Electronic Supplementary Material (ESI) for Lab on a Chip

Determining phase diagrams of gas-liquid systems using a microfluidic PVT

Farshid Mostowfi[1*], Shahnawaz Molla[1], and Patrick Tabeling[2]

[1]Schlumberger DBR Technology Center, Edmonton, AB, T6N 1M9 Canada
[2]MMN, ESPCI, 10 rue Vauquelin, 75005, Paris, France

S2 – Manifold design

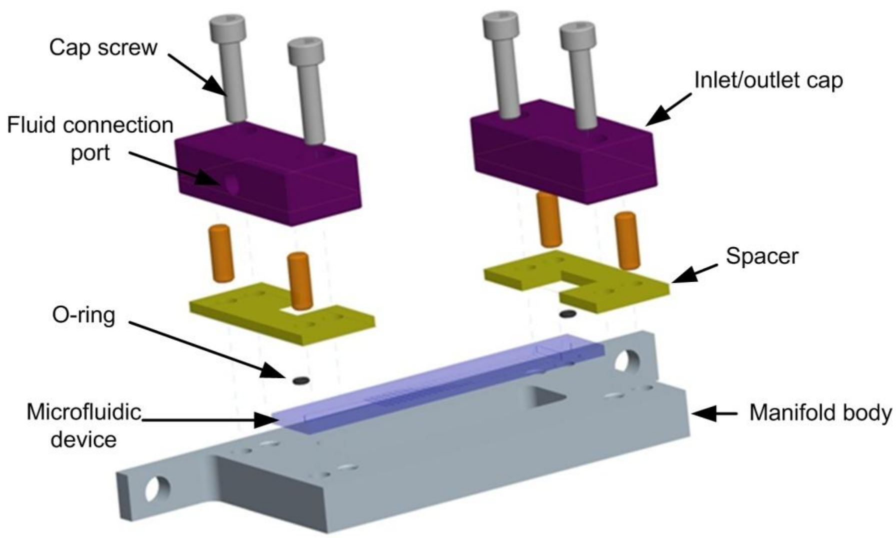

Fig. S2— Assembly view of the microfluidic device manifold. All parts except the o-ring and the microfluidic device is made of stainless steel. The o-ring material is viton (Apple Rubber USA).

S3 – Sample preparation

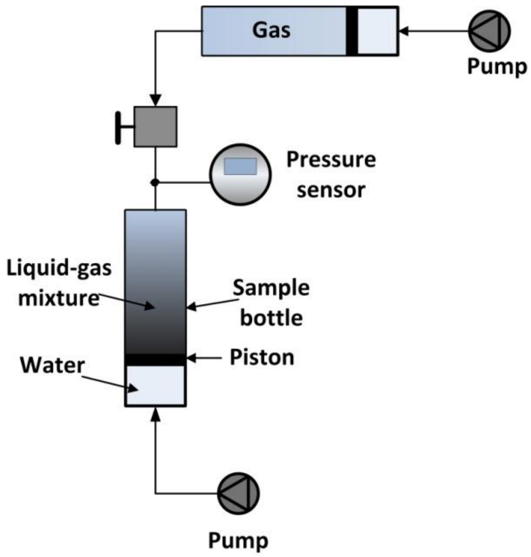

Fig. S3— Schematic showing the preparation of gas-saturated liquid sample.

S4 – Estimation of pressure drop at the inlet restriction

The pressure drop across the inlet restriction is estimated based on minor loss calculation in pipe systems.[1] The geometry of the restriction is shown in Fig. S4. The width of the different sections are W_{in} = 300 μm, W_{se} = 10 μm, and W_{chan} = 100 μm. The height of the channel is same everywhere.

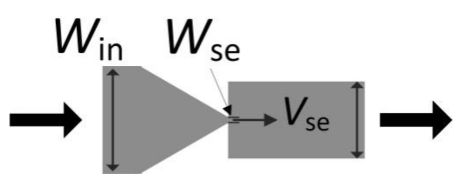

Fig. S4— Geometry of the inlet restriction. Flow is from left to right.

The pressure loss at the restriction is estimated by

Eq. S4.1 $$\Delta p_{loss} = \tfrac{1}{2} K_{se} \rho V_{se}^2$$

where V_{se} is the flow velocity at the restriction, ρ is the liquid density (760 kg/m^3 in this case), and K_{se} is the loss coefficient. The flow velocity is estimated based on velocity measured at the inlet of the channel. For a velocity of 0.3 m/s at the inlet, V_{se} = 9 m/s.

The restriction at the inlet opens into the main channel which is similar to the case of sudden expansion in ducts. The loss coefficient in this case is

Eq. S4.2
$$K_{se} = \left(1 - \left(\frac{W_{se}}{W_{chan}}\right)^2\right)^2 = 0.98$$

The pressure loss based on Eq. S2.1 is 0.29 bar which is only 0.83% of the injection pressure at the inlet (p_{inlet}=36 bar). Based on the pressure measurements at the inlet and in the channel, the total pressure drop between the location of the inlet and the first pressure sensing membrane is 2-3% of the inlet pressure.

Supplementary references

1. F. M. White, in *Fluid Mechanics*, McGraw-Hill, New York, 2003, pp. 384-391.