Coupled Optical & Thermal Model of a Silicon Microprobe

Cs. Ö. Boros [1], Sz. Beleznai[1], P. Koppa[1], Z. Fekete[2], Á. Cs. Horváth[3]

email: beleznai@dept.phy.bme.hu

[1]Department of Atomic Physics, Budapest University of Technology and Economics, Budapest, Hungary
[2]MTA EK NAP B Research Group for Implantable Microsystems, Budapest, Hungary
[3]Óbuda University Doctoral School of Material Science & Technology, Budapest, Hungary

Introduction

The topic of our work is modeling of a multimodal waveguide silicon micro-probe, which is suitable for deep brain infrared stimulation. We developed the optical-thermal coupled Comsol model of the device, which calculates the temperature distribution of brain tissues around the microprobe.

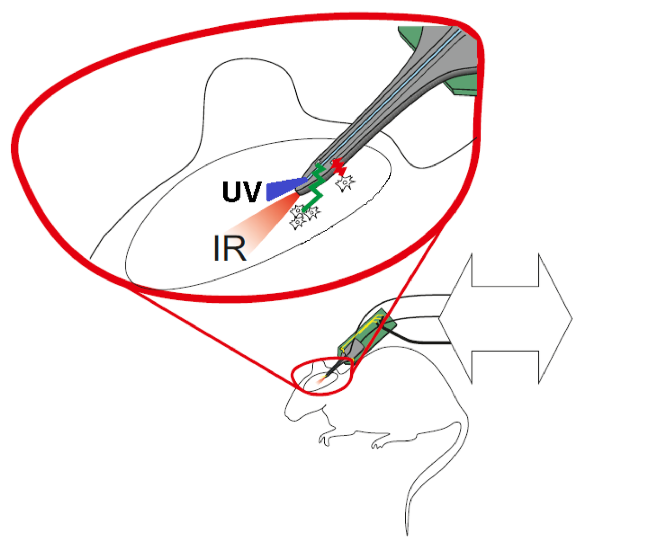


Fig. 1. Application plane

Coupled Ray Optics and Heat transfer simulation

The goal of the model is to determine the intensity distribution around the microprobe, the outcoupling efficiency of the device and the thermal distribution around the shaft.

Experimental Setup

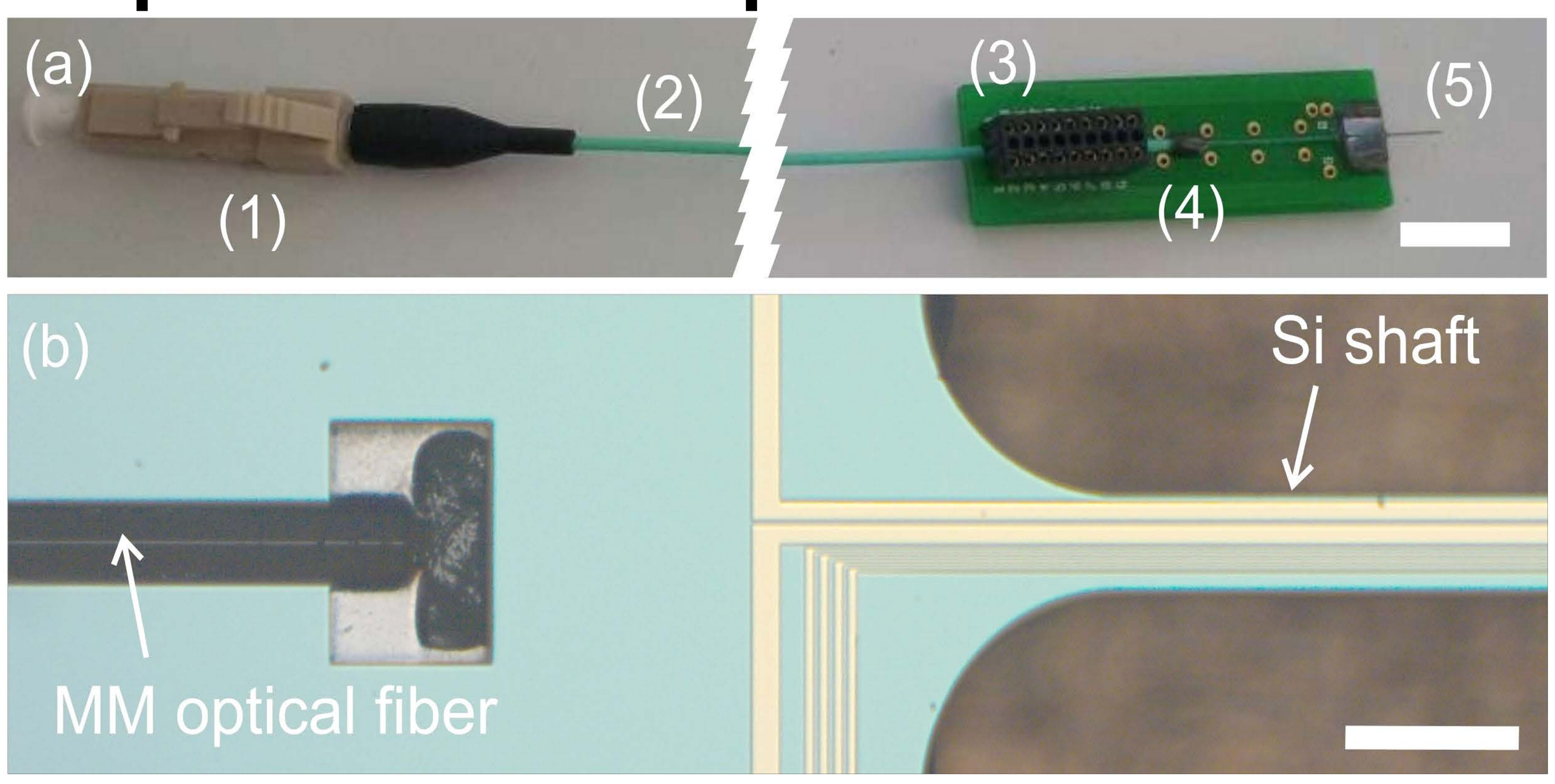
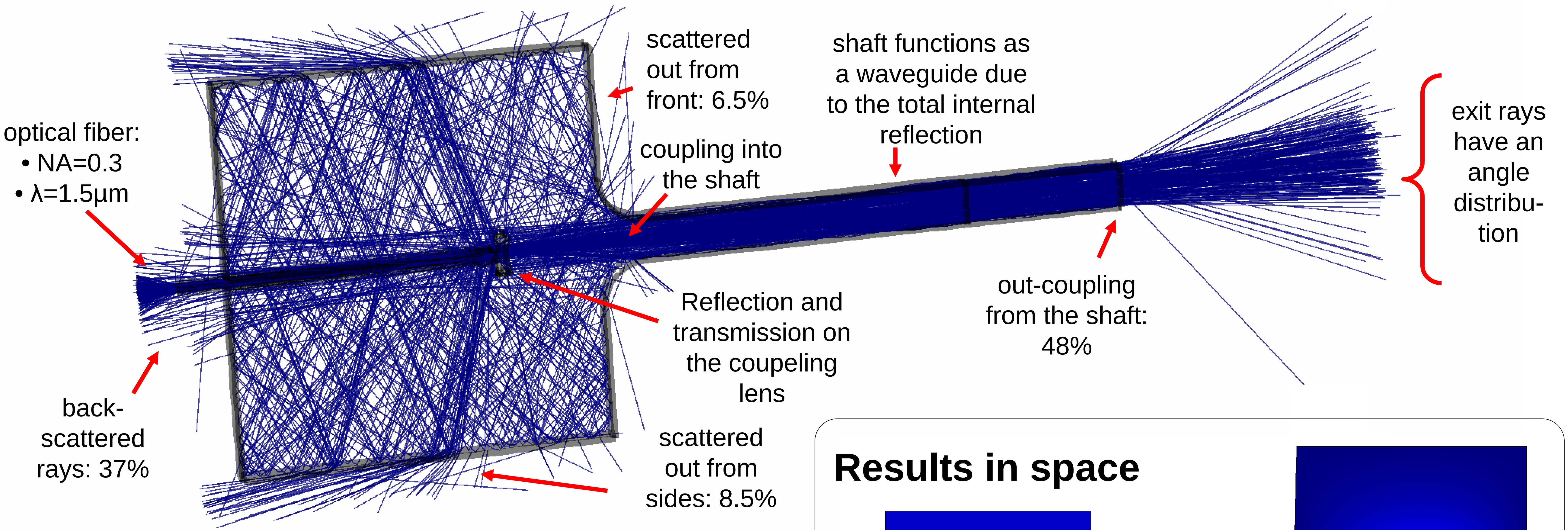


Figure 2. Perspective view of packaged INS microelectrode (a) (1) LC optical connector, (2) Multimode optical fiber, (3) PreciDip electrical connector, (4) Printed circuit board, (5) microchip. Close view of coupled fiber



Model settings

- Ray Optics module and Heat transfer module
- number of rays is 50, number of secondary rays is 20000
- ideally smooth Si surfaces
- intensity accumulators around the device

Results in space

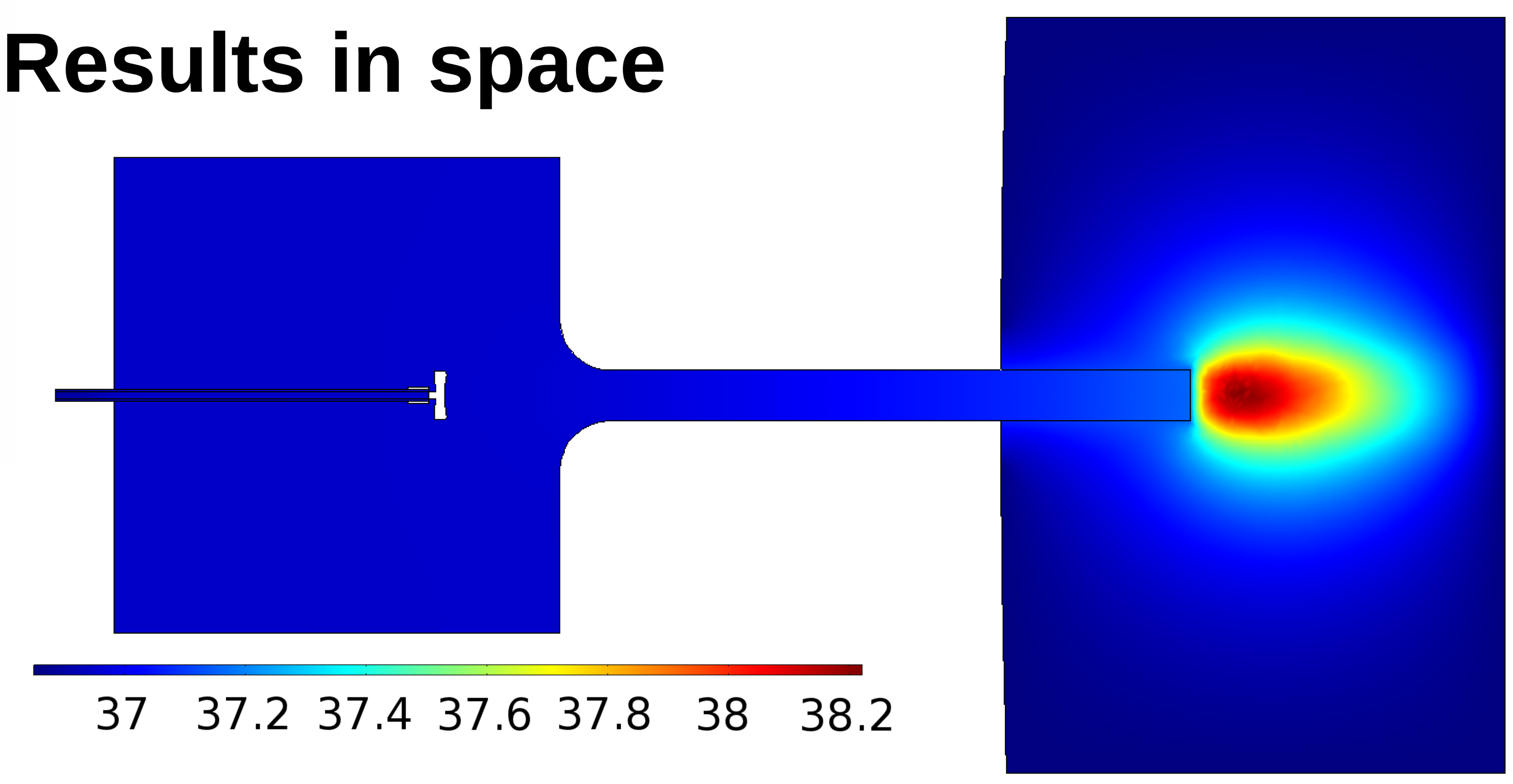
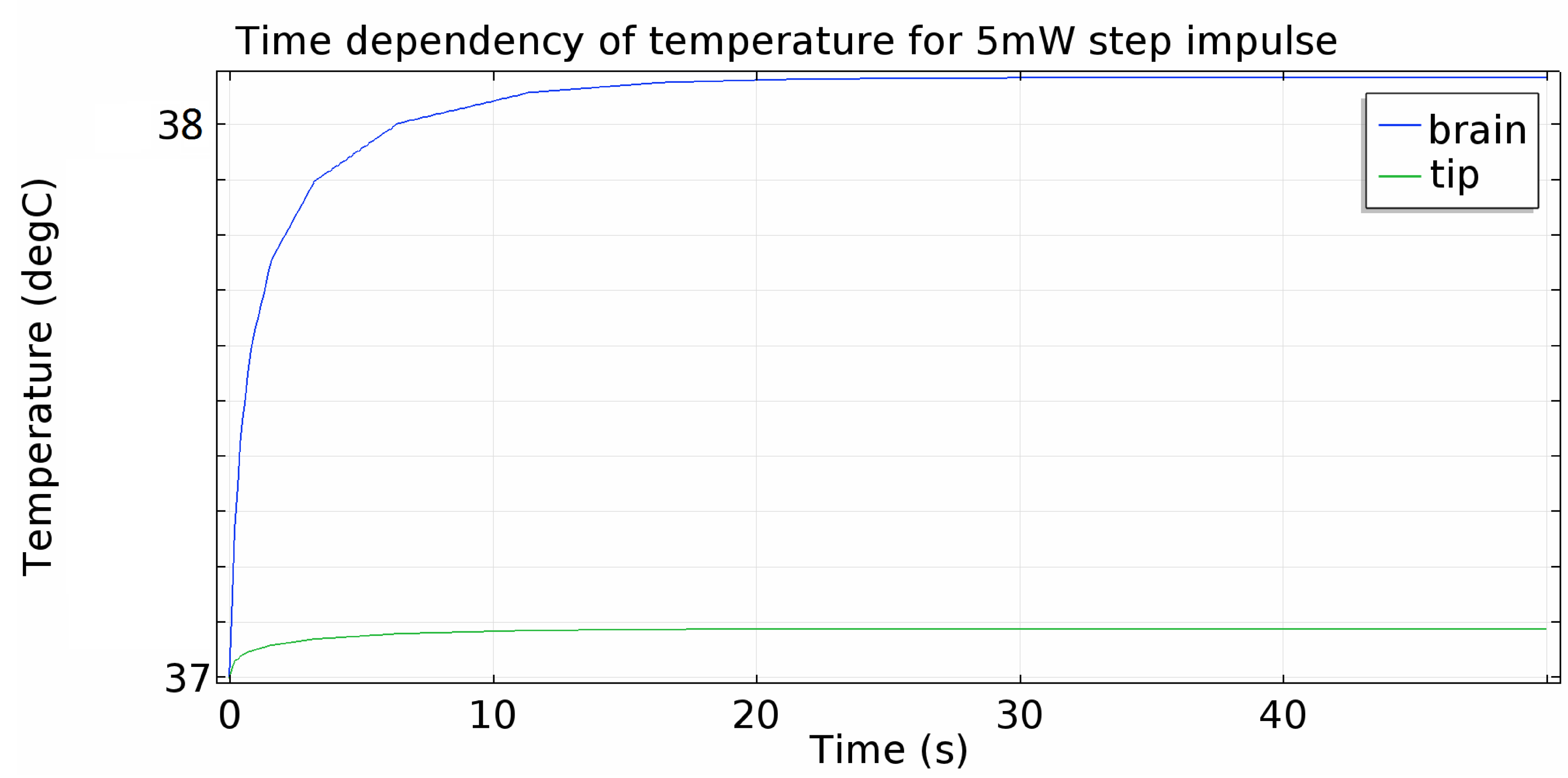


Figure 6. Temperature distribution (°C). The results show us that we can reach 1-2°C temperature rise within 4mm radius area at the tip of the device in case of 10mW laser power. The silicon shaft remains cold due to the low absorbent coefficient for infrared light and the high heat transfer coefficient compared to brain marerial.

Results in time



Conclusion

The temperature distribution around the microprobe due to the ray heating shows 1-2°C temperature rise within 4mm radius area around the device. This temperature rise is in the right range for neural stimulation.

Excerpt from the Proceedings of the 2017 COMSOL Conference in Rotterdam