Optofluidic Applications of Plasmonic Heating

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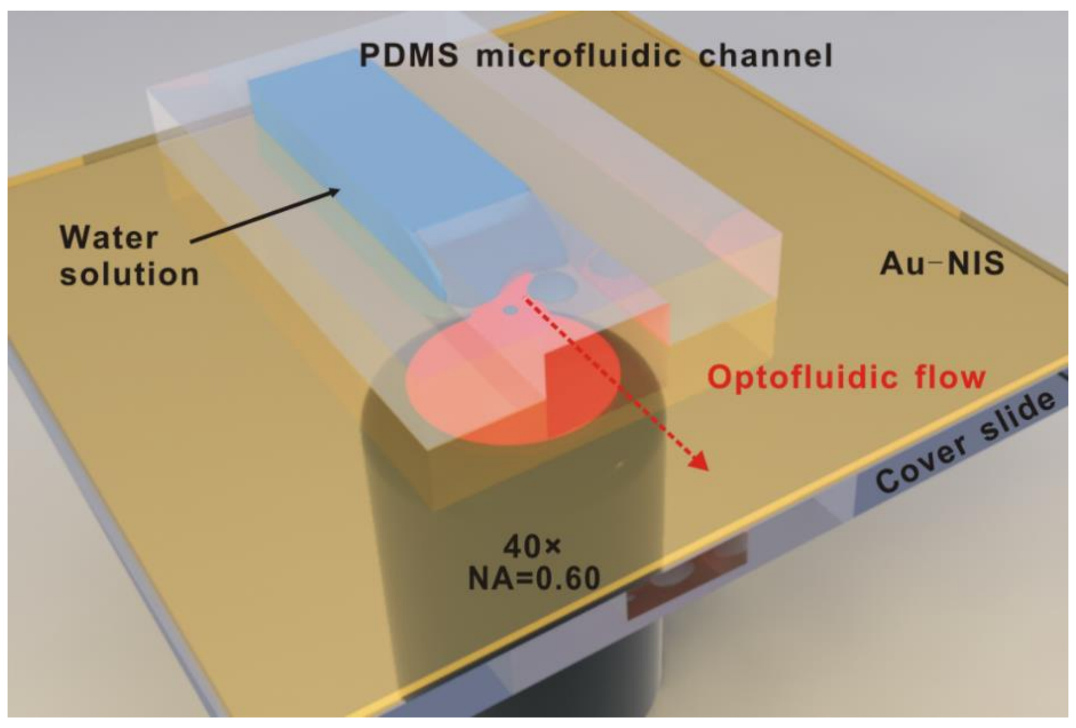
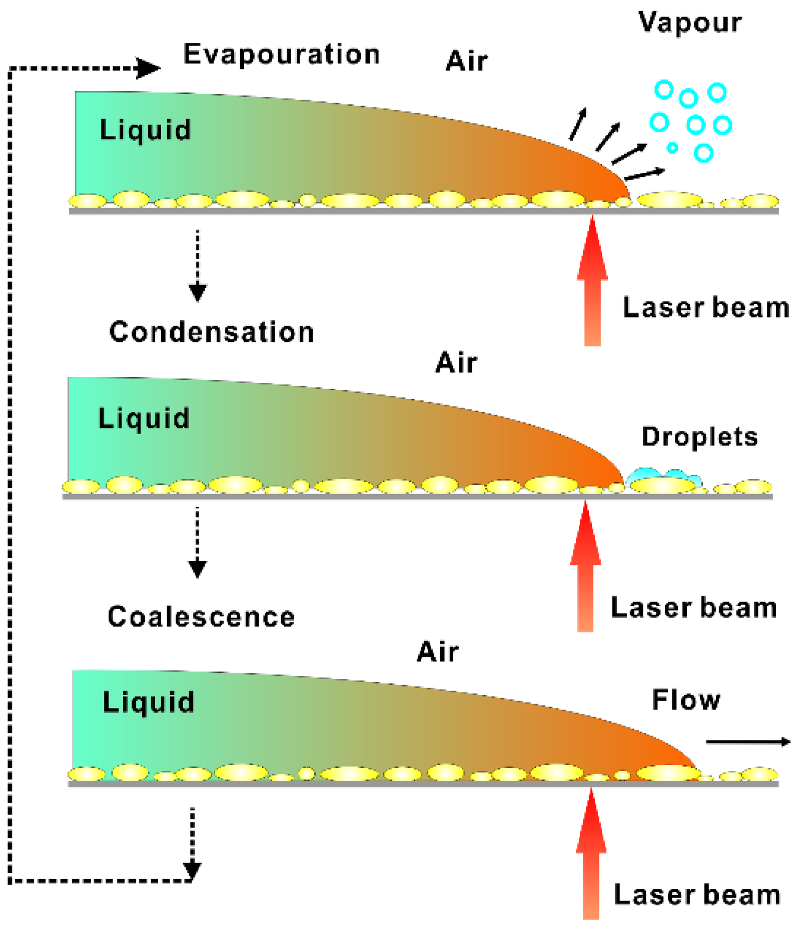
Experimental setup of optofluidic guiding

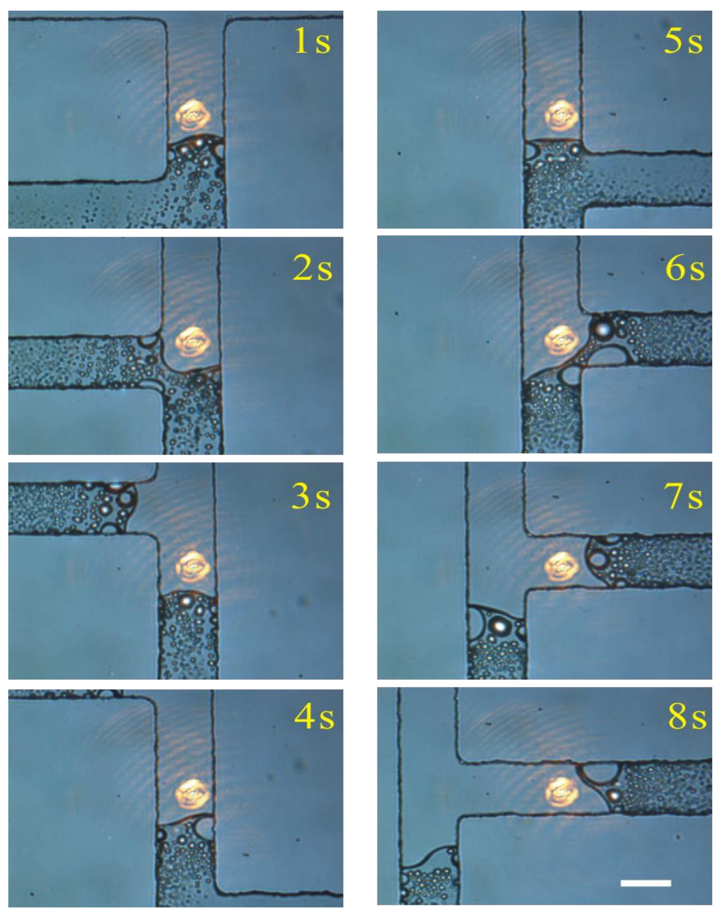
Optofluidic control by using Au-NIS



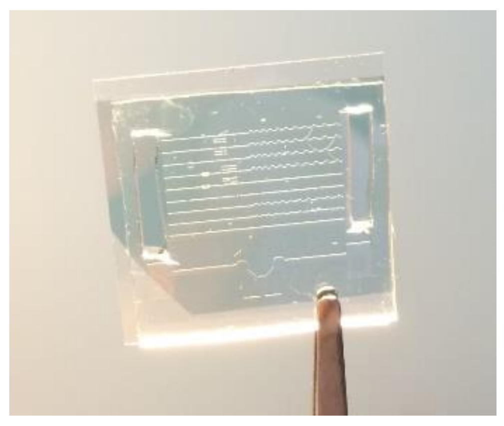
Optical setup of the experimental system



Basic principles of flow guiding



Videos of the optofluidic control
Scale bar: 40µm



➢The focused light illumination on the Au-NIS

➢The vapour in the relatively cold air condenses into droplets in front of the liquid–air interface.

➢The droplets coalesce with the original bulk liquid body and the liquid–air interface advances.

Maximal flow speed comparison

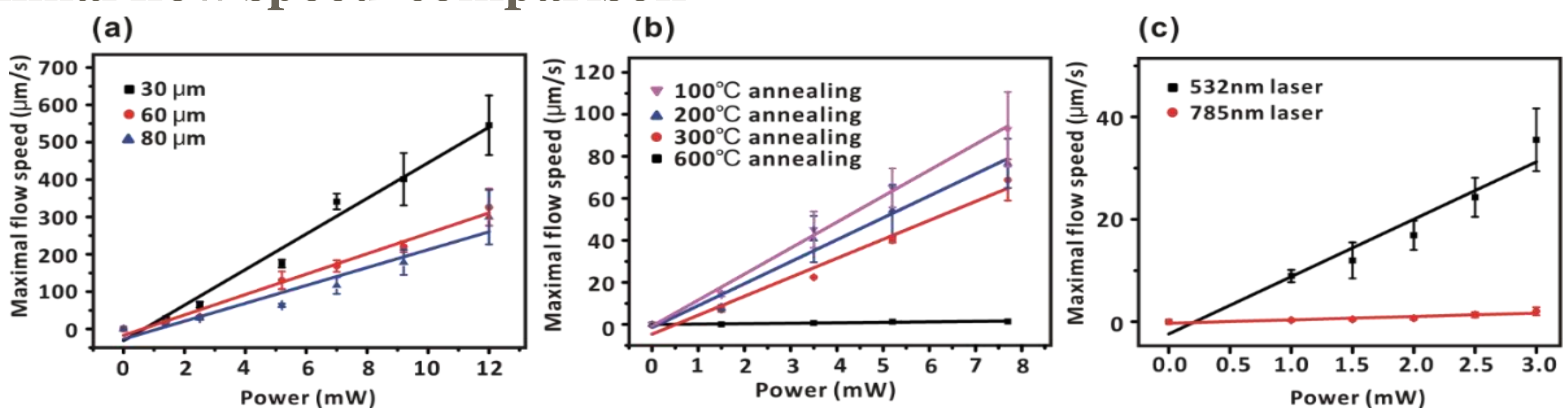


Fig.1 (a) At 100 ºC annealing substrate (b) In the 80 µm wide channel (c) Two laser lines

Three factors

➢**Laser power**
➢**Surface wettability and extinction peak**
➢**Channel width**

Maximum flow speed ~1600 µm/s

Optofluidic valve actuated with laser irradiation

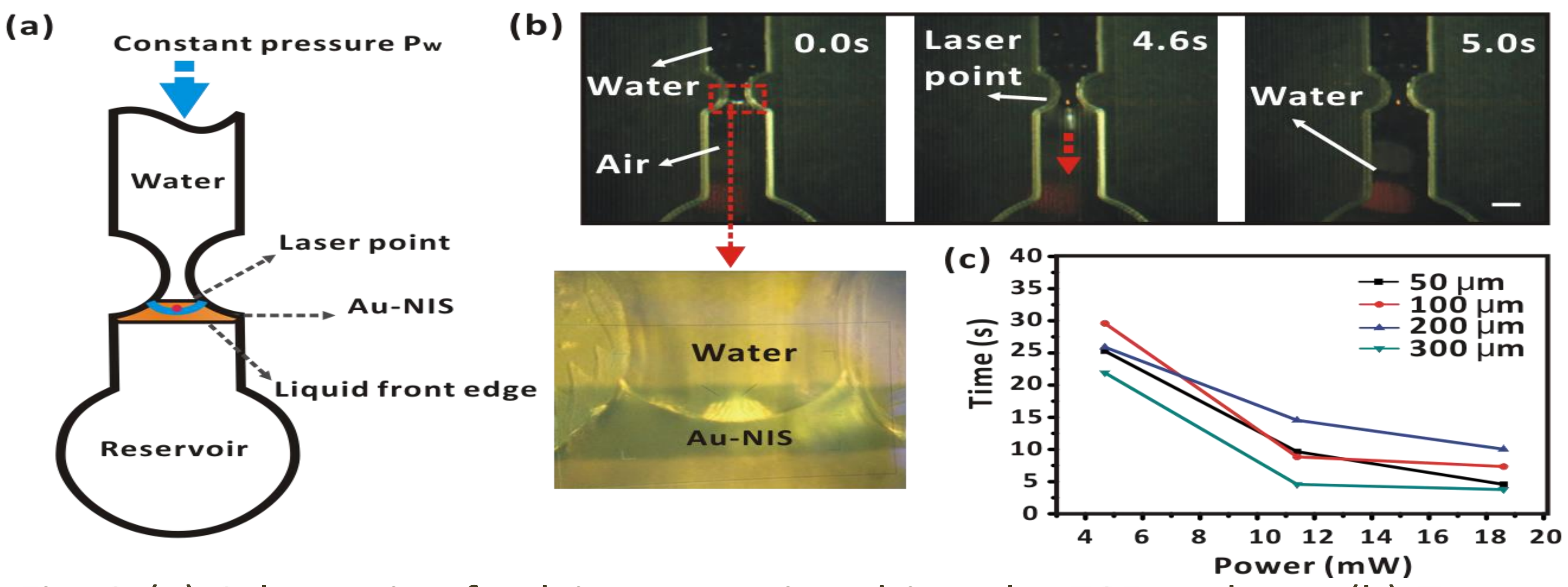


Fig. 2 (a) Schematic of valving operation driven by 785nm laser. (b) Temporal sequence of a 300 µm wide microfluidic valve (c) Valve opening time versus laser power for different valve.

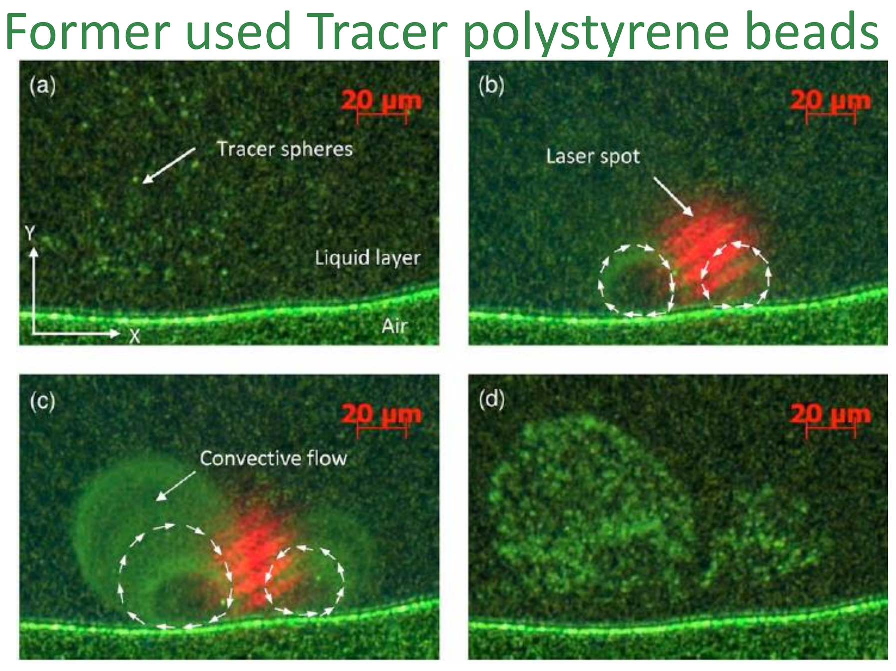
The basic mechanism of this valve can be explained by Fig. 2 (a), the water being gated at the abrupt expanding region satisfy the following condition :

$$P_w \le P_c = 4\gamma_{a1} sin\theta_c / D_h$$

where P_w is the water pressure, P_c is the critical burst pressure, γ_{a1} is the surface energy per unit area of the liquid–air interface, θ_c is the equilibrium contact angle, and D_h is the hydraulic diameter. And the hydraulic diameter of a rectangular channel is: $D_h = 2wh/(w+h)$ The hydraulic diameter, D_h, is a commonly used term when handling flow in noncircular tubes and channels.

Optofluidic mixing

Former used Tracer polystyrene beads



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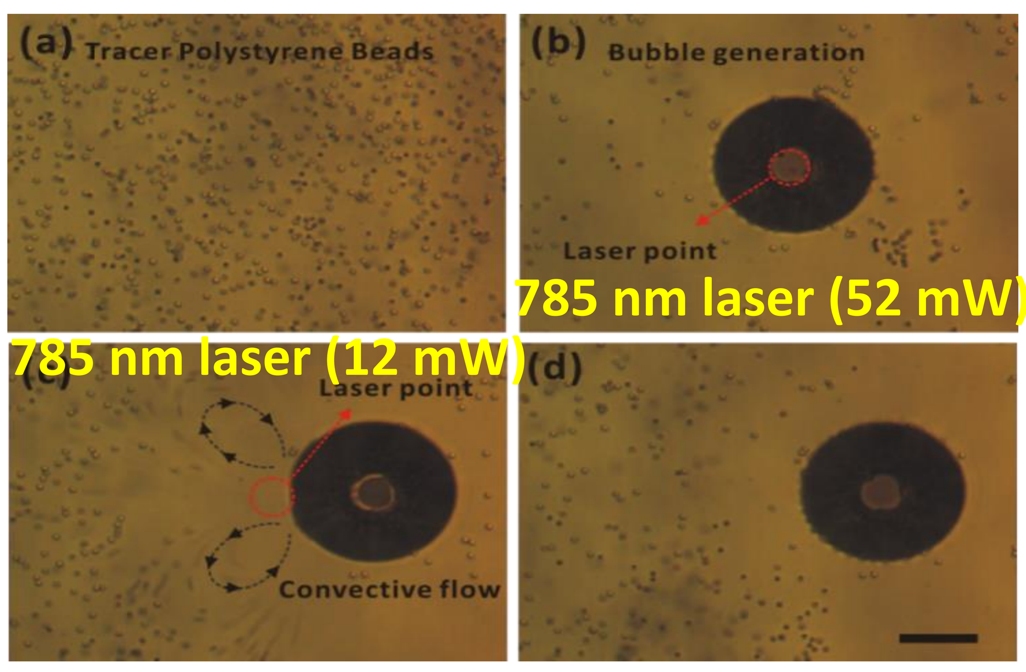

The scale bar is 40µm

Tracer polystyrene beads suspended in water
↓
Bubble generated in 0.5s
↓
Reduce power to sustain stable convective flow
↓
Laser turned off

Conclusion: The presented optofluidic system has made several important advances in different aspects:

➢ No extra functional materials are added to the sample solution, thus, avoid sample contamination;

➢ A wider flow guiding speed is achieved (from 0µm/s to 1600 µm/s) while with less power consumption, and the plasmonic assisted microfluidic valving is implemented for the first time;

➢ A position-free mixing strategy is achieved, which means we can stir the sample solution at any point of interest.

This system can be an independent component to do all optical bio-sensing, and it also can be integrated to LOAD platform to improve the performance when implementing biochemical experiment .

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