Dendritic polymer functionalized carbon nanodiscs/poly(vinyl alcohol) nanocomposite membranes for water treatment applications

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One of the major challenges of modern society is to secure adequate highly quality water resources. Thus, various polymeric nanostructured membranes have been prepared. In the present study, porous poly(vinyl alcohol) (PVA) nanocomposite membranes were developed and their performance in separations was evaluated[1]. One way to improve membrane properties is by the addition of nanoparticles resulting in mixed matrix structures, with carbon based nanoparticles attracting much research attention[2]. Since the hydrophobic nature of carbon hinders it's dispersion in aqueous solutions, the following modification process was carried out: two guanidinylated derivatives of hyperbranched poly(ethylenimine) (GPEIs) having molecular weights of 5000 and 25000 Da, were used to functionalize oxidized carbon nanodiscs through covalent bonding between the functional groups of GPEIs and the oxygen containing groups of the nanodiscs. Nanocomposite PVA membranes were then prepared containing 0.1, 0.25 and 0.5 wt% of functionalized carbon nanodiscs.[2] Subsequently, the membranes of about 50-100μm thickness were crosslinked using glutaraldehyde, rendering them water stable.[3]

The hybrid nanomaterials, oxCNDs@GPEIs, were physicochemically characterized using a variety of techniques such as ^{1}H and ^{13}C NMR, FT-IR, SEM, TEM (Fig.1a-b), RAMAN and XRD. Furthermore, the prepared membranes were studied in regards to their water permeability and their anti-fouling properties. They were also characterized by SEM (Fig.1 c-d), FTIR, XRD, water contact angle, porosity and pore size. Finally, the antibacterial properties of the membranes were assessed against a Gram-positive bacterium, Escherichia coli, where it was found that upon increase of the portion of oxCNDs@GPEIs, their antibacterial activity increased. Based on the above results, it was found that the nanocomposite membrane with 0.25% oxCNDs@GPEI-25KDa exhibited better overall properties.

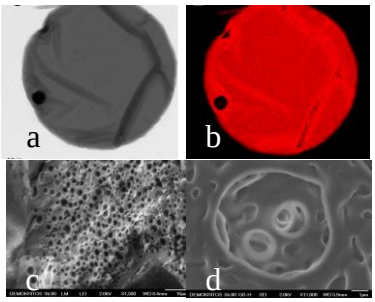

Fig. 1 HRTEM images: (a) Bright field image and (b) EFTEM compositional maps of N (red) of oxCNDs@GPEI and SEM images of PVA membranes containing 0.5 wt% oxCNDs@GPEI (c, d).

References:
1. Sapalidis A. *Symmetry (Basel)*. 2020;12(6):1-24.
2. Sapalidis A et al. *Front Mater*. 2018;5(March):1-10.
3. Chae S-K et al. *Langmuir*. 2014;30(41):12107-12113.