

Hybrid 2D Zeolite-based Membranes

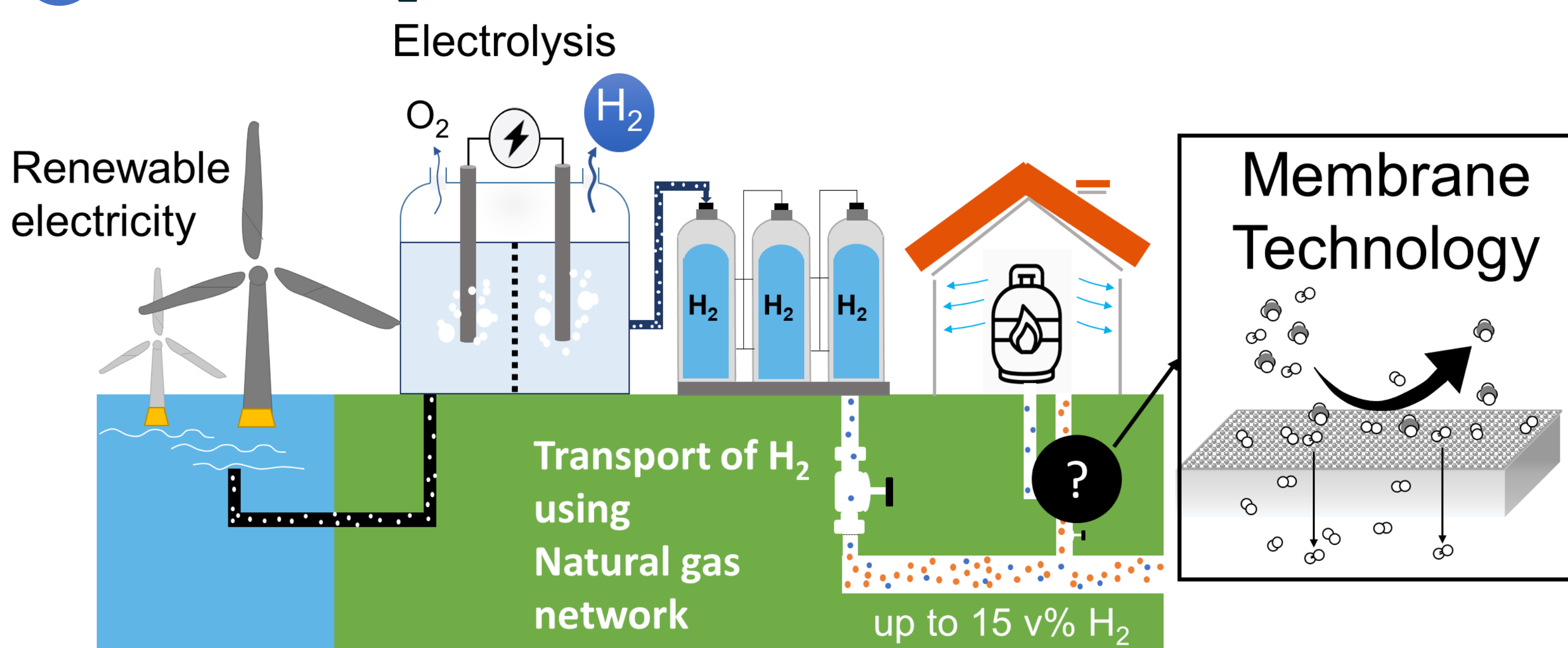
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- Hydrogen is a key component in the transition to sustainable energy systems. Therefore, the separation of Hydrogen from various gas mixtures is crucial for numerous industrial processes and environmental initiatives.
- We aim to develop innovative synthesis approaches for the preparation of 2D zeolite-based membranes with enhanced Hydrogen selectivity and permeability addressing the challenges associated with current gas separation membranes.

1 Context: H₂ separation using gas separation membranes

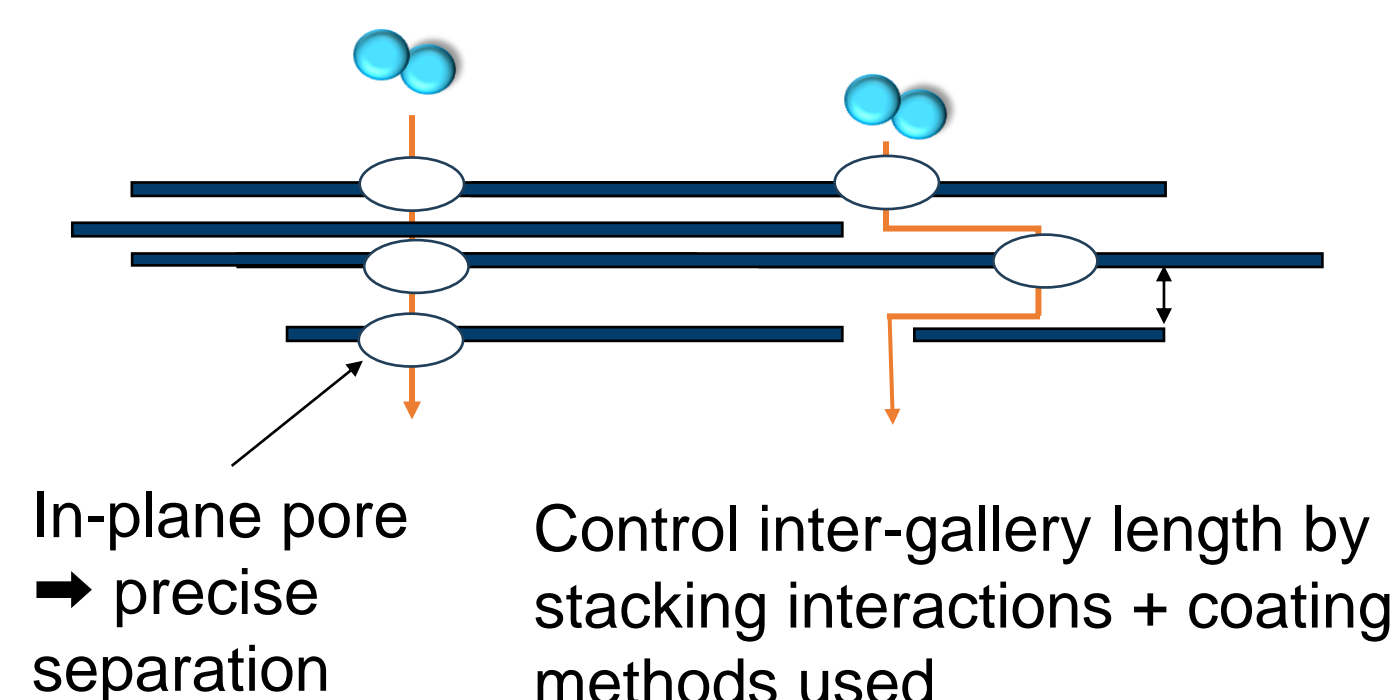


The ideal membrane ?

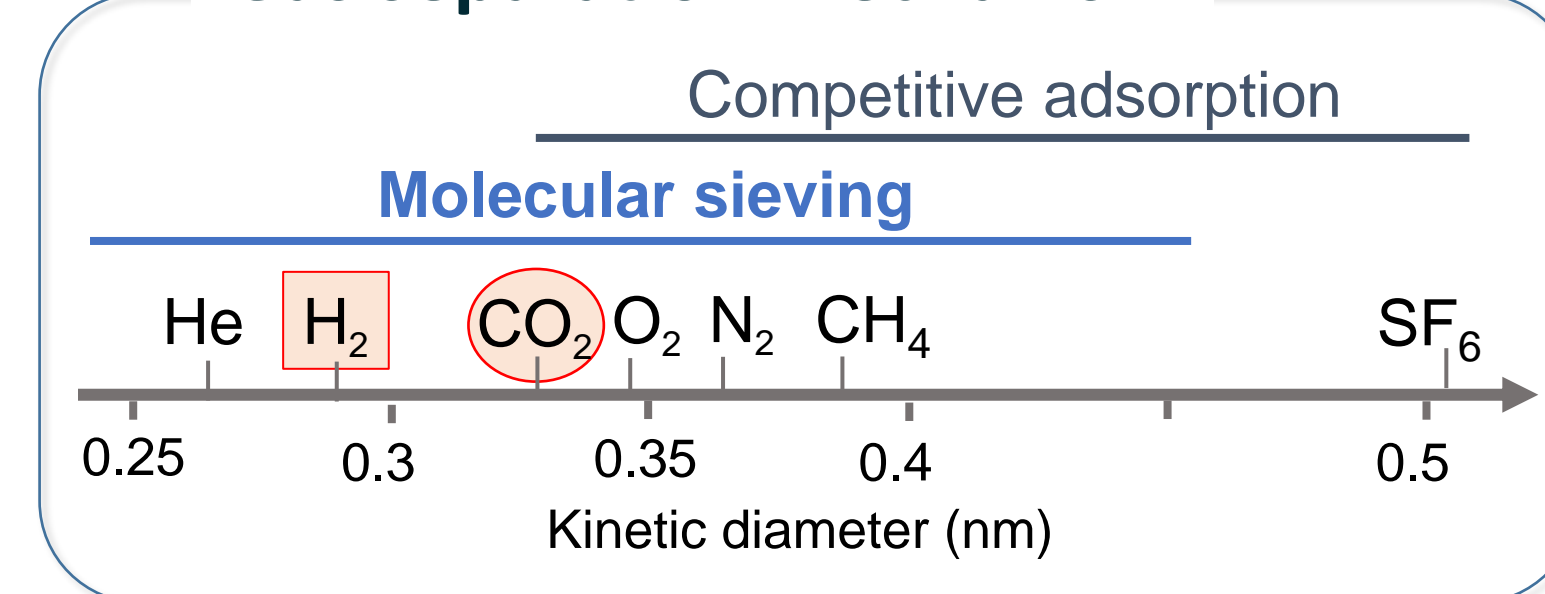
- ❑ Robust
- ❑ Defined and rigid pore diameter
- ❑ Ultrathin

Macroporous ceramic supports

The solution: Porous 2D zeolite-based membranes

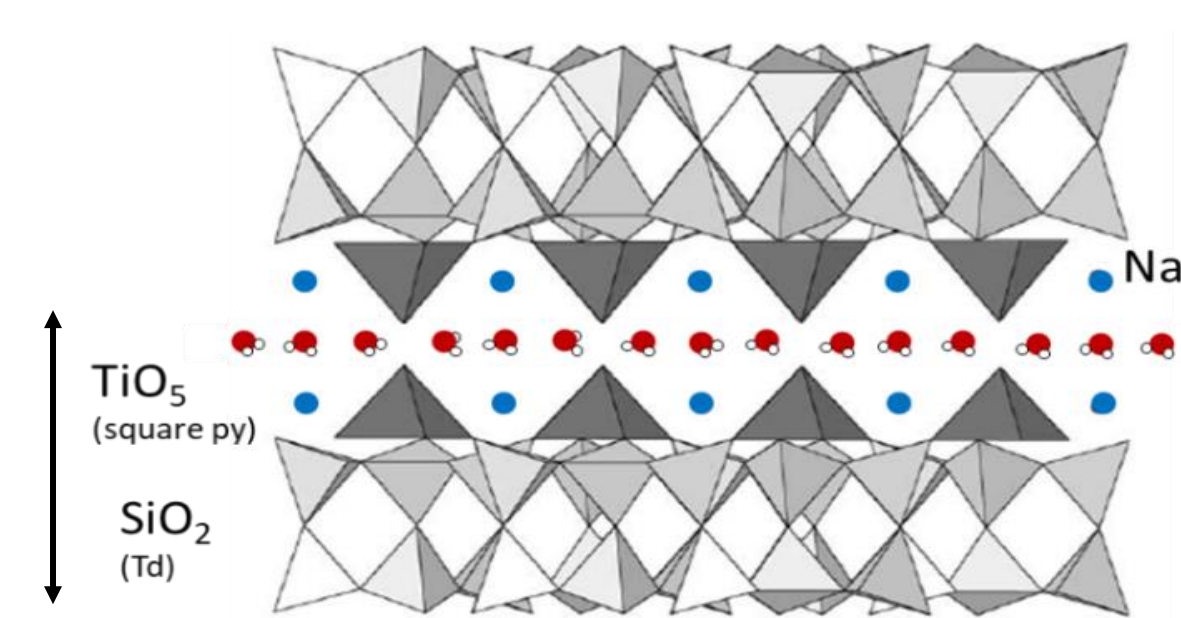


Gas separation mechanism



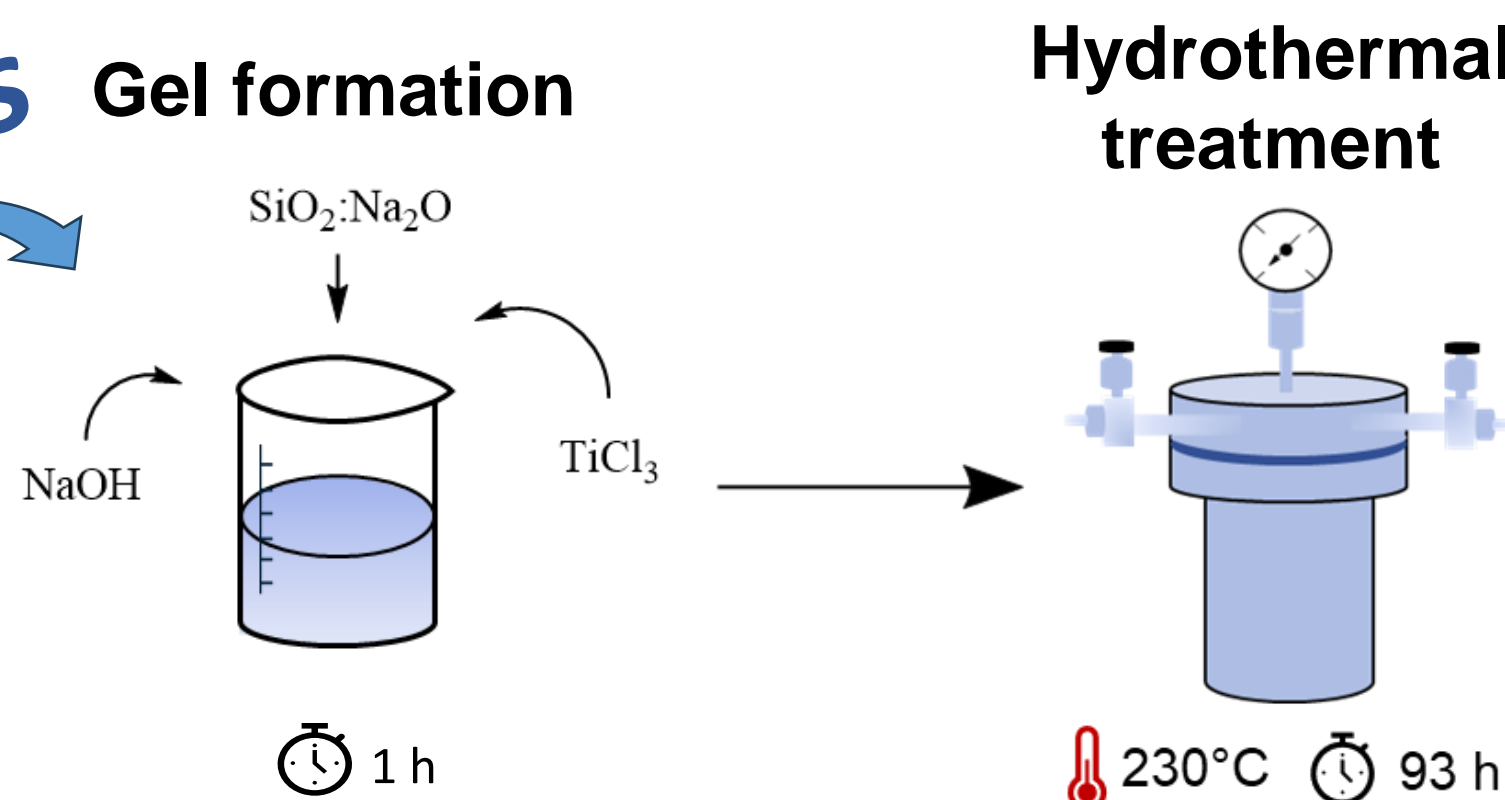
2 Selection of an H₂ selective 2D-based zeolite

Titanosilicate (JDF-1)

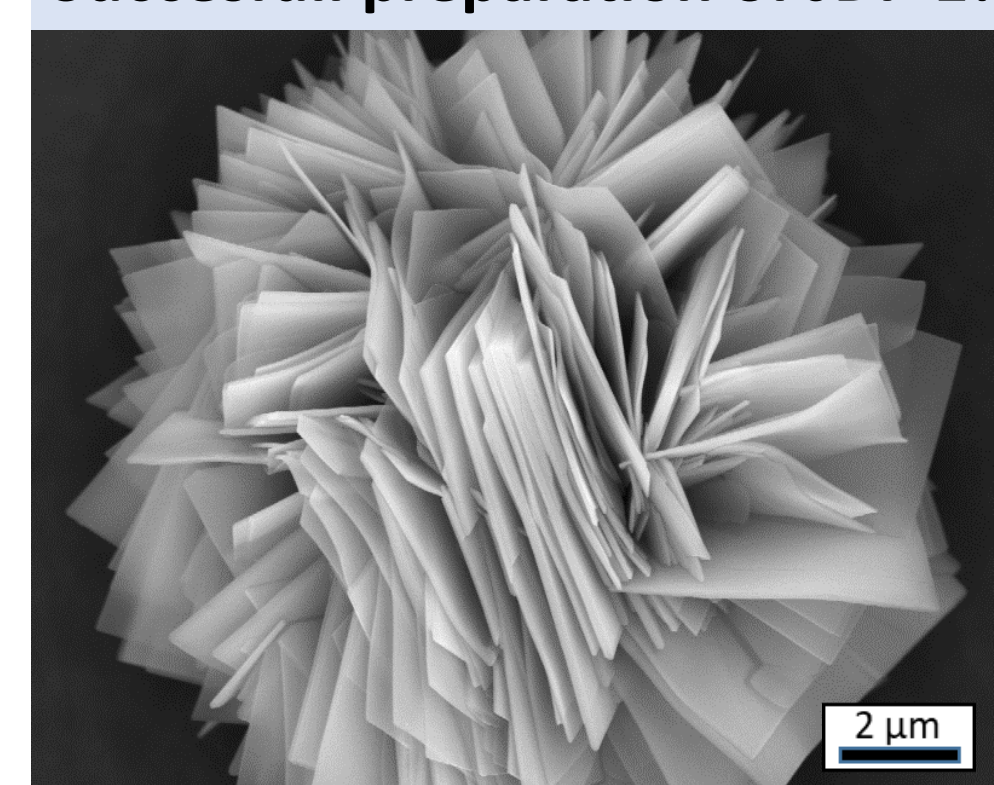


- ✓ 2D zeolite material → exfoliation possible
- ✓ Defined and rigid pores (0.3 nm)
- ✓ H₂/CH₄ ~ 32^[1]
- ✗ H₂/CO₂ selectivity unknown

Synthesis



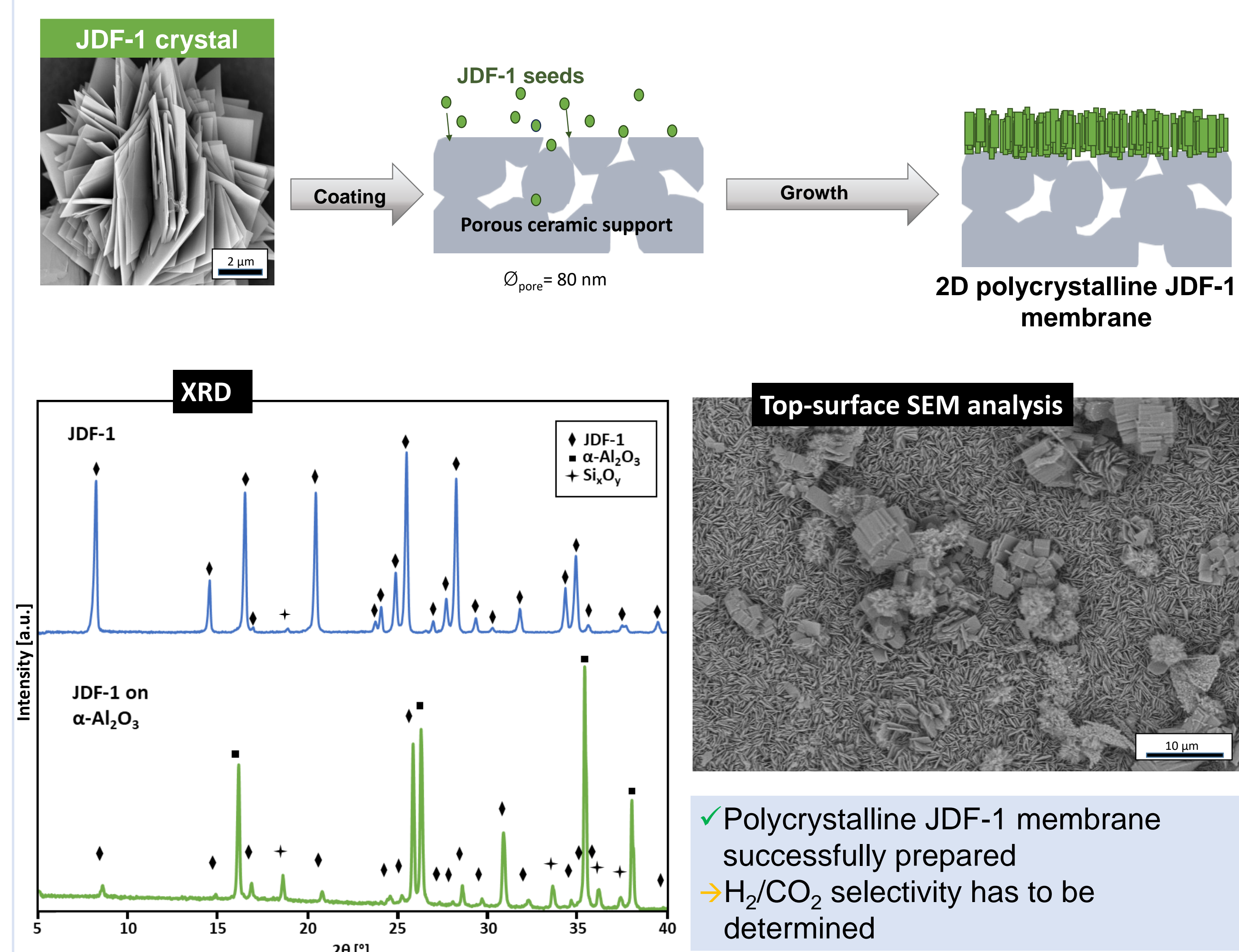
Successful preparation of JDF-1!



Important synthesis parameters:
→ molar ratio of the precursors, reaction time, and temperature.

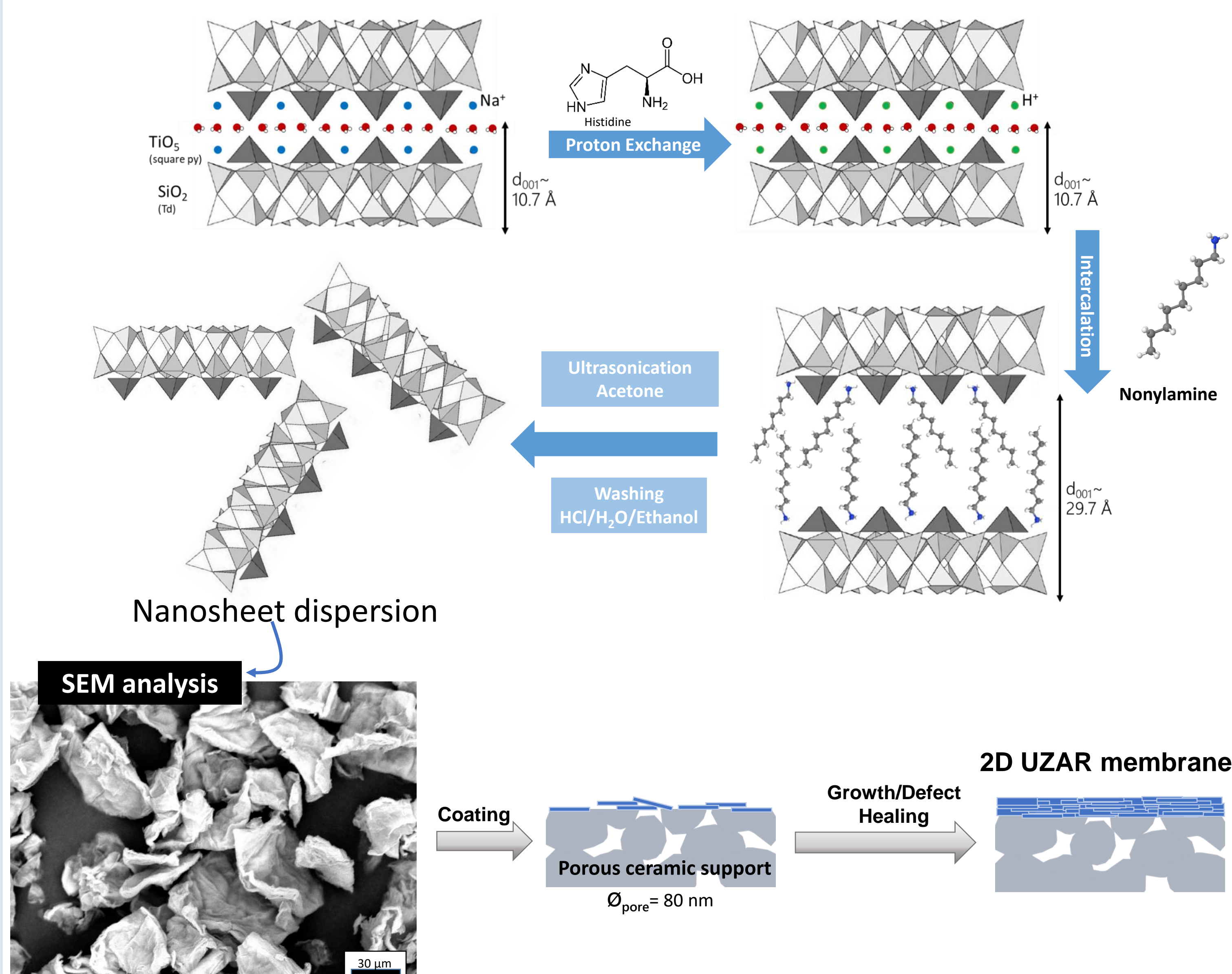
What is the influence of the membrane morphology?

3 1 2D Polycrystalline membranes



- ✓ Crystals of JDF-1 were successfully grown on porous ceramic support. The coverage of the support is highly dependent on the reaction time and can thus be controlled. In the next step, the performance of the as-made membrane will be determined, and the gas separation performance will be improved with the help of post-synthetic methods.

3 2 Nanosheet based membrane



- ✓ A big challenge in nanosheet science is the creation of a stable nanosheet dispersion. Drying the nanosheets for instance leads to restacking of the sheets. Therefore, the next steps to create a zeolite nanosheet membrane is to create a stable nanosheet dispersion followed by coating the support with the nanosheets.



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(1) Galve et al. Journal of Membrane Science, 2013, 431, 163-170