Membrane-free approaches to harvest osmotic Energy

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The mixing of two electrolyte solutions of different concentrations is characterized by a free enthalpy of mixing. Its conversion to useful mechanical work or electricity has the potential to be a source of renewable energy and is commonly called osmotic or blue energy in the case of mixing of river water with sea water. The remarkable development of membrane technology has opened new perspectives to harvest this osmotic energy. However, the establishment of several prototypes has resulted in the identification of some inherent limitations in membrane-based approaches, such as concentration polarization [1].

The first segment of this talk will introduce a top-down approach based on the design of a silicon nanofluidic exchanger[2]. This design gives the ability to minimize concentration polarization issues and to maintain the high conversion capabilities of individual nanopores. This section's main emphasis will be on the optimization of the coupled solute transport at multiscales and the subsequent design of a "Multi-Scale exchanger".

The second segment of this talk, concerns a bottom-up approach based on the usage of nanoporous hydrophobic materials[3]. Inspired from the pressure swing adsorption technologies, well known for gas separation, we propose a membrane-free method to recover osmotic energy based on osmosis between the inside and the outside of nanoporous particles. This method operates as a cycle with a characteristic time hundreds time quicker than the hydrogel method which makes it valuable to rich high power densities. The Zeolitic Imidazolate Framework 8 material (ZIF-8) is used to illustrate experimentally this approach.

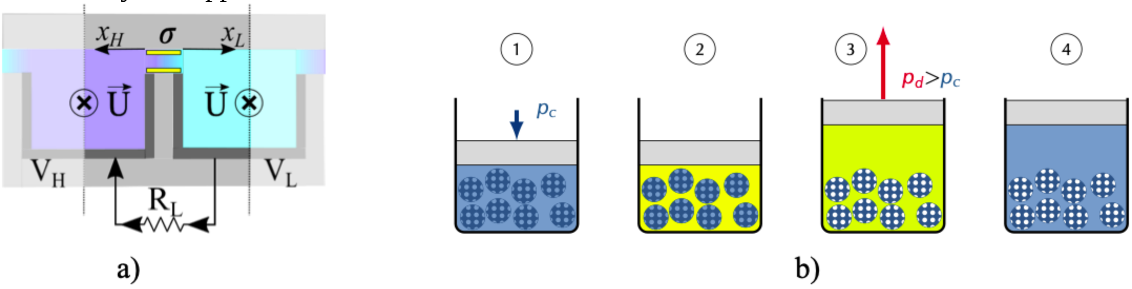

Figure 1: **(a)** Sectional schematic of an *Elemental nanofluidic Exchanger* **(b)** schematic of the principle of the volume swing osmosis method based on hydrophobic selective nanoporous material.

References

[1] L. Wang, Z. Wang, S. K. Patel, S. Lin, S. and M. Elimelech, M. *Nanopore-based power generation from salinity gradient: why it is not viable.* ACS nano, **15(3)**, pp.4093-4107 (2021).

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