Spontaneous Imbibition Dynamics of an n-Alkane in Nanopores: Evidence of Meniscus Freezing and Monolayer Sticking

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SIMON GRUENER, Experimental Physics, Saarland University, D-66041 Saarbruecken (Germany), SAARLAND UNIVERSITY COLLABORATION — Capillary filling dynamics of liquid n-tetracosane (n-C_{24}H_{50}) in a network of cylindrical pores with 7 and 10 nm mean diameter in monolithic silica glass (Vycor) exhibit an abrupt temperature-slope change at $T_s = 54 \degree C$, $\sim 4 \degree C$ above bulk and $\sim 16 \degree C$, $8 \degree C$, resp., above pore freezing. It can be traced to a sudden inversion of the surface tension's $T$-slope, and thus to a decrease in surface entropy at the advancing pore menisci, characteristic of the formation of a single solid monolayer of rectified molecules, known as surface freezing from macroscopic, quiescent tetracosane melts. The imbibition speeds, that are the squared prefactors of the observed square-root-of-time Lucas-Washburn invasion kinetics, indicate a conserved bulk fluidity and capillarity of the nanopore-confined liquid, if we assume a flat lying, sticky hydrocarbon backbone monolayer at the silica walls.