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Electrospun polyethylene oxide/cellulose acetate nanofibers incorporated with a nanocomposite for the removal of heavy metals from water

E. U. I. de Silva, K. M. N. de Silva, and W. R. M. de Silva*

Department of Chemistry, University of Colombo, Colombo 03, Sri Lanka

At present, electrospun nanofibers are extensively utilized in addressing various environmental issues, especially to account for water quality problems. Their unique structural characteristics including extraordinary surface area and interconnected porosity have aided in gathering more interest towards water purification. The ability to incorporate other nanomaterials into nanofibers presents an opportunity to develop high performance water treatment technologies that are energy efficient. Hence, nanofibers are found to be suitable for the removal of a wide range of pollutants of chemical and biological nature. The major objective of the present study was to synthesize a novel efficient adsorbent to remove Pb(II) and Cd(II) in water. Accordingly, polyethylene oxide/ cellulose acetate (PEO/CA) was selected as the most appropriate polymer blend, incorporated with synthesized HAp/Zr/CTS (Hydroxyapatite/Zr/Chitosan) nanocomposite to enhance its adsorption efficacy. The so-formed composite mat PEO/CA/HAp/Zr/CTS and neat mat were fabricated by electrospinning and were characterized. Fourier transform infrared (FT-IR) analysis confirmed successful synthesis of fiber mats. X-ray diffraction (XRD) analysis explained the crystal structure of synthesized material. Thermogravimetric analysis (TGA) evaluated the thermal stability and the volatile component content. Scanning electron microscope (SEM) data indicated the texture of fibers on nanocomposite incorporation. The electrospun mats were then subjected to adsorption studies to analyze the effects of parameters such as contact time, pH and initial concentration on Pb(II) and Cd(II) removal. The maximum adsorption capacity for the neat mat was 51.02 mg/g and 1.40 mg/g for Pb(II) and Cd(II), respectively. For the composite, adsorption had been improved to values of 90.91 mg/g and 6.59 mg/g for Pb(II) and Cd(II), respectively. Experimental data fitted better with Langmuir isotherm model for both neat and composite mat. Leaching studies were carried out and it exhibited quite low levels of Ca(II) leaching from the composite mat and almost zero leaching of Zr(IV). According to the attained results of the study, PEO/CA/HAp/Zr/CTS fiber mat was recognized to be exhibiting a higher efficiency in the removal of Pb(II) and Cd(II) ions, thus suggesting it to be improved as a promising material that can readily be used in water purification applications.

Keywords: Electrospinning, nanofibers, cellulose acetate, PEO

E-mail: rohini@chem.cmb.ac.lk