# New membrane efficiently separates mirrored molecules

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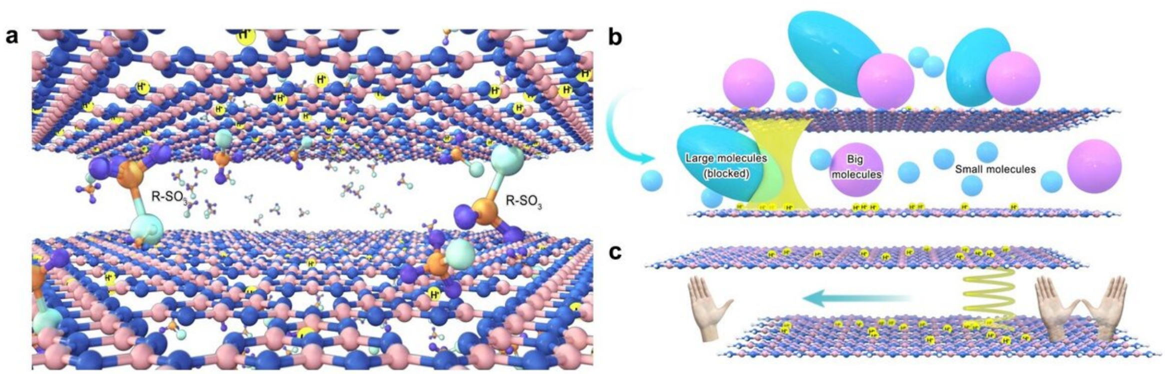


Illustration of the chiral membrane for selective permeation. Credit: LIU Bo's team

Prof. Liu Bo and colleagues at the University of Science and Technology of China (USTC) have developed a chiral separation membrane capable of capturing left-handed chiral molecules and releasing the right-handed counterpart using two-dimensional layered materials. The chiral membrane, showing a separation efficiency up to 89% towards limonene racemate, is expected to be put into industrial production. The research was published in *Nature Communications* on June 7.

In the classic Chinese tale *Journey to the West*, no one could tell the difference between the real Monkey King and his "evil twin" Six Ears, thus causing much confusion. Only the Buddha could distinguish the real Monkey King from the fake, ensuring that the Monkey King could continue his journey.

Among biomolecules, many are inseparable from each other—just like the Monkey King and Six Ears. These are the so-called chiral isomers (enantiomers), which have identical chemical formulas but rotate in space in opposite directions. They are mirror images of each other and are non-superposable.

However, despite their chemical similarity, enantiomers may function very differently. For example, levamlodipine can treat high blood pressure while dextroamphetamine has no such effect. In the biopharmaceutical process, chiral isomers are often produced at the same time, so the mixture must be separated. However, left-handed and right-handed molecules are as difficult to identify and separate as the Monkey King and Six Ears.

Chiral sites (trees)are inserted between two layers of graphite-phase carbon nitride (cloud layers). The 'trees' can catch the left-handed molecules (Six Ears) while allowing the right-handed ones (Monkey King) to be transported away, thus resulting in high separation efficiency. Credit: CUI Jie

Chiral separation membranes are the most impressive solution. However, polymer membranes have low separation efficiency, and crystalline compounds don't easily form membranes. Liu Bo and his research team, using a two-dimensional (2-D) layered material, tuned its interlayer distance and introduced chiral sites into the interlayer space, and assembled the layers into efficient and stable chiral separation membrane.

"The membrane exhibits high selective permeation efficiency among various enantiomers," said Wang Yang, a Ph.D. student at USTC and the first author. "It can efficiently separate the R-limonene and retain most of the L-limonene. The separation performance can be further improved when applying a certain pressure."

This work demonstrates the potential of tuning the chemical environment within interlayer space via electrostatic interaction in order to fabricate stable membranes that fulfill the function of precise sieving at the sub-nanometer scale. Such membranes could be applied to sewage processing and desalination, among other things. Indeed, Liu Bo sees "broad application prospects" for chiral membranes comprising 2-D layers.

Currently, the researchers are able to fabricate chiral membranes at the centimeter scale in the lab. The team is increasing the membrane size into meter-scale membranes, aiming to separate chiral drug molecules for the pharmaceutical industry.

**More information:** Yang Wang et al, Graphite phase carbon nitride based membrane for selective permeation, *Nature Communications* (2019). DOI: 10.1038/s41467-019-10381-z

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