Critical Temperature Control of Silicon Micro-Reactors for Lab-On-Chip Applications

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INTRODUCTION: This work investigates micro-reactor design, with integrated resistive heating elements so that the fluid under test can be brought to a controlled temperature level.

USES OF THE TECHNOLOGY: Chemical and biological research: study of chemical/biological reaction processes in real-time

CRUITICAL GOAL: Achieving **uniformity of temperature** within the micro-reactor.

CONSTRAINTS: The minimum feature size should be compatible with current fabrication capacity at the University of Calcutta. In this work it was kept at 5 micrometer. Silicon wafer thickness was kept at 500 micrometer. The sidewalls slope of the micro-reactor is given by the parameters of crystallographic etch process in Silicon (54.7 Degree).

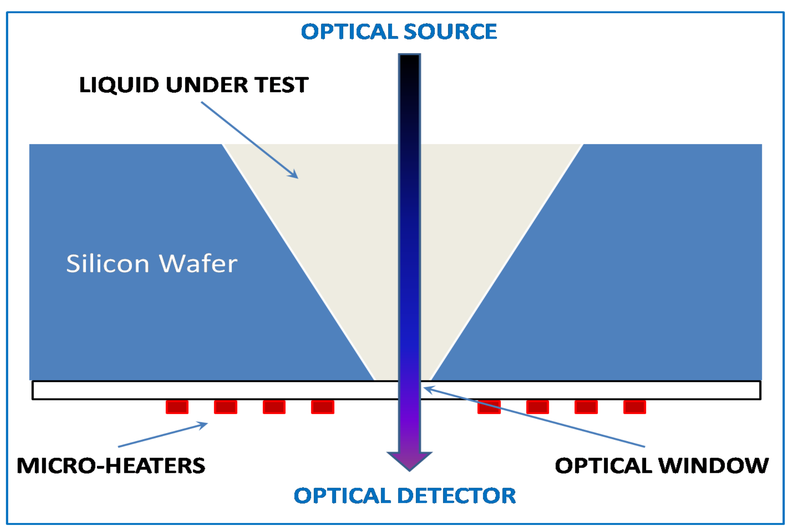


Figure 1. SCHEMATIC OF MICROREACTOR

MODE: Simulation was carried using General heat transfer and Conductive Media DC (under AC/DC module) of COMSOL® 3.5

Materials: Silicon base with Tungsten Microheater

Boundary conditions: Sidewalls of Silicon kept at 300K, Voltage at one end of micro-heater is varied, the other end pulled to ground.

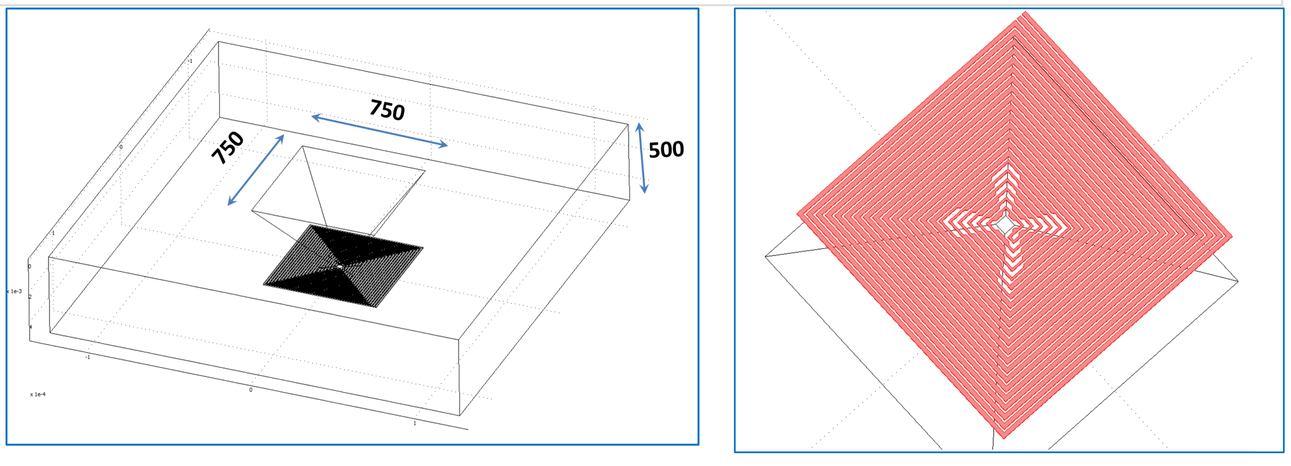
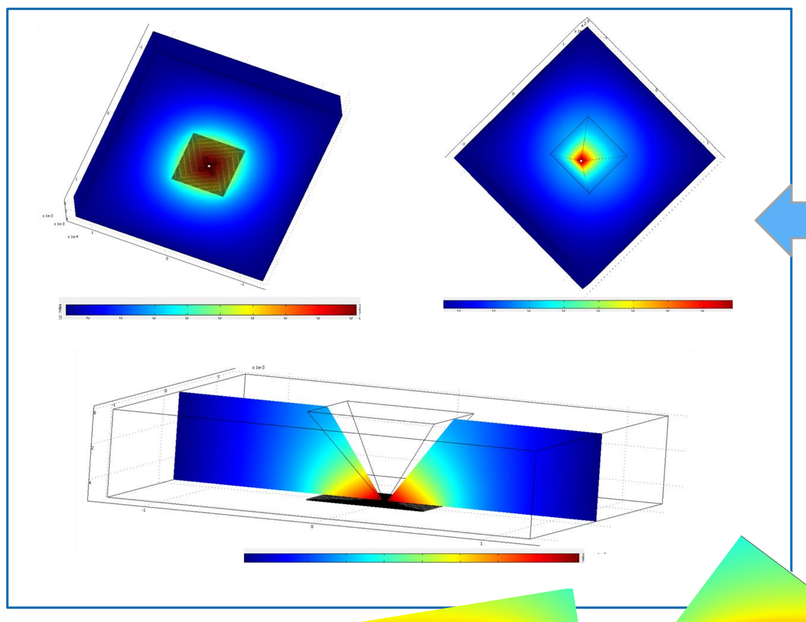


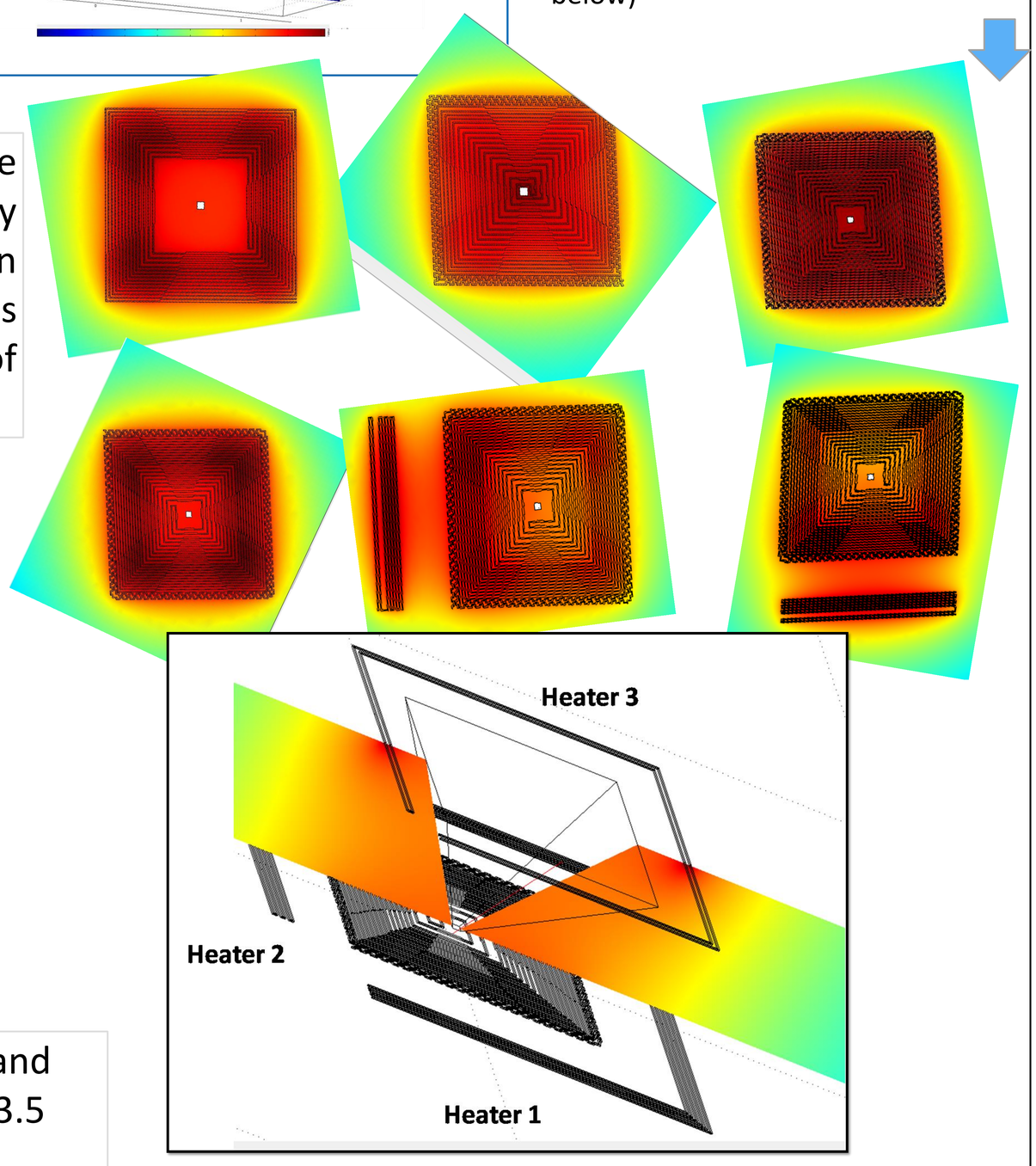
Figure 2. COMSOL® Model #1: (Full structure, (a) and Micro-heater (b))



Initial Design: Single uniform heater:

Figure 3: Temperature distribution Center of micro-reactor much hotter than the edge (right). This is not optimal for use in micro-reactors.

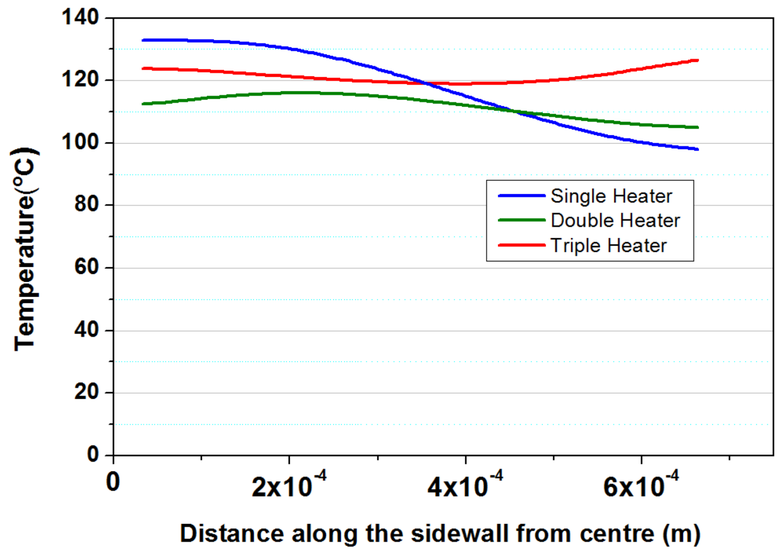
Multiple heater configurations were evaluated (**Figure 4**) with variations in number, spacing and width . (see below)



Final Design: Three non-uniform heaters

Figure 5: Temperature distribution with this configuration is much more uniform along the sidewalls of the micro-reactor.

Figure 6: Variation of temperature along micro-reactor sidewalls for single, dual and triple heater configuration



CONCLUSIONS Multiple heater, each with non-uniform spacing and width may be necessary for uniform heating of micro-reactors, even though design and fabrication complexity may go up.

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