# Novel Approach to Lithium Extraction on a String

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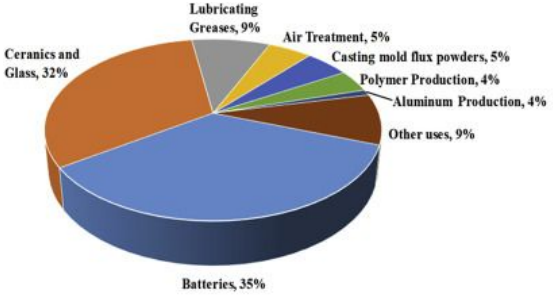
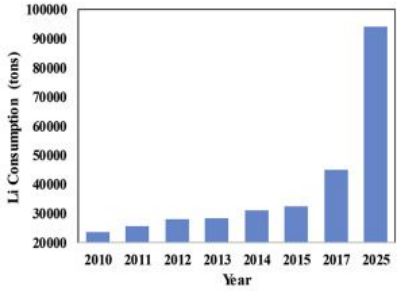
# Why Lithium?

- Electric vehicles, consumer electronics and energy storage systems
- Limited Li supply cannot keep up with demand




(a)




(b)

Xianhui Li, Yinghui Mo, Weihua Qing, Senlin Shao, Chuyang Y. Tang, Jianxin Li, Membrane-based technologies for lithium recovery from water lithium resources: A review, Journal of Membrane Science, Volume 591, 2019, 117317, ISSN 0376-7388, https://doi.org/10.1016/j.memsci.2019.117317.

# Motivation

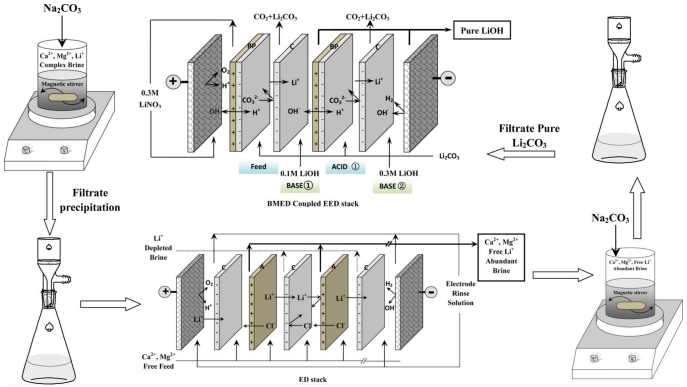
- Almost all lithium mining occurs in Latin America, Australia and China

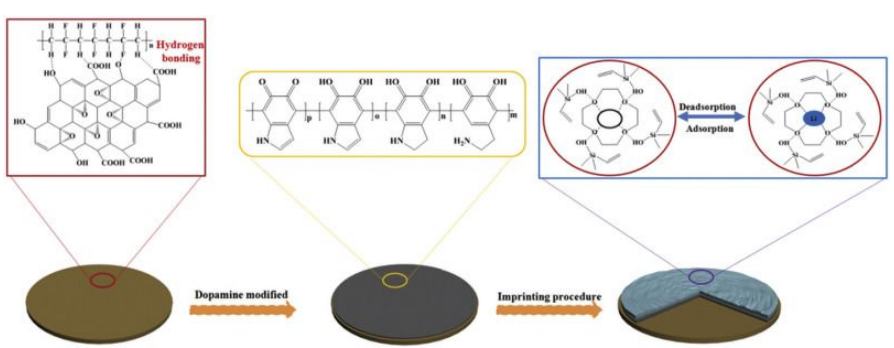
Salar de Atacama Lithium Production Site

Chile's national lithium strategy raises questions about the environmental and social costs of EVs | Grist

# Membrane-based Li Extraction Technologies

- Costly, high energy and use more chemicals



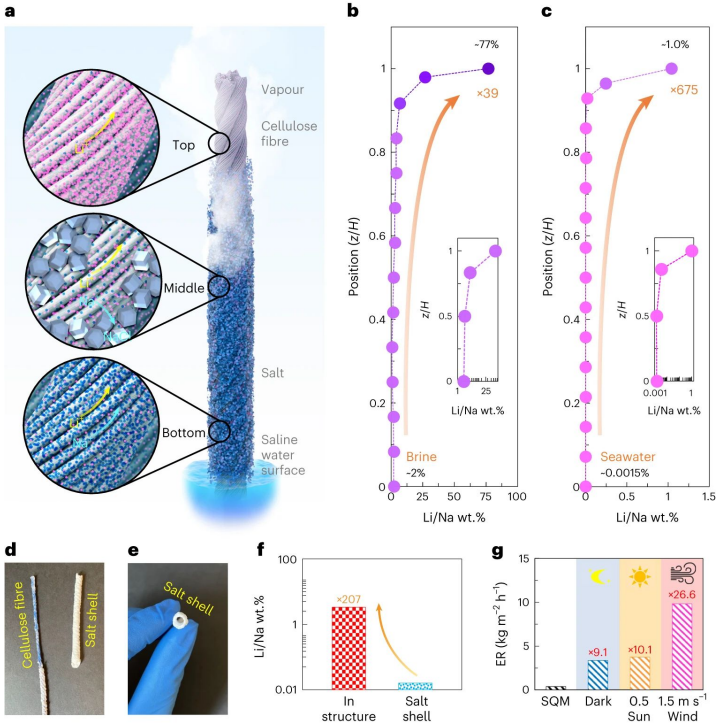




Chenxiao Jiang, Yaoming Wang, Qiuyue Wang, Hongyan Feng, and Tongwen Xu
Industrial & Engineering Chemistry Research 2014 *53* (14), 6103-6112
DOI: 10.1021/ie404334s

J.Y. Cui, Y.F. Zhang, Y. Wang, J.Y. Ding, P.H. Yu, Y.S. Yan, C.X. Li, Z.P. Zhou, New J. Chem., 42 (2018), pp. 118-128
DOI: 10.1039/C7NJ03152A

# How the Li extraction works?

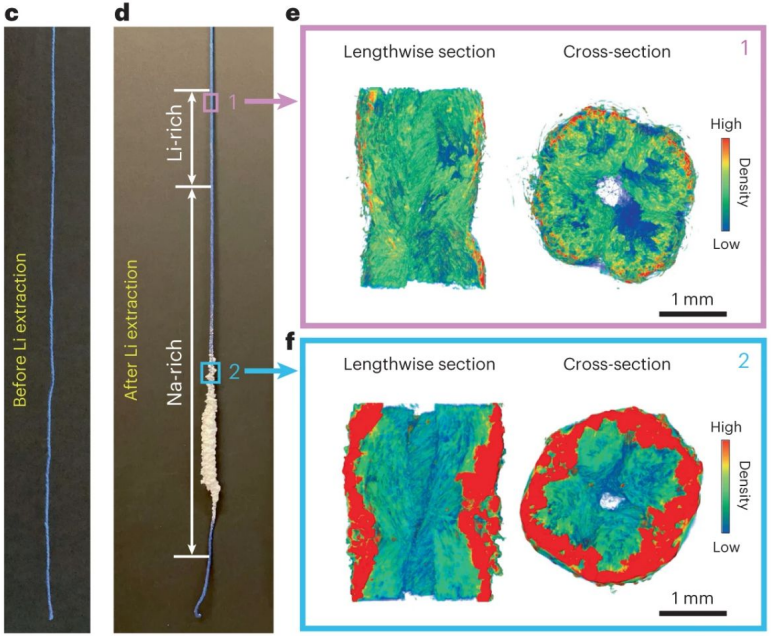
- Chen et al. 2023 developed an extraction process for Li using evaporation and capillary action



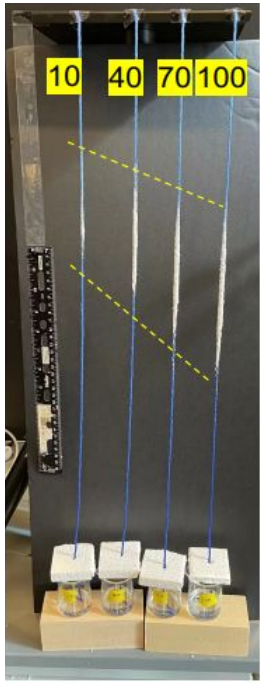

Crystallization process of Na and Li on porous strings

Chen, X., Yang, M., Zheng, S. *et al.* Spatially separated crystallization for selective lithium extraction from saline water. *Nat Water* 1, 808–817 (2023). https://doi.org/10.1038/s44221-023-00131-3

# Experimental Results




Crystallization from brine before and after 60 hr




NaCl crystallization at various heights along porous string

Chen, X., Yang, M., Zheng, S. *et al.* Spatially separated crystallization for selective lithium extraction from saline water. *Nat Water* 1, 808–817 (2023). https://doi.org/10.1038/s44221-023-00131-3

# Model

- 1D Tracer Transport for Li and Na ions through the porous string

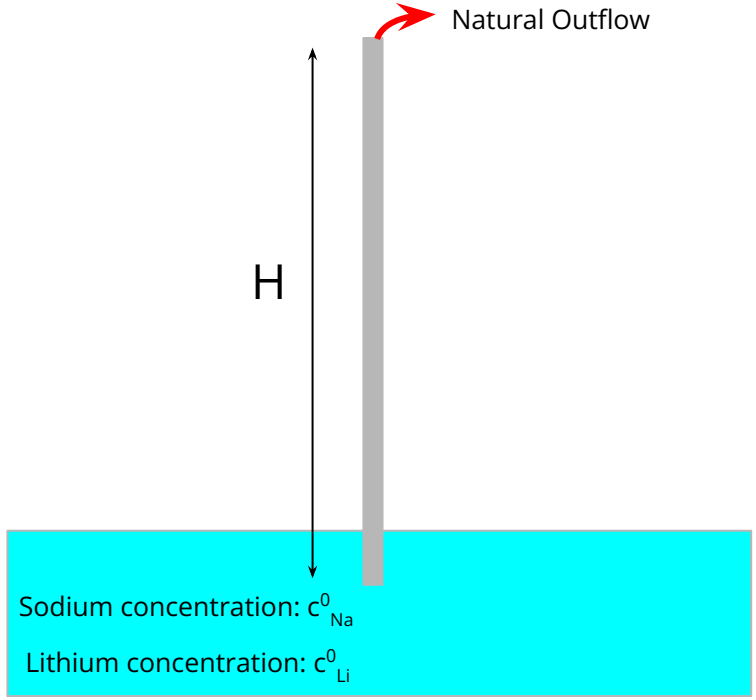
$$\frac{\partial c}{\partial t} + \frac{\partial}{\partial z}(vc) = D\frac{\partial^2 c}{\partial z^2}$$

$$v(z) = v_0\left(1 - \frac{z}{H}\right) \qquad v_0 = \frac{2jH}{\rho R}$$

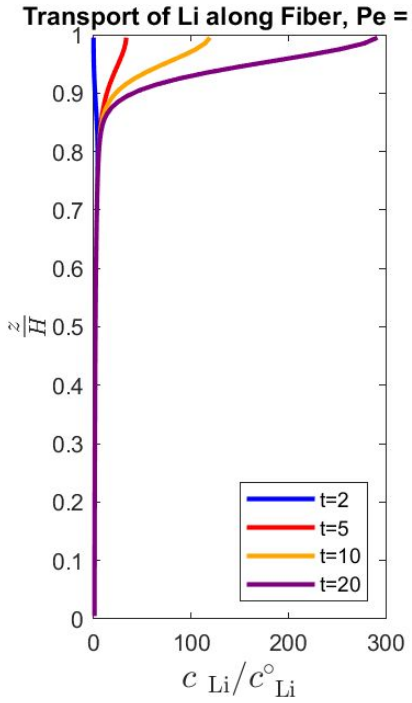
- Scaling Analysis:

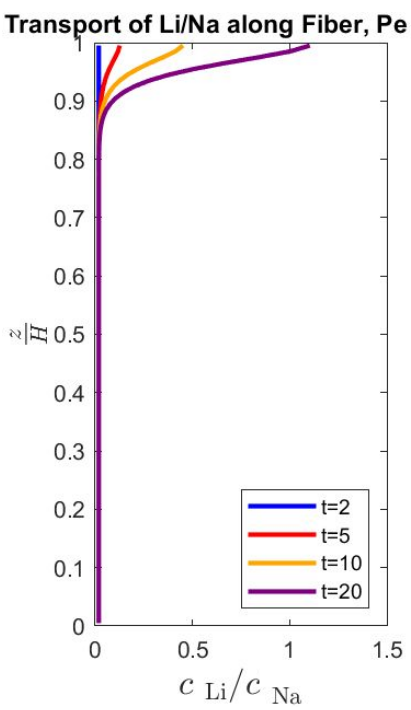
$$\frac{\partial c'}{\partial t'} + \frac{\partial}{\partial z'}\left[(1-z')c' - \frac{1}{\mathrm{Pe}}\frac{\partial c'}{\partial z'}\right] = 0$$

$$Pe = \frac{H \cdot v_0}{D}$$

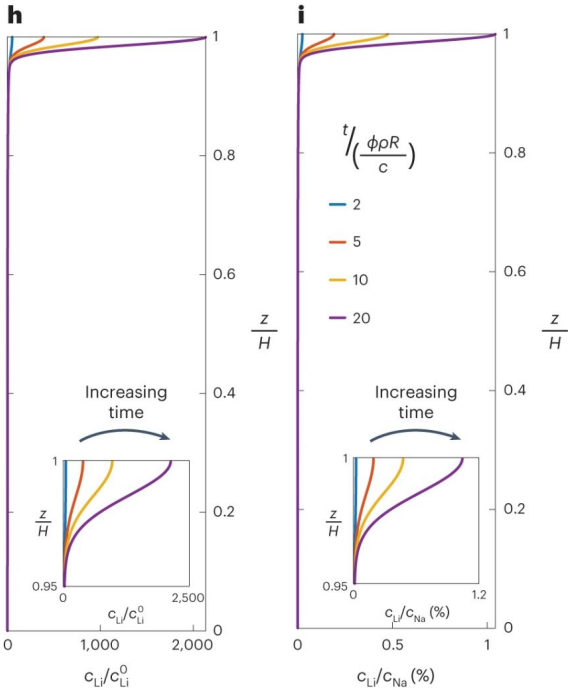


# Model Results




Our Results

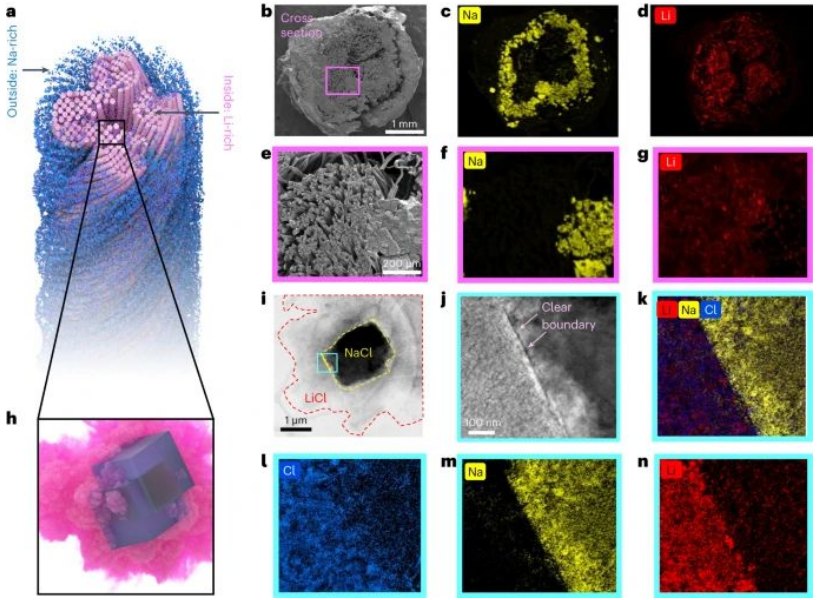



Results from Chen et al. 2023

Chen, X., Yang, M., Zheng, S. *et al.* Spatially separated crystallization for selective lithium extraction from saline water. *Nat Water* 1, 808–817 (2023). https://doi.org/10.1038/s44221-023-00131-3

# Limitations of Model

- Does not factor in crystallization of ionic species
- In radial direction, Na crystallizes on the outside while Li concentrates towards the center




Spatial mapping of Na and Li crystallization across porous strings

Chen, X., Yang, M., Zheng, S. *et al.* Spatially separated crystallization for selective lithium extraction from saline water. *Nat Water* 1, 808–817 (2023). https://doi.org/10.1038/s44221-023-00131-3

# Conclusion

- Li separation from saltwater brine using porous fibers is a powerful technique using evaporation and capillary action
- More compact, affordable and efficient solution