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Diffusion of Rarified Gases in Silicon Nanotubes

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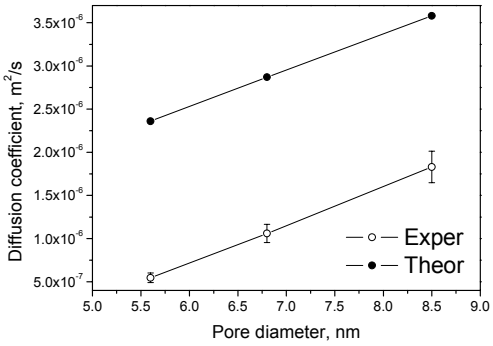
1. Introduction

Transport of molecules in confined spaces is one of the fundamental problems still requiring theoretical description. The so far existing theories, starting with the Knudsen prediction for diffusion of non-interacting gases in long capillary tubes and subsequent classical theories do not properly capture the effects of interactions of molecules with the pore walls. Recent computer simulation studies, however, have revealed that the latter may govern molecular transport at low densities [2]. To check the validity of the existing theories, mesoporous hosts with well defined geometries are highly desirable.



2. Results and conclusion

In this contribution, we present permeation studies of inert gases at low densities through nanoporous silicon membranes with straight cylindrical pores. The main result of this study is shown in the figure where the measured diffusivities of He are depicted together with the predictions using the pure Knudsen mechanism of diffusion. It is seen that the latter shows overprediction by factor of about 3 for all pore sizes studied. This result is very similar to that found in [2] for methane in silica cylindrical pores. The results obtained may indicate strong impact of molecule-wall dispersive interaction on molecular propagation or the effect of atomistic pore roughness [3, 4]. Our current experimental activities are focused on elucidating which of these mechanisms is responsible for the attenuation of the transport as compared to the Knudsen diffusivity by exploiting a broader range of the noble gases.

References

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