Azobenzene Functionalized Light-Responsive Membranes for Solute Speciation during Water Purification

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Abstract

Light-responsive membranes represent an innovative solution to address the critical challenges of water purification and desalination in the 21st century, particularly in the context of an escalating global water crisis. As freshwater resources become increasingly scarce, the need for innovative technologies that enhance the efficiency of water treatment processes is paramount. This study explores the integration of photo-responsive molecules, such as azobenzene compounds, into membrane surfaces to create materials that can dynamically regulate separation processes in response to light stimuli. Molecular design and chemical functionalization advances enable precise control over membrane properties under varying light conditions, including permeability, pore size, and surface characteristics. Our research focuses on the functionalization of alumina membranes with light-responsive molecules to produce light-tunable membranes for solute speciation in water purification. The functionalization of membranes with azobenzene moieties is validated through analytical tools, including XPS, FTIR, and laser profilometer. The wettability and pore size of the functional membranes can be tuned upon exposure to UV/Vis light for specific time intervals. These membranes demonstrate efficacy in the selective fractionation of pharmaceuticals (Sulfamethoxazole and tetracycline) from their aqueous solution or contaminated water during continuous exposure with light. This work not only demonstrates the potential of light-responsive membranes for tunable filtration systems but also highlights their role in enhancing the efficiency of water purification. By harnessing molecular engineering and photo-switchable chemistry, we aim to develop sustainable and effective water treatment technologies that contribute to addressing water scarcity worldwide.

References

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