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Knudsen Diffusion in Nanochannels PATRICK HUBER, SIMON GRUENER, Saarland University, D-66041, Germany, STEFAN BOMMER, Saarland University, D-66031, Germany — Measurements on helium and argon gas flow through an array of parallel, linear channels of 12 nm diameter and 200 μm length in a single crystalline silicon membrane reveal a Knudsen diffusion type transport from 10^2 to 10^7 in Knudsen number Kn. The classic scaling prediction for the transport diffusion coefficient on temperature and mass of diffusing species, $D_{\rm He} \propto \sqrt{T}$ is confirmed over a T-range from 40 K to 300 K for He and for the ratio of $D_{\rm He}/D_{\rm Ar} \propto \sqrt{m_{\rm Ar}/m_{\rm He}}$. Deviations of the channels from a cylindrical form, resolved with electron microscopy down to subnanometer scales, quantitatively account for a reduced diffusivity as compared to Knudsen diffusion in ideal tubular channels. The membrane permeation experiments are described over 10 orders of magnitude in Kn, encompassing the transition flow regime, by the unified flow model of Beskok and Karniadakis. Simon Gruener and Patrick Huber, Phys. Rev. Lett. 100, 064502 (2008).

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