Characterization of optical microsystems designed to thermal control of the neural tissue

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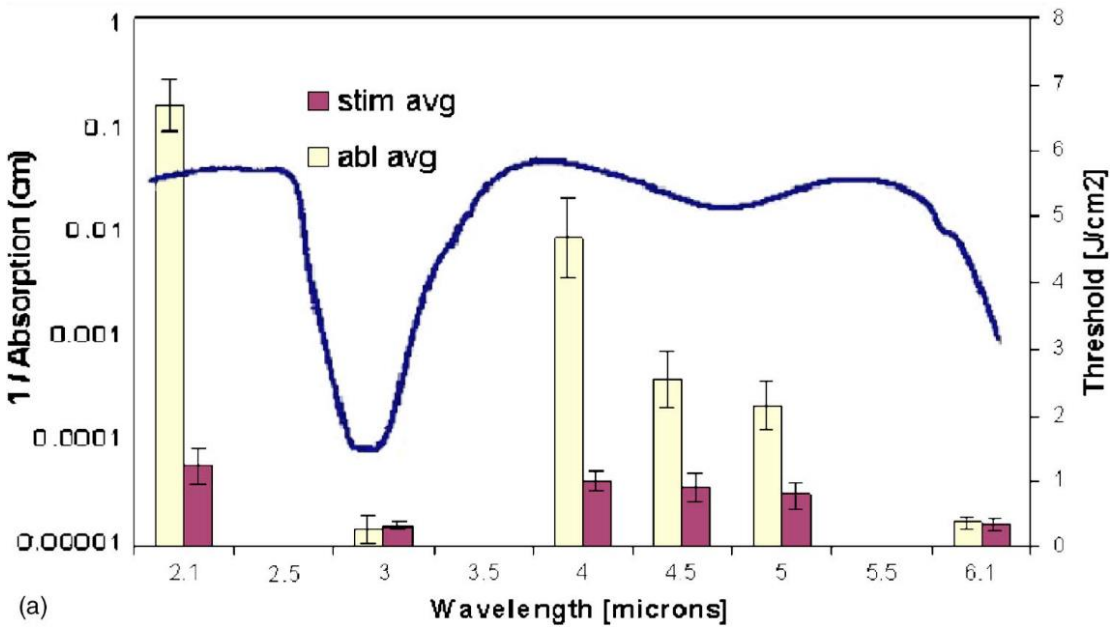
Neuroscientific motivations

- Effect of body temperature and brain temperature on neural activity
- Pulsed infrared neural stimulation (INS)
- Biological mechanism of INS?

- Precise, multimodal tool is needed
- Current INS is limited to cortical investigations



Wells et al., J. Biomed. Opt. 10 (2005)

→ My work: multimodal Si brain electrode = optrode

Multimodal brain electrode

- Modality 1: Optical stimulation
  - Bulk Si: mechanical carrier and IR waveguide (2 in 1)
- Modality 2: Monitoring heat accumulation
  - Pt thinfilm thermometer (100 x 100 μm^2) at tip
- Modality 3: Electrophysiology
  - 900 μm^2 Pt recording sites with 100 µm spacing

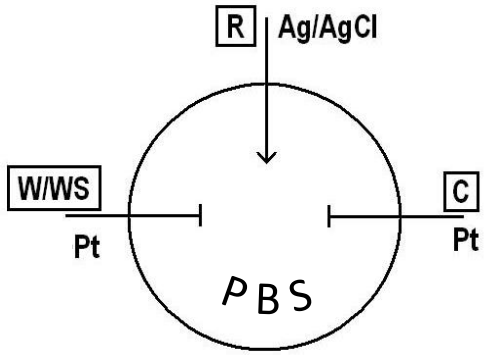
Characterization of modalities

- The optrode device has 3 modalities:
  - Temperature sensor → thermometer calibration (in earlier semesters)
  - IR waveguiding → optical characterization:
    - Waveguiding efficiency
    - Optical power
    - Beam size, beam divergence
    - Optical heating
  - Electrophysiological recording → reduction of the recording sites' impedance

Optical heating

- I observed and mapped the spatial distribution of temperature rise
- The resolution was 100 μm
- Experimental medium was small amount of water

Reduction of the recording sites' impedance



- Potentiostatic EIS: |Z| @ 1 kHz

Summary

- Multimodal MEMS brain electrode development
  - 3 integrated modalities: electrical recording, thermal measurement, IR wave guiding
- Measurements
  - Characterization of optical heating
  - Reduction of the recording sites' impedance
- Further aims:
  - Redesign the layout of the optrode chips: optimization and development
  - Simultaneous testing of the three modalities on packaged devices
  - In vivo validation

Nemzeti Kiválóság Program

➢ New National Excellence Foundation (ÚNKP): I was awarded a 10 months scholarship to realize and develop measurement automation of my research

Publications – completed & in prep.

- **Ágoston, Csaba Horváth** ; Örs, Csanád Boros ; Szabolcs, Beleznai ; Örs, Sepsi ; Pál, Koppa ; Zoltán, Fekete: A multimodal microtool for spatially controlled infrared neural stimulation in the deep brain tissue, SENSORS AND ACTUATORS B-CHEMICAL 263 pp. 77-86. , 10 p., 2018. (2017/2018 Impact Factor: 5.667)
- Zátonyi, A ; Szabó, Á ; Fedor, F ; **Horváth, Á** ; Pongrácz, A ; Fekete, Z, Trendek a polimer alapú mikroimplantátumok fejlesztésében, ANYAGOK VILÁGA 15 : 1 pp. 17-33. , 17 p., 2018. (*compulsory journal article in Hungarian*)
- Ö C, Boros ; **Á C, Horváth** ; S, Beleznai ; Ö, Sepsi ; S, Lenk ; Z, Fekete ; P, Koppa, Optical and thermal modeling of an optrode microdevice for infrared neural stimulation, APPLIED OPTICS 57 : 24 pp. 6952-6957. , 6 p., 2018. (2017/2018 Impact Factor 1.791)
  - Ö C, Boros ; **Á C, Horváth** ; S, Beleznai ; Ö, Sepsi ; Z, Fekete ; P, Koppa, Optimization of an optrode microdevice for infrared neural stimulation, *article under review*