Abstract Submitted
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A Study of Homogeneous and Heterogeneous Bubble Nucleation Inside Nanopores through Resistive Pulse Sensing[1] SOUMYADEEP PAUL, WEI-LUN HSU, Univ of Tokyo, MIRCO MAGNINI, Univ of Nottingham, LACHLAN MASON, The Alan Turing Institute, YA-LUN HO, Univ of Tokyo, OMAR MATAR, Imperial College London, HIROFUMI DAIGUJI, Univ of Tokyo — The explosive growth of nano-confined bubbles is inherently difficult to capture using traditional imaging techniques due to high surface tension dominance. In this study, we employ Joule heating in nanopores filled with a 3M aqueous solution of NaCl, to raise liquid temperatures and detect the nucleation point at nanosecond time resolution. This is achieved by measuring bubble induced ion-flow blockage using a high bandwidth oscilloscope. Through continuum simulations we obtain temperature distributions at nucleation points, based on which we are able to ascertain whether bubbles nucleated heterogeneously on the pore walls or homogeneously at the pore center. Joule heating results in a positive temperature difference (ΔT_p) between the pore center and the pore walls, allowing homogenous bubble clusters to incur a lower free-energy cost. Compared to a larger pore (525 nm), a smaller pore (280 nm) has higher values of ΔT_p and pinning free-energy barrier for heterogeneous nucleation. This suppresses heterogeneous nucleation and homogenous nucleation emerges as the dominant mode for bubble nucleation inside small-diameter pores.

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