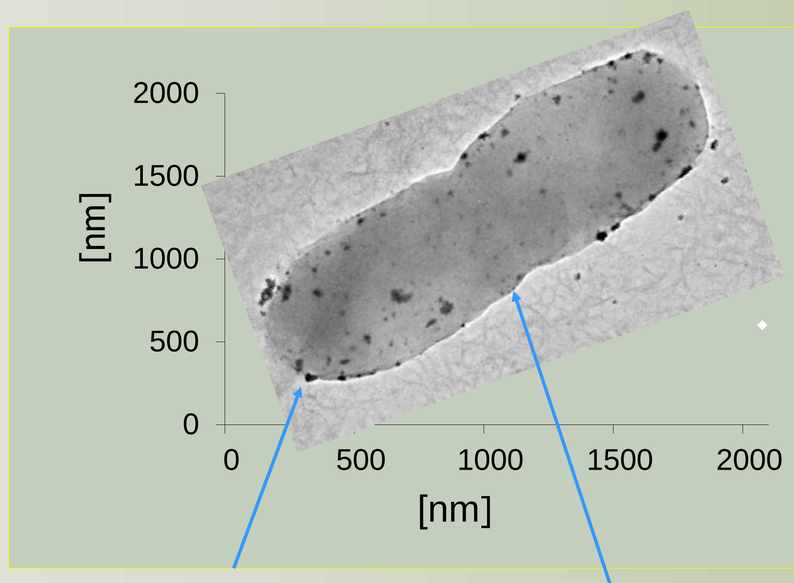


TEM micrographs present

1. Ag-MCNPs (bar=50nm)

2. bacterial cell interacted with Ag-MCNPs

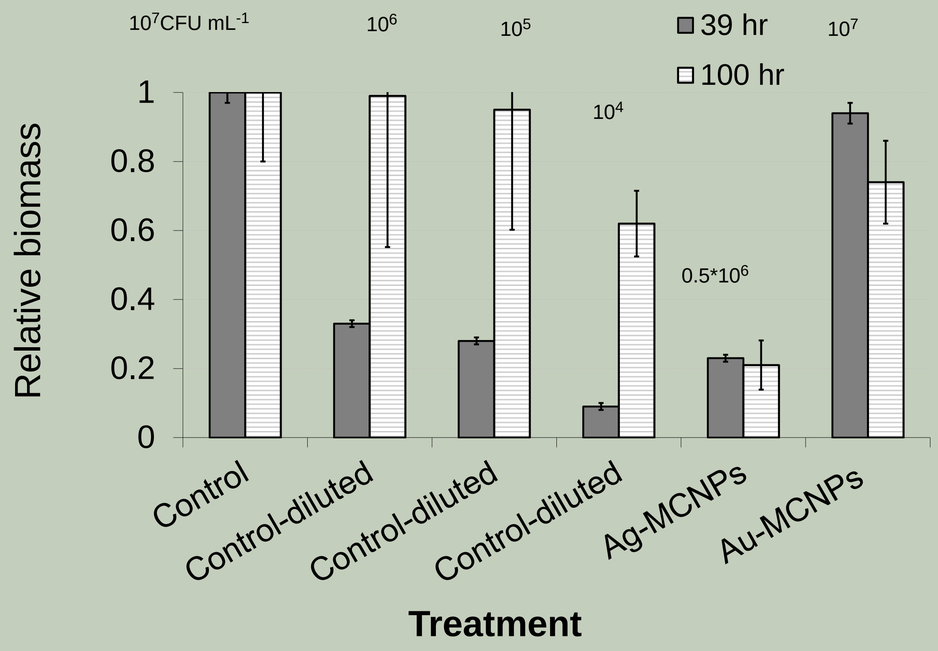
2



Ag-NPs mean size: 8nm

Bacterial cell (*E.coli*) size: 2 μm

Impact of initial cells count (colony forming unit - CFU); comparison of diluted control and survived cells after interaction with Ag-MCNPs; short and long incubation periods were compared.

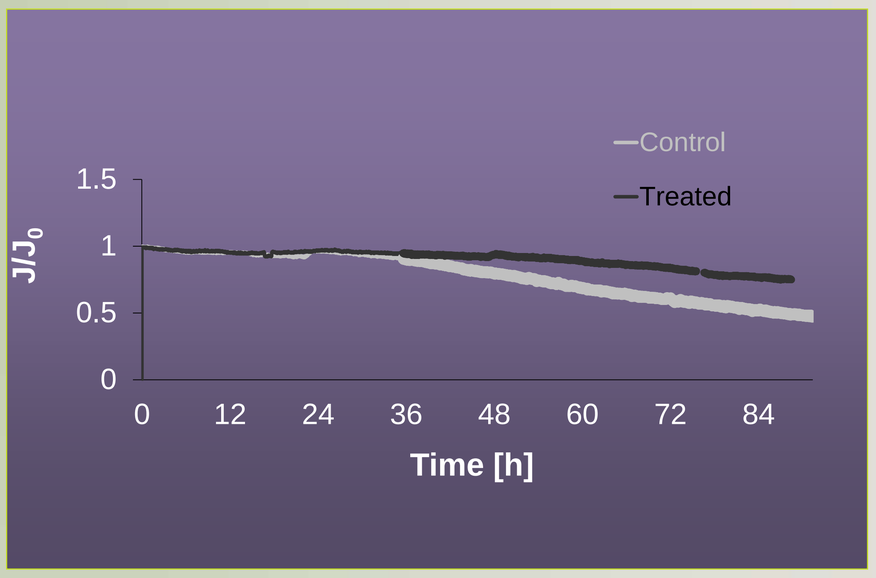


Concentration of MCNPs - 45μg/mL

The ability of *P.aeruginosa* cells that were pre-exposed to MCNPs to form biofilm was quantified by using a screening assay. Biofilm formation is presented as relative percentage of biomass while control of non-exposed cells constituted 100% of biomass formation. Inert Au-MCNPs were used as a nano-size control. Various incubation periods, particles concentrations and initial cells concentrations were elucidated.

Concentration of MCNPs - 45μg/mL

The method was tested in a dead-end UF membrane system that was fed with bacterial cells – treated with Ag-MCNPs and control. The impact of the treatment on the performance of the system was assessed by tracing the alteration of the permeate flux verse time.



At the end of the filtration process the membranes (polycarbonate) were observed by SEM.

The micrographs show:

1. **Control cells that formed a biofilm**
2. **Treated cells (arrow shows accumulation of Ag-MCNPs)**

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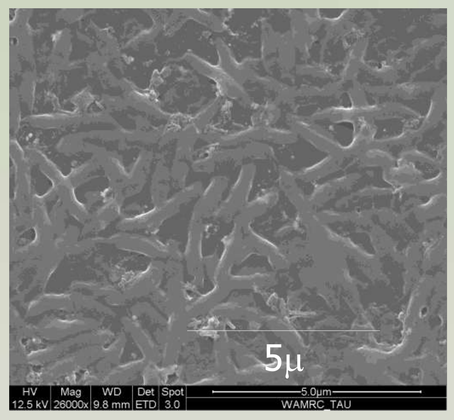

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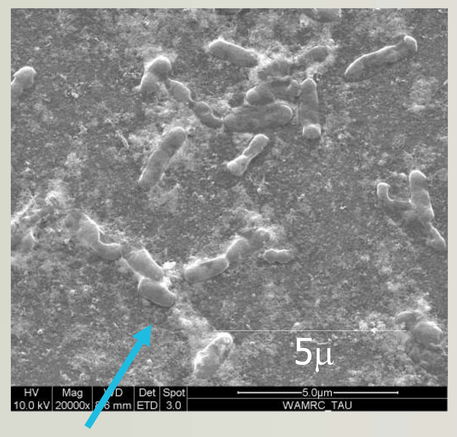

Conclusions

- The bacterial cell interacted with Ag-MCNPs, the cells remained intact.
- Retardation in the formation of biofilm and biofouling has been demonstrated.
- The performance of the tested UF membrane has been improved.
- Further implementation in other water systems is envisaged.

Acknowledgement

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