Synthesis and Characterization of Modified and Unmodified Polyethersulfone Microfiltration Membranes by Electrospinning

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Introduction

Microfiltration refers to filtration processes that use porous membranes to separate suspended particles with diameters between 0.1 and 10 µm. thus microfiltration membranes fall between ultrafiltration membranes and conventional filters [1]. One major established application field for MF membranes is the clear filtration of aqueous streams, i.e. the removal of particulate and colloidal matter based on size. Polyethersulfone (PES) is considered one of the most polymers that used for fabrication of microfiltration membranes [2]. But the main limitation of this material is that it is prone to foul due to its relatively hydrophobic character [3].
Therefore, membrane modification is usually done to increase hydrophilicity of the membrane by blending of the membrane polymer with modifying agent (additive) such as Pluronic and Tetronic.

Pluronic and Tetronic typical amphiphilic copolymers bearing hydrophilic PEO segments and hydrophobic PPO segments.
The hydrophobic polypropylene oxide (PPO) segments in Pluronic or Tetronic ensured that they will be firmly anchored in the polymer matrix, while the hydrophilic polyethylene oxide (PEO) segments endowed the membranes surface with higher hydrophilicity [4].
In this work we prepared unmodified and Tetronic 901/PES nano-fibrous microfiltration membranes by using electrospinning technique and the resulting membrane characteristics were investigated.

Methods

PES/PET nanofibrous membranes were produced by an electrospinning setup .
Briefly, prepared PES solution (22 wt%) in NMP was fed with a constant rate of 20 µL /min into a needle by using a syringe pump (Harvard Apparatus, USA). By applying a 18kV voltage, PES was electrospun on PET non-woven supported by Aluminum foil (as the control substrate).
The same steps were done to prepare modified PES membrane by addition of Tetronic® 901 Block Copolymer Surfactant to PES/NMP solution at the ratio 3-5 wt%.
All experiments of hydraulic permeability were carried out by using a dead-end stirred cell (Amicon cell model 8010, Millipore Corp.) connected to a feed reservoir (~450 mL) and pressurized by the effect of hydrostatic pressure.
Hydraulic permeability was measured from the average of at least four measurements from different membrane samples.

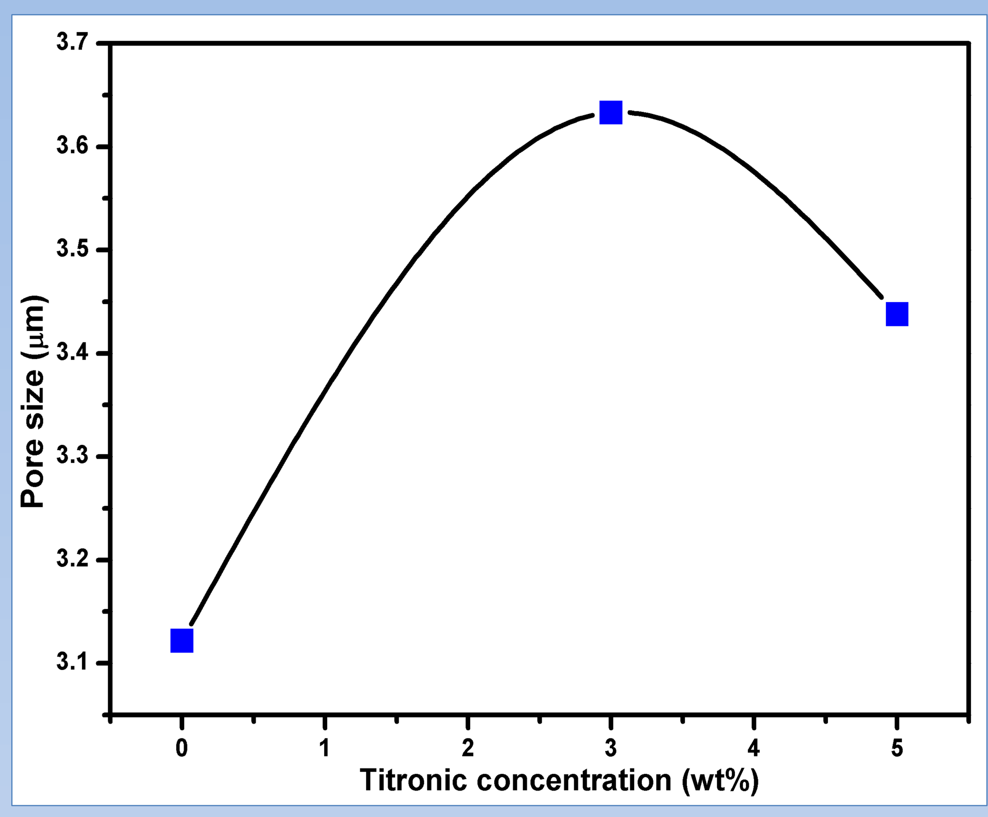

Figure 1: Pore size of PES membranes as a function of Tetronic concentration

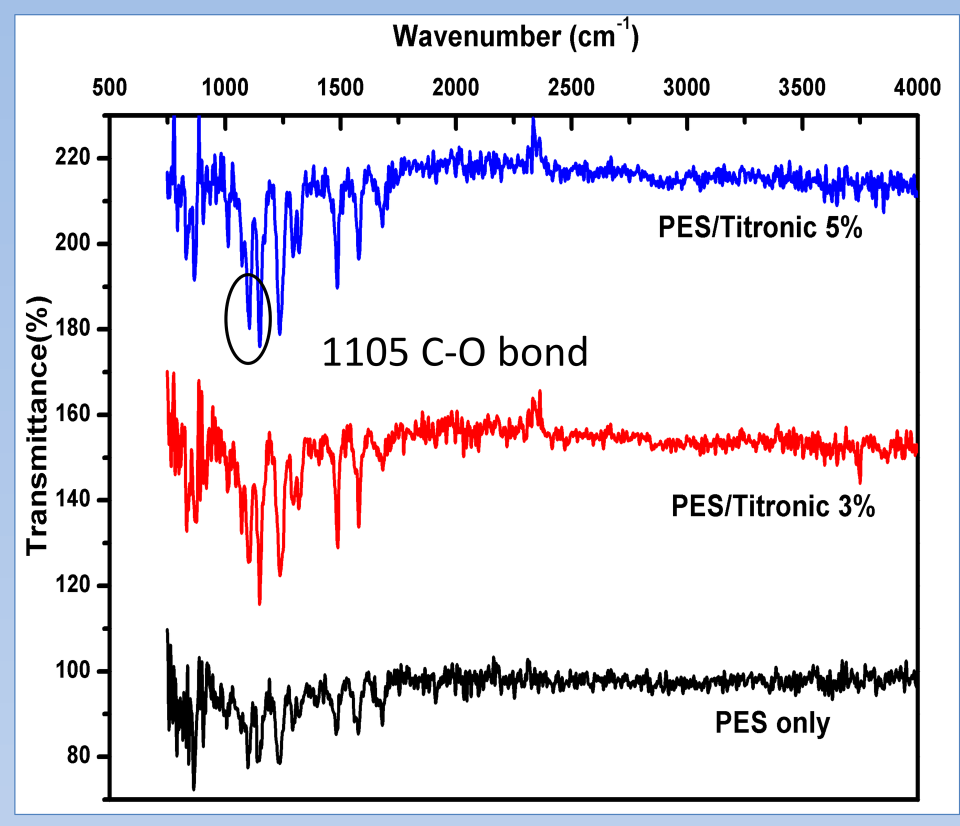

Figure 2: FT-IR of the PES prepared membranes

Results

1. The pore size of the PES/Tetronic membrane increased with the increase of Tetronic content (Fig. 1).
2. SEM pictures show the produced nanofibers for all membranes with no beads formation and slight decrease in the fibers diameters by the increase of Tetronic content.
3. The FTIR spectra revealed additional intensity of C–O bond at ~1105cm^{-1} (from Tetronic) and this peak increases by increasing Tetronic content as shown in Fig. 2.
4. From Fig. 3, Contact angle measurements showed that PES surface is converted from higher hydrophobic to more hydrophilic after addition of Tetronic where the contact angle changed from about 107° for PES to about 71° for PES/3 wt% Tetronic and about 69° for PES/ 5 wt% Tetronic.
5. Modification effects on membrane characteristic were clearly observed in a significant increase in water permeability by increasing the Tetronic content due to increasing of the hydrophilicity. (Fig. 4,/5).

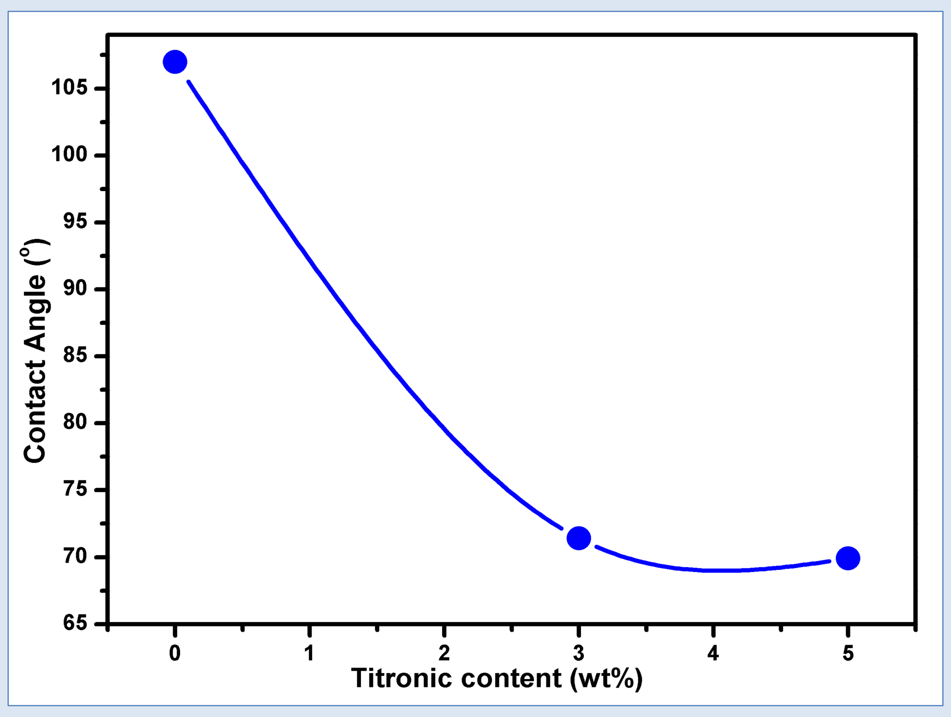

Figure 3: Water Contact angles on the PES membranes as a function of Tetronic content

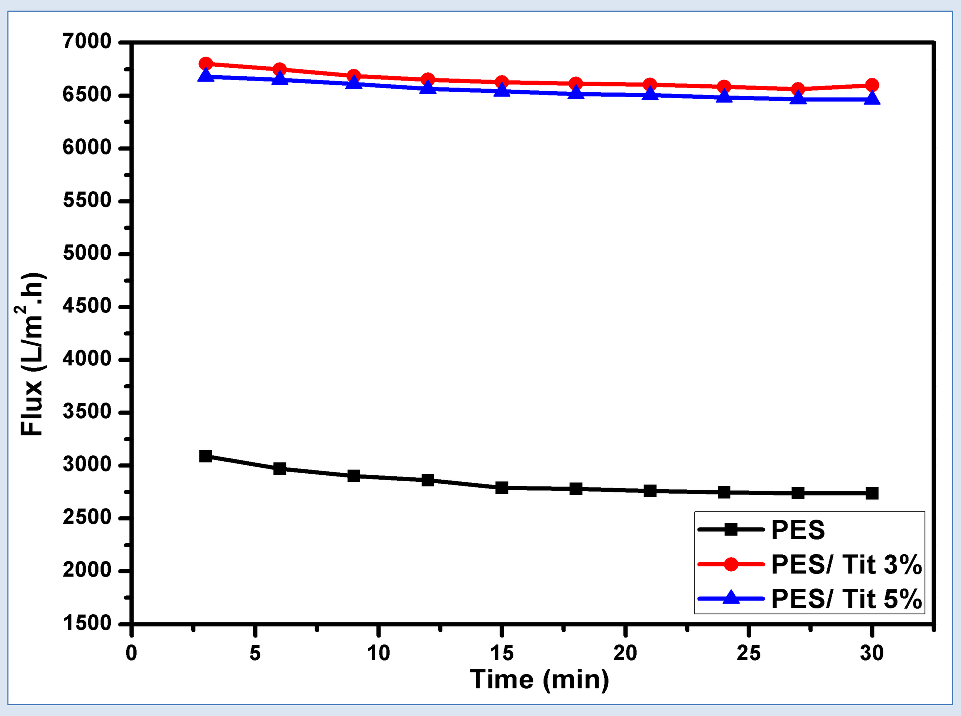

Figure 4: Water flux as a function of time

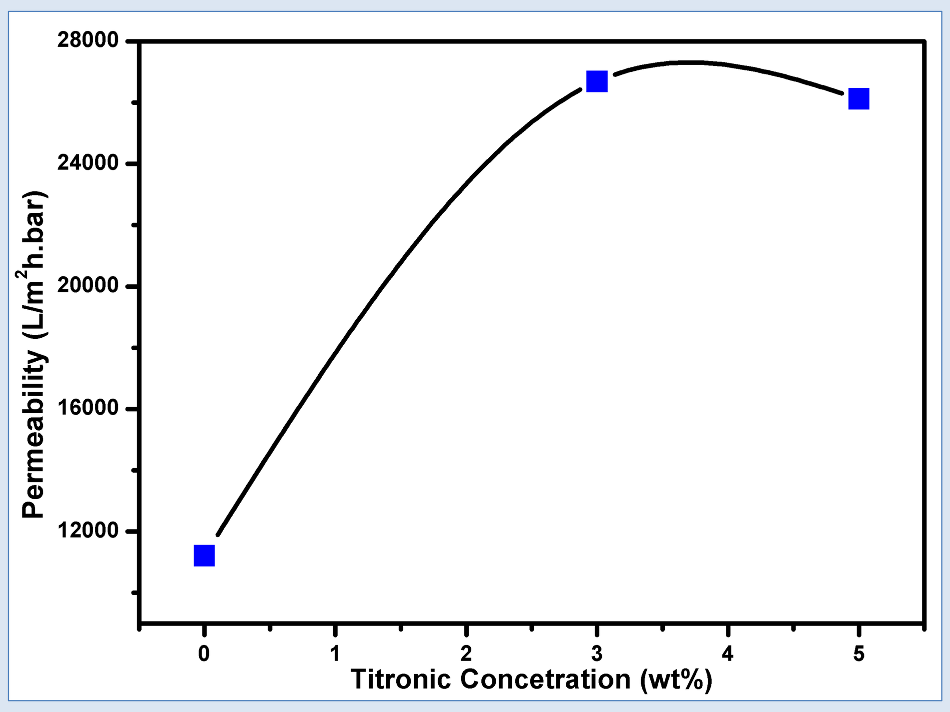

Figure 5: Water permeability as a function of Tetronic concⁿ

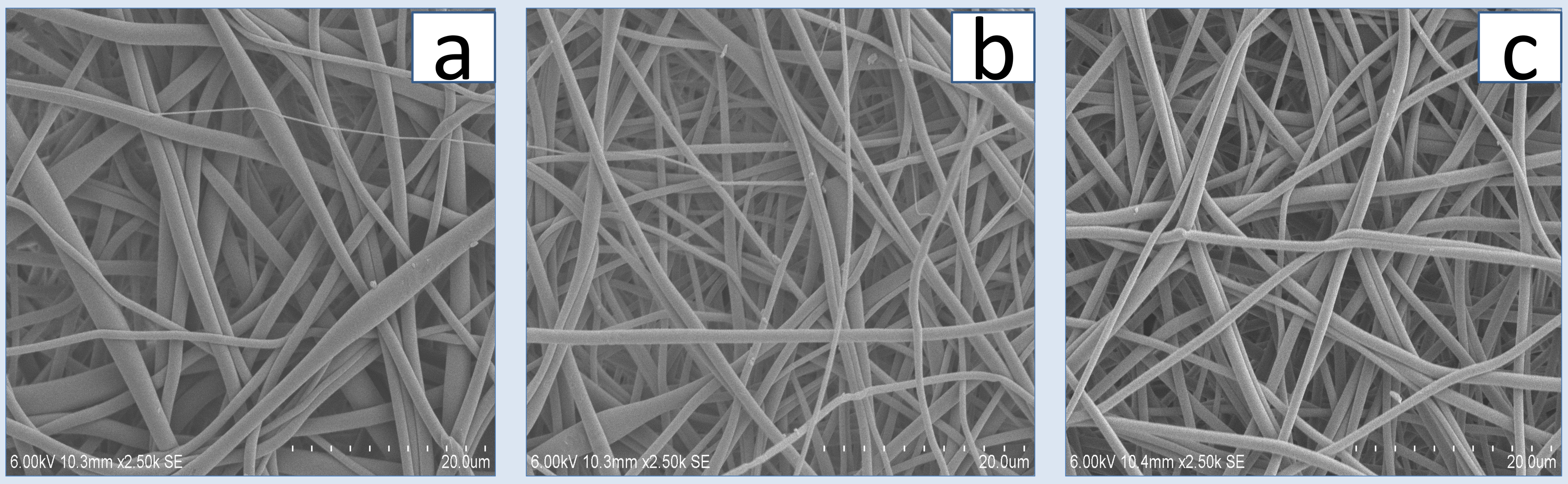

Figure 6: SEM micrographs of the PES nanofibers membranes a) unmodified PES, b) PES/3wt% Tetronic and c) PES/3wt% Tetronic

Conclusion and Outlook

Tetronic copolymer was blended with PES to fabricate microfiltration membranes by electrospinning. FTIR confirmed the presence of Tetronic due to the increase in the intensity of C–O bond at ~1105cm^{-1}. Both the hydrophilicity and water flux increased by increasing the Tetronic content.
Further experiments will be carried out to study the antifouling properties of the prepared membranes. Other additives such as metal nanoparticles (e.g. silver nanoparticles) in the matrix of the membranes will be tested .

References

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