Development of a Highly Efficient Low-Cost Filter for Effective Dissolved Heavy-Metal and Organic Contaminant Removal

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One of the direst threats to our ecosystems and public health is heavy metal pollution. The results of ecological bio-magnification and accumulation in animal and human tissues has led to the WHO establishing strict limits on the concentration of heavy metal ions in our environment, which, in many locations, are highly exceeded. Current removal methods that use activated carbon, silica, metal oxides, polymer resins, or biological treatment lack efficiency and capacity. This work posits a nanomaterial solution that is low-cost, scalable, highly efficient, reusable, and high-capacity, effectively solving the problems plaguing previous methods of heavy metal removal. Additionally, this solution shows strong promise in removing organic pollutants in a highly efficient manner. The bacterial nanocellulose substrate is easily grown in large quantities, and polydopamine nanoparticle synthesis is simple. As a result of the high electronic affinity of the active catecholamine group as well as the pi-pi interactions between PDA and other aromatic molecules, a small BNC/PDA membrane is able to adsorb >99.8% of Pb2+, Cd2+, and Cu2+ ions, as well as Rhodamine 6G, Methyl Orange, and Methylene Blue organic dyes from solutions with many times the WHO limit of pollutant concentration, which was demonstrated to be 4.5 times the capacity of a similar mass of activated carbon. Most importantly, this method of pollutant removal is reusable, nonspecific, and environmentally friendly unlike previous efforts which relied on complex, harmful cleaning and disposal procedures. This nanoscale solution to one of the world's most important problems promises to bring rapid relief to locations plagued with heavy metal pollution, as well as become a better solution for major water treatment endeavors.

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