Homochiral polymer-graphene oxide nanocomposite membrane for enantioselective separation

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Abstract:

Chirality describes the relationship between two molecules that are mirror-image of each other and are non-superposable. These so-called enantiomers are optically active and show distinct pharmaceutical or biological activities due to the chiral resolution capacity of biological molecules. In some cases, one enantiomer is active while its mirror image is non-effective or even toxic, highlighting a need for separation. Enantiomers are often found as racemic mixtures but are difficult to separate due to their identical physical and chemical properties. Membrane-assisted separation is a promising candidate for efficient chiral resolution because of its high capacity, low cost, and potential to scale-up. Graphene oxide (GO) has received great attention for fabricating highly efficient enantioselective membranes due to its mechanical properties, atomic thickness, and versatility in functionalization. However, the preparation of modified GO-based chiral separation membranes with long-term stability in enantioselectivity remains challenging due to the limited efficiency of modification, and the uncontrolled enlargement in layer spacing due to the introduction of chiral moieties. Herein, we used GO laminates as building blocks of a membrane, and the homochiral S-poly(2,4-dimethyl 2-oxazoline) (S-PdMeOx) along with a crosslinker to create enantiomeric cavities. The resulting highly crosslinked network successfully entwined the nanosheets and led to precise control of the layer spacing. 100 ee % enantioselectivity of S-(-)-limonene over R-(+)-limonene was achieved by the nanocomposite membrane. The effect of feed solvent on chiral separation performance of the S-PdMeOx/GO nanocomposite membrane was also studied. This work provides new insights into the development of highly efficient enantioselective composite membranes.

Keywords: chiral resolution, enantioselective composite membranes, homochiral polymers, two-dimensional materials