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www.elsevier.com/locate/memsci

PII: S0376-7388(17)32708-4
DOI: https://doi.org/10.1016/j.memsci.2018.02.063
Reference: MEMSCI15988

To appear in: *Journal of Membrane Science*

Received date: 20 September 2017
Revised date: 26 January 2018
Accepted date: 26 February 2018

Cite this article as: Ambreen, Tauqir A. Sherazi, Yaqoob Khan, Shenghai Li, Syed Ali Raza Naqvi and Zhaoliang Cui, Fabrication and characterization of polysulfone/modified nanocarbon black composite antifouling ultrafiltration membranes, *Journal of Membrane Science,* https://doi.org/10.1016/j.memsci.2018.02.063

Fabrication and characterization of polysulfone/modified nanocarbon black composite antifouling ultrafiltration membranes

Ambreen[1], Tauqir A. Sherazi[1*], Yaqoob Khan[2], Shenghai Li[3], Syed Ali Raza Naqvi[4], Zhaoliang Cui[5]

[1]Department of Chemistry, COMSATS Institute of Information Technology, Abbottabad, 22060, KPK, Pakistan
[2]Nanosciences and Catalysis Division, NCP, QAU Campus, 45320 Islamabad, Pakistan
[3]Key Laboratory of Polymer Ecomaterials, Changchun Institute of Applied Chemistry, Chinese Academy of Sciences, Changchun 130022, China
[4]Department of Chemistry, Government College University, Allama Iqbal Road, Faisalabad, Pakistan
[5]National Engineering Research Center for Special Separation Membrane, Nanjing Tech University, Nanjing 210009, China

Abstract

Membrane fouling in membrane filtration technology is the major obstacle in maximizing its efficiency leading to short membrane lifetime and high operating cost. Here we reported that the use of oxidized nanocarbon black (ONC) in the preparation of composite ultrafiltration membrane, suppresses the fouling together with improved hydrophilicity and water permeate flux. Nanocarbon black (NC) was oxidized using ammonium persulfate, while morphology, nature and extent of oxidized groups were determined through scanning electron microscope (SEM), X-ray photoelectron spectroscopy (XPS), fourier transform infrared spectroscopy (FTIR), thermogravimetric analysis (TGA) and ion exchange capacity (IEC) measurement. The dispersion of the ONC was stable in organic solvent (NMP) and in DI water even after 6 months. Oxidized nanocarbon black was incorporated in polysulfone matrix to prepare nanocomposite membranes (CNC) through phase inversion method. The influence of ONC on surface morphology, surface chemical composition, hydrophilicity, mechanical strength, surface negative charge, porosity, ultrafiltration and anti-fouling characteristics were evaluated. The results showed that inclusion of 1.0 wt.% ONC enhance water permeate flux from 188.5 to 307 $Lm^{-2}h^{-1}$, protein rejection up to 97.6%, highest flux recovery ratio of 89.4% after three cycle permeation and lowest irreversible fouling of 10.5%. Considering relatively low cost, excellent anti-fouling properties and mechanical strength of CNC membranes, make it potential candidate as anti-fouling membrane for water purification.

Graphical abstract