

# IWA Conferences

## Functionalisation of electrospun nanofibre membranes with titaniumdioxide nanoparticles. --Manuscript Draft--

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<b>Abstract:</b>	Electrospun nanofibre membranes have a high water flux in comparison to other microporous structures. In this research the added value of functionalisation of nanofibers with titanium dioxide nanoparticles (nTiO <sub>2</sub> ) is evaluated. Titaniumdioxide nanoparticles have been used in this study because of their low cost and advanced oxidation properties. This leads to efficient removal of pathogens and recalcitrant molecules in water. Preliminary tests with nanofibre membranes functionalised with TiO <sub>2</sub> performed in this study indicated an enhanced removal of methylene blue, used as indicator, with 40 to 80% after 6 hours illumination with UV-A.
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## Functionalisation of electrospun nanofibre membranes with titaniumdioxide nanoparticles.

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**Abstract:** Electrospun nanofibre membranes have a high water flux in comparison to other microporous structures. In this research the added value of functionalisation of nanofibers with titanium dioxide nanoparticles (nTiO<sub>2</sub>) is evaluated. Titaniumdioxide nanoparticles have been used in this study because of their low cost and advanced oxidation properties. This leads to efficient removal of pathogens and recalcitrant molecules in water. Preliminary tests with nanofibre membranes functionalised with TiO<sub>2</sub> performed in this study indicated an enhanced removal of methylene blue, used as indicator, with 40 to 80% after 6 hours illumination with UV-A.

**Keywords:** electrospinning; microfiltration; nanofibres; non-woven; photocatalytic; titaniumdioxide; UV-A;

### Introduction

The electrospinning technique is a process for making continuous nanofibres in a non-woven form. This process spins fibres ranging from 80 nm diameter to several hundred nanometers. The production technique gives the possibility to introduce functional agents on the surface of the nanofibres. Titaniumdioxide nanoparticles have been used as a functional agent for the nanofibre membranes because of their antibacterial properties and the possibility to oxidize organic material offering a high efficiency at low cost. A possible application of these functionalised nanofibers is WWTP effluent filtration in view of water re-use. In order to assess these functionalised nanofibers tests with methylene blue were performed. In a later stage also tests with a standard mixture of humic acids and real waste water effluent will be performed.

### Material and Methods

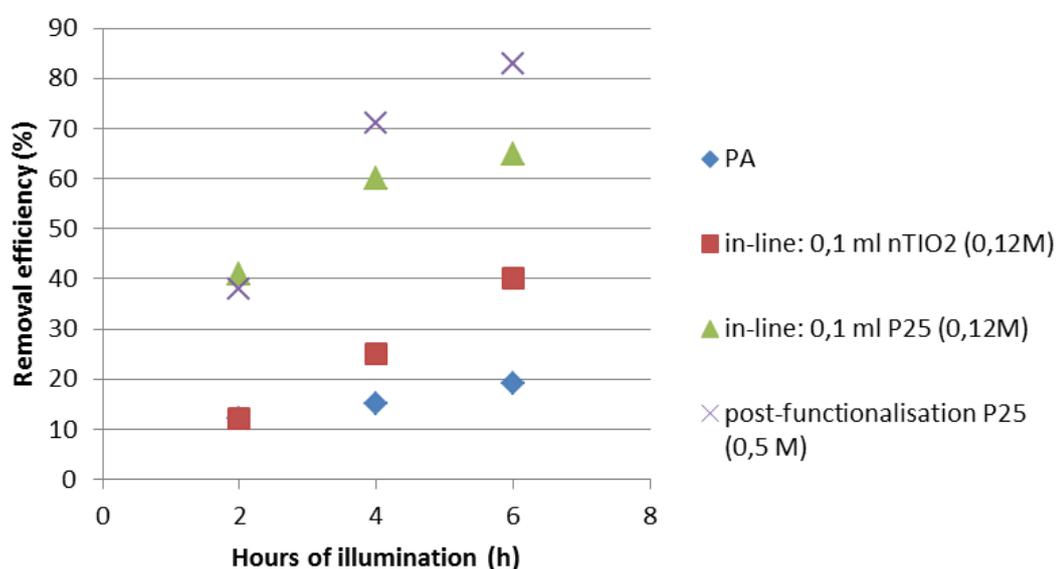
Two possible ways of functionalisation are being studied: dip-coating and in-line functionalisation (Decostere et al., 2009). Two titaniumdioxide-solutions have been tested. Degussa P25 (Sigma Aldrich), offering a mixture of anatase and rutile TiO<sub>2</sub> in the range of 25 nm and a synthesized colloid consisting of faceted, single-crystalline,

anatase TiO<sub>2</sub> nanoparticles (nTiO<sub>2</sub>) with an average size of about 6 nm (Mihailovic et al., 2010).

Photocatalytic activity of the nanofibre membranes functionalised with TiO<sub>2</sub> was assessed by degradation of methylene blue. The membrane was put in a methylene blue solution (10 mg/l) and illuminated by ULTRA-VITALUX lamp, 300W (Osram) for 6 h. Contact tests were performed by adding 2 ml *E. Coli* on a nanofibre membrane under UV-A light for 15 minutes.

## Results and Conclusions

Preliminary tests with nanofibre membranes functionalised with TiO<sub>2</sub> indicated an enhanced efficiency on the removal of methylene blue with a removal of 40 to 80% of the colour after 6 hours illumination with UV-A. These are promising results on lab scale.



**Figure 1.1: removal efficiency by different functionalised nanofibre membranes of methylene blue (intensity at 664 nm) after illumination with UVA. PA= non-functionalised polyamide nanofibre membrane. In-line: 0,1 ml TiO<sub>2</sub> added to 20 ml spinning solution.**

Contact tests were done on *E-coli*. A nanofibre membrane in-line functionalised with 0,1 ml nTiO<sub>2</sub> give a 2 log<sub>10</sub> higher removal then a non functionalised PA 6 nanofibre membrane. Future tests will be done on the use of the functionalised membranes on pilot-scale, giving us an idea on the biofouling-enhancement of the added functionalisation. This will be performed with methylene blue, a standard mixture of humic acids and real waste water effluent.

## References

Daels, Nele, Sander De Vrieze, Imca Sampers, Bjorge Decostere, Philippe Westbroek, Ann Dumoulin, Pascal Dejans, Karen De Clerck, Stijn Van Hulle (2011). Potential of a Functionalised Nanofibre Microfiltration Membrane as an Antibacterial Water Filter. *Desalination*, **275** (1-3), 285–290.

Decostere, B., Daels, N., De Vrieze, S., Dejans, P., Van Camp, T., Audenaert, W., Hogie, J., Stijn Van Hulle (2009). Performance assessment of electrospun nanofibres for filter applications. *Desalination*, **249**(3), 942–948.

Mihailović, D., Šaponjić, Z., Radoičić, M., Radetić, T., Jovančić, P., Nedeljković, J., Radetić, M. (2010) Functionalization of Polyester Fabrics with Alginates and TiO<sub>2</sub> Nanoparticles. *Carbohydrate Polymers*, **79**, 526-532

Figure

