Sudden, Laser-induced Heating Through Silicon Nanopatterning
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Introduction

• Temperature drives a wide variety of chemical/bio-processes.
• Control of temperature on the microscale is useful for lab-on-chip applications.

Patterned Silicon Slab Fano Resonance

- Here: New strategy for temporal control of temperature.

Sudden Laser-induced Heating in Water

Membrane transfer process

Unpatterned

Patterned

Spectrum

Temporal Response

Unpatterned

Spatial transfer process

Patterned

Programmable Heating

Simulation

Experiment

Opto-thermo-fluidic simulation

\[ \frac{\partial T(x, y, z, t)}{\partial t} = \nabla \cdot (k \nabla T(x, y, z, t)) + P_{abs}(t), \]

\[ P_{abs}(t) = P_{in} \gamma \frac{2\gamma \rho s C s}{\omega_0^2 + (\omega_0^2)^2 + (\dot{\gamma} + \gamma_i^2)^2} \]

Turbulence, Microbubble Formation and Trapping

Heat-induced convection and microbubble generation

Spot-size tuning

1μm polystyrene particle assembly

Conclusions

• All-silicon, laser-induced nanoheater is proposed and demonstrated
• Operates in both air and water
• Time-dependent temperature response can be “programmed” into design or controlled with wavelength
• Generation of controllable micro-bubbles was demonstrated
• Heat-induced convection has been used to trap microparticles to the hot spot

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