Electronic Supplementary Material (ESI) for Lab on a Chip.

Microchannel measurements of viscosity for both gases and liquids

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If $\Delta h << w$,

$$l^2 = l_0^2 + \Delta h^2$$
$$= l_0^2 \left(1 + \frac{\Delta h^2}{l_0^2}\right)$$
$$l = l_0 \left(1 + \frac{\Delta h^2}{l_0^2}\right)^{1/2}$$
$$\frac{l}{l_0} \sim 1 + \frac{1}{2} \cdot \frac{\Delta h^2}{l_0^2} \quad \cdots \text{(S1)}$$

Strain is given by

$$\varepsilon = \frac{l - l_0}{l_0} = \frac{l}{l_0} - 1 \quad \cdots \text{(S2)}$$

Equations (S1) and (S2) lead to

$$\varepsilon \sim 1 + \frac{1}{2} \cdot \frac{\Delta h^2}{l_0^2} - 1 = \frac{2}{w^2} \cdot \Delta h^2$$

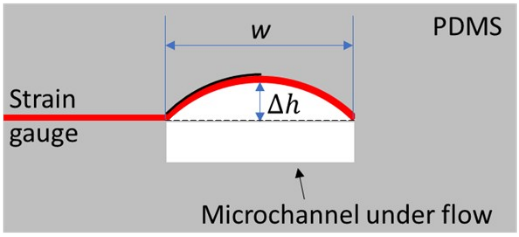

Fig. S1 Schematic and analytic calculation for correlating ε with Δh.

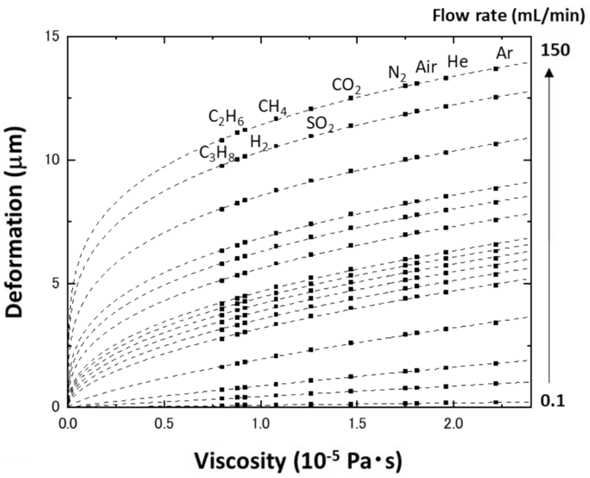

Fig. S2 FEA-based deformation as a function of viscosity for 10 gases, C_3H_8, H_2, C_2H_6, CH_4, SO_2, CO_2, N_2, Air, He, and Ar at flow rates ranging from 0.1 to 150 mL/min. Flow rates are: 0.1, 0.5, 1.0, 2.5, 5, 6, 7, 8, 9, 10, 15, 20, 25, 50, 100, and 150 mL/min (from bottom to top). All the data points at each flow rate are fit with a power-law (dashed lines).

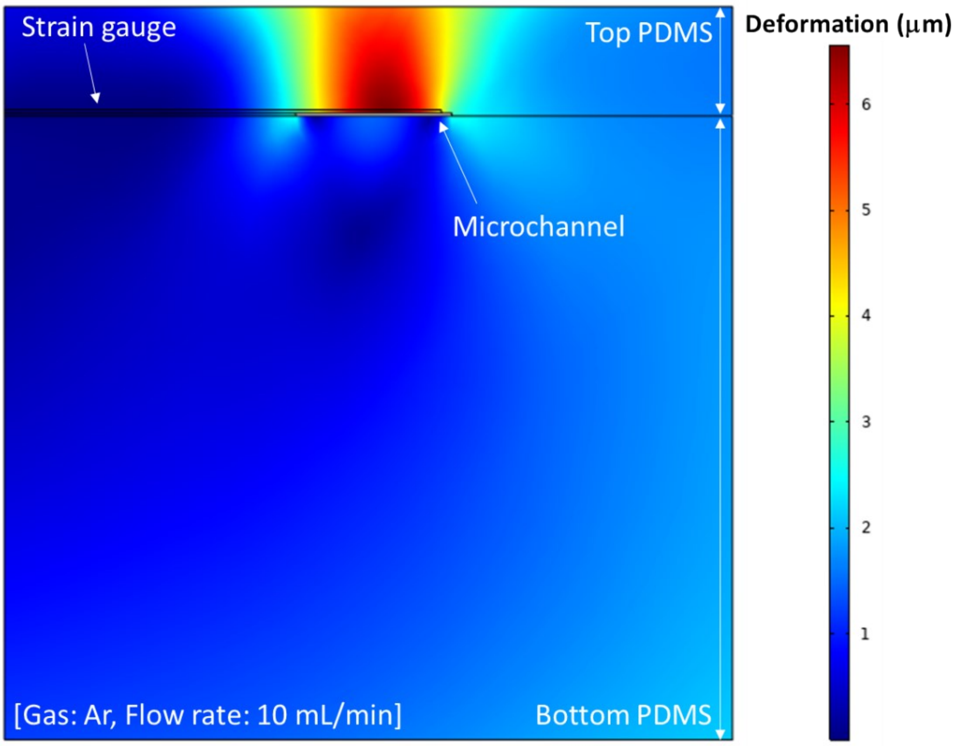

Fig. S3 Color map showing deformation under flow of Ar at a flow rate of 10 mL/min.

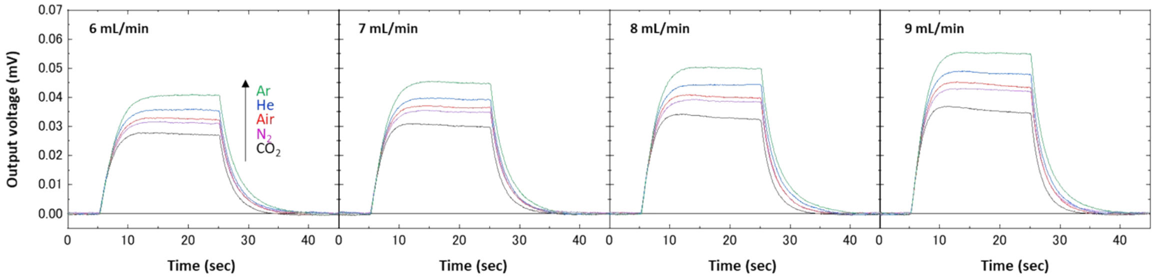

Fig. S4 Output voltages measured as a function of time for five gases, CO_2, N_2, Air, He, and Ar at flow rates of 6, 7, 8, and 9 mL/min (from left to right).

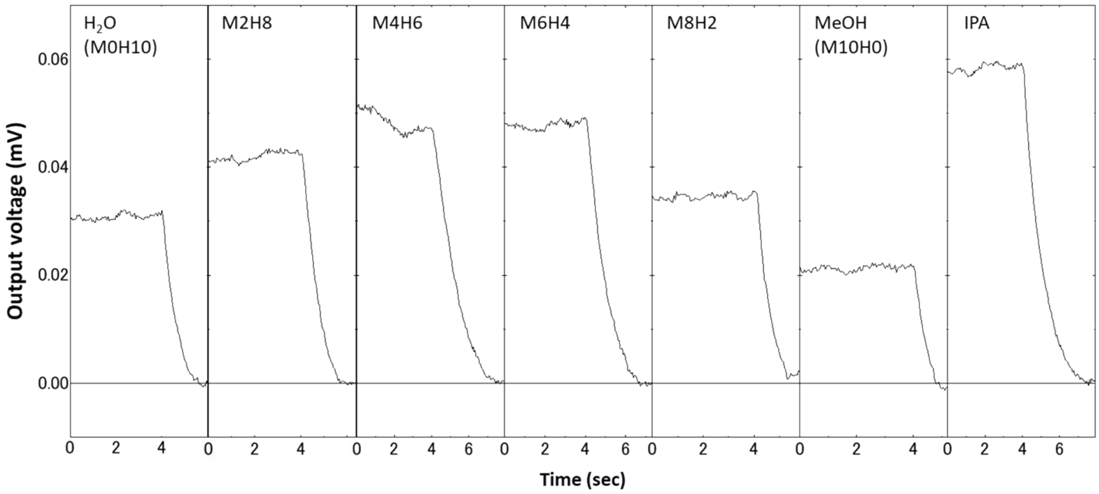

Fig. S5 Output voltages measured as a function of time for seven liquids, MeOH, water, IPA, and MeOH-aqueous solution with four different concentrations at a flow rate of 0.25 mL/min (from left to right).

Table S1. Summary of all the parameters used for FEA simulation.

Parameters	Values
Thickness of top layer	1 mm
Thickness of bottom layer	6 mm
Young's modulus of PDMS	1.1 MPa[1]
Height of microchannel	27 μm
Width of microchannel	1.5 mm
Length of microchannel	20 mm
Gap between microchannel and strain gauge	1 μm
Thickness of strain gauge	30 μm
Width of strain gauge	1.4 mm
Length of strain gauge	4.3 mm
Young's modulus of epoxy	2.5 GPa[2]
Inner diameter of inlet	0.75 mm
Outer diameter of inlet	1.5 mm
Inner diameter of outlet	0.75 mm
Outer diameter of outlet	1.5 mm

[1] Gervais, T. *et al.*, *Lab Chip* **6**, 500-507 (2006).
[2] Ogasawara, T. *et al.*, *Compos. Sci. Technol.* **71**, 1826-1833 (2011).