A degassing plate with hydrophobic bubble capture and distributed venting for microfluidic devices

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Abstract

This paper introduces a microfluidic wall plate that allows the removal of gas bubbles from a gas/liquid mixture in a distributed fashion, i.e., throughout the flow path, eliminating the need for discrete separators common in macroscopic practice. Integrated into a microfluidic system at critical locations, such a degassing plate prevents the build up of gas bubbles in microchannels so as to maximize the effective reaction area, decrease the flow resistance and keep the chamber pressure under check. Furthermore, the plate surface is designed to capture the gas bubbles preferentially on designated venting sites, so that the rest of the surface can be dedicated to other functions, such as the catalyst or electrodes. The mechanism of bubble capture is explained by surface energy minimization, and two types of bubble sinks are proposed and verified. Once captured, the bubbles can be vented out through hydrophobic venting holes small enough (e.g. sub-micron) to block the liquid by surface tension. By chemically generating CO2 inside a small chamber (30 mm × 50 mm × 1.5 mm) sealed by the degassing plate, the process of bubble capture and removal is visually demonstrated. A porous polypropylene membrane with ~0.2 μm diameter holes shows that gas can be removed with only several kPa of internal pressure while water stays free of leakage even under 2.4 × 105 Pa (35 psi). Venting is effective in any gravitational orientation, paving the way for portable microfluidic devices.