Quantum sieving based Hydrogen isotope separation at room temperature using vermiculite laminates

Lalita Saini
Aparna Rathi, Suvigya Kaushik, Gopinadhan Kalon
Indian Institute of technology, Palaj, Gandhinagar 382355, Gujarat, India
saini_lalita@iitgn.ac.in

Abstract

The traditional processes used for separation of hydrogen isotopes, is extremely energy intensive as they require cryogenic temperatures. They also suffer from a poor separation factor D_2/H_2 of 0.71. Achieving room-temperature separation with large separation factors is very important for several applications. Here, we report an efficient room-temperature hydrogen isotope separation with a large separation factor D_2/H_2 of 2.22 using vermiculite (clay) laminates [1]. For the first time, we achieved an interlayer space of ≈2 Å with deuterium intercalation in vermiculite, a size comparable to the de Broglie wavelength of hydrogen isotopes at room temperature. Between proton and deuteron, the smaller wavelength deuteron easily transports across these interlayer spaces, confirming kinetic quantum sieving [2]. This result shows that 2D laminates with controllable interlayer spacing are highly suitable for realizing quantum sieving effects at room temperature. The scalable and cost-effective nature of these laminates makes them ideal for isotope separation applications.

References

[1] A. Rathi, K. Singh, **L. Saini**, S. Kaushik, B. Dhal, Shivam Parmar, G. Kalon. *Materials Today Nano*, 22, 2023, 100328
[2] Beenakker, J. J. M., Borman, V. D. & Krylov, S. Yu. *Chemical Physics Letters* 232, 1995, 379–382

Figures

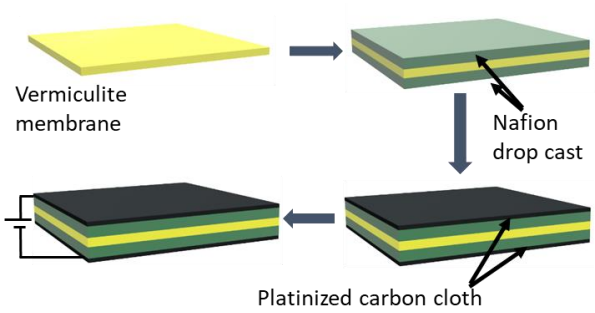

Figure 1: Schematic representation of device fabrication of vermiculite device for intercalation and hydrogen isotope transport studies at room temperature.

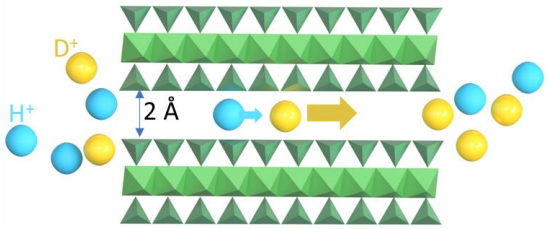

Figure 2: Faster transport of deuterons through interlayer spacing of vermiculite.