Thermo-osmosis : is it possible to desalinate water using thermal gradients ?

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The development of sustainable alternative energies is one of the greatest challenges faced by our society, and nanofluidic systems could contribute significantly in that field [1]. For instance, nanoporous membranes subject to a salinity gradient generate an electric current [2]. Similarly, membranes could be used to harvest energy from waste heat [3, 4]. Membranes with microscale porosity have been successfully used to generate pressure gradients under small temperature differences [5], but waste heat harvesting with nanoporous membranes has been much less explored. Using molecular dynamics simulations, we measured the thermo-osmosis coefficient by both mechanocaloric and thermo-osmosis routes, against different solid-liquid interfacial energies. We show that a modified Derjaguin's formula [6, 7] which takes into account the interfacial hydrodynamic conditions describes well the simulation results. For a non-wetting surface, thermo-osmosis transport is controlled and largely amplified by the existence of a slippage at the interface. Whereas for a wetting surface, the position of the hydrodynamic shear plane plays a key role in the determination of thermo-osmosis coefficient. The thermo-osmosis coefficient decreases for increasing wettability and a change of sign is clearly observed. Finally, in spite of a hydrodynamic backflow induced by hydrodynamic entrance effects, we found a fast thermo-osmotic flow velocity in carbon nanotube systems, which could be used to desalinate water.

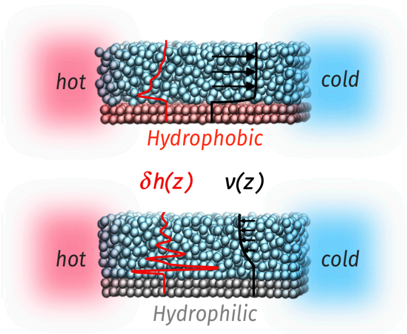

FIGURE 1 : Illustration of the thermo-osmosis flow

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