A Study on the Development of Multifunctional Nanocomposite Materials

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다기능성 나노복합소재 개발에 관한 연구

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Abstract

With the rapid development of industry, air pollution, water pollution and soil pollution have become a world environmental problem. More and more attention had been paid on these environment questions. Air pollutants such as volatile organic compounds (VOCs) mainly come from coal chemical industry, petrochemical industry, fuel manufacturing, coating manufacturing, solvent manufacturing and so on. Type and nature of VOCs depend on the source of emission, mainly including halogenated hydrocarbons, alcohols, aldehydes, aromatics, alkanes, ketones, olefins, ethers, esters, paraffins, and sulfur containing compounds. VOCs participate in the formation of ozone and secondary aerosols in the atmospheric environment, which has an important impact on regional atmospheric ozone pollution and PM2.5 pollution. Most VOCs have unpleasant special smell, toxicity, irritation, teratogenicity and carcinogenicity, especially benzene, toluene and formaldehyde, which will cause great harm to human health. VOCs are important precursors leading to urban haze and photochemical smog. On the other hand, water pollutants mainly include organic pollutants, inorganic pollutants, biological pollutants and macro pollutants. In particular, the heavy metal ions introduced into the environment by human activities are mostly bioaccumulated through cumulative exposure, which are not easy to decompose and pose a threat to human health through the whole food chain.

Therefore, it is a very innovative research to develop a multifunctional nanocomposite, which can not only remove VOCs in the air, but also adsorb heavy metal ions in water, and has good antibacterial activity. In this study, fly ash with polyacrylonitrile (PAN) matrix was electrospun into a multifunctional nanofibrous membrane for trapping of VOCs including benzene, toluene and xylene, and heavy metal ions. These obtained multifunctional nanofibrous membranes possessed the satisfactory adsorption capacity for benzene, toluene, xylene, and heavy metal ions including Co(II), Pb(II) and Cr(VI). In addition, due to the addition of silver nitrate, the electrospun composite membrane also has excellent antibacterial ability on Gram-negative Escherichia coli (E. coli) (ATCC 52922) and Gram-positive Staphylococcus aureus (S. aureus) (ATCC 29231) bacteria. The composite fiber membrane prepared by electrospinning has the advantages of small fiber diameter, porosity, excellent pore interconnectivity and high surface-to-volume ratio. Therefore, electrospun fiber membrane has great application potential in the field of environmental remediation.

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