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Use of a porous membrane for gas bubble removal in microfluidic channels: physical mechanisms and design criteria JIE XU, Washington State University Vancouver, REGIS VAILLANT, DANIEL ATTINGER, Columbia University — We demonstrate and explain a simple and efficient way to remove gas bubbles from microchannels, by integrating a hydrophobic porous membrane on top of the microchannel. A prototype chip is made in PMMA with the ability to completely filter gas plugs out of a segmented flow at rates up to 7.4 μL/s/mm^2. In our device, gas plugs in a water stream are generated continuously from a T-junction and are then transported towards the gas removal section, where they slide along and vent through a hydrophobic membrane. To achieve complete gas removal without membrane leakage, our analysis shows that four necessary operating criteria are needed. These criteria are verified by experimental results. The first criterion is that the bubble length needs to be larger than the channel diameter. The second criterion is that the bubble should stay on the membrane for a time sufficient to transport all the gas through the membrane. The third criterion is that the bubble travel speed should be lower than a critical value: otherwise a stable liquid film between the bubble and the membrane prevents mass transfer. The fourth criterion is that the pressure difference across the membrane should not be larger than the Laplace pressure to prevent water from leaking through the membrane. Experiments on our device show a good agreement with these criteria.

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