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Multifunctional Porous Carbon Textiles decorated with Bimetallic MOFs for Air & Water Decontamination via Adsorption-Catalysis Synergy

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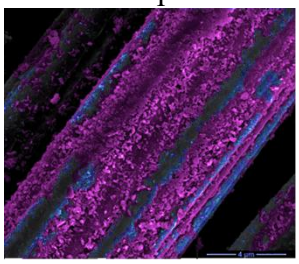
The development of advanced materials for air and water purification, ranging from household filtration systems to protective media for crises such as gas masks, demands innovative and multifunctional adsorbents. Nanoporous carbon textiles (C-Texts) are highly promising due to their high surface area, tunable surface chemistry, low weight, and cost. However, optimizing C-Texts remains challenging, and two approaches are followed: (i) tuning of key physicochemical features and (ii) nanoengineering through the incorporation of active nanophases. Organic micropollutants, including pharmaceuticals, represent a persistent source of water contamination, while chemical warfare agents (CWAs), such as blister and nerve agents, continue to pose serious threats.

This work highlights strategies to enhance the multifunctional performance of C-Texts for both air and water decontamination. We first evaluated the adsorption efficiency of commercial and chemically modified C-Texts, identifying the physicochemical parameters most critical to performance, while systematically investigating the influence of humidity under realistic conditions. Further improvements were achieved by developing scalable, cost-effective methods to decorate C-Texts with minimal loadings of mono- and bimetallic Metal-Organic Frameworks (MOFs), specifically ZIF-based active phases. The resulting hybrid textiles exhibited superior removal of diclofenac from water, and detoxification of CWAs vapors and droplets, alongside extra-high antibacterial efficiency. These enhancements are attributed to homogeneous nanoparticles dispersion and synergistic adsorption-catalysis interfacial effects, enabling efficient catalytic detoxification coupled with strong and stable retention of hazardous molecules.



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