Alkali and acid polysaccharides blend nanofibrous membranes prepared by electrospinning

C. Santos¹, A. Silva¹*, Z. Büttelé*, G. Guimarães, P. Tamagnini², A. Zille²

¹CENTI - Centro de Nanotecnologia e Matériais Técnicos, Funcionais e Intelectuais, Rua Fernando Morroca 2785, 4760-034 V. Famaíco, Portugal.
²IBMC - Instituto de Biologia Molecular e Celular, Universidade do Porto, Rua do Campo Alegre 823, 4150-180 Porto, Portugal

Introduction

Electrospinning allows the production of polymer fibres with diameters in the sub-micron size range, through the application of an external electric field, keeping intact the bulk properties of the polymers. Electrospun membranes possess some unique structural features, such as a high surface to volume ratio and very good mechanical performance, properties that are determinant to their use in several applications such as air and liquid filtration, tissue engineering, optical and chemical sensors [1].

In this work, alkali and acid biopolysaccharides blended with polyvinyl alcohol (PVA) were electrospun into a polyvinylidene difluoride (PVDF) based microfiltration membrane, with the goal of developing a mid-layer nanofibrous porous support for exploitable thin-film composite (TFC) membranes for water filtration. The alkali and acid biopolysaccharides chosen were, respectively, chitosan (CS), a cationic polyelectrolyte (in this case with deacetylation degree around 85%), and cyanobacterial extracellular polymeric substances (EPS), an acidic polysaccharide isolated from Cyclotella sp. CCM 0110 [2].

The electrospun blended nanofibrous membranes were fully characterized in order to investigate their morphology, diameter, structure, mechanical and thermal properties. The results showed that these membranes have great potential for filtration purposes [3].

Experimental

Electrospinning

Conditions:
- Room temperature
- 10mL syringe with needles of 0.6mm of inner diameter
- Electric field strength of 2.5kV
- Feed rate: 0.1 to 1mL/h
- Viscosity and conductivity of the polymer solutions:
  - Polymer blend (%) Conductivity (μS cm⁻¹) Viscosity (cP)
  - 12% PVA 874 9 96 3
  - 12% PVA + 0.5% EPS 1149 26 963 3
  - 12% PVA + 0.5% CS 1274 20 442 12

Characterization of electrospun PVA/polysaccharides membranes:
AFM, SEM, EDS, DMA, TOA, DSC, ATR-FTIR

Results

EDS Analysis

<table>
<thead>
<tr>
<th>Element</th>
<th>PVA/CS</th>
<th>PVA/EPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>4.30</td>
<td>51.44</td>
</tr>
<tr>
<td>O</td>
<td>58.57</td>
<td>48.96</td>
</tr>
<tr>
<td>N</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>S</td>
<td>0.71</td>
<td>0.38</td>
</tr>
</tbody>
</table>

Total 100.00 100.00 100.00 100.00 100.00 100.00

Table 1: Variation of weight and atomic percentages of the atoms C, O, N and S in the electrospun nanofibres

Conclusion

- Electrospun PVA/alkali polysaccharide (CS) and PVA/acid polysaccharide (EPS) blend nanofibrous membranes were successfully prepared, with an uniform and smooth morphology, and narrow diameter distribution from ~50 to 130nm.
- Thermal and mechanical analysis demonstrated the presence of intermolecular hydrogen bonds between the polysaccharides and PVA.
- The electrospun PVA/polysaccharides blended membranes showed better tensile mechanical properties when compared with PVA alone, and resisted more against diamagnetism in the temperature range between 10 and 50°C.
- In future work, these membranes will be further coated with an ultra-thin selective top layer.

References:

Acknowledgments:
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