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 \cite{1}. For instance, nanoporous membranes subject to a salinity gradient generate an electric current \cite{2}. Similarly, membranes could be used to harvest energy from waste heat \cite{3, 4}. Membranes with microscale porosity have been successfully used to generate pressure gradients under small temperature differences \cite{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 \cite{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

Références

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