



Optical-based integrated oxygen sensor for long-term O_2 monitoring for use in organ-on-chip platforms

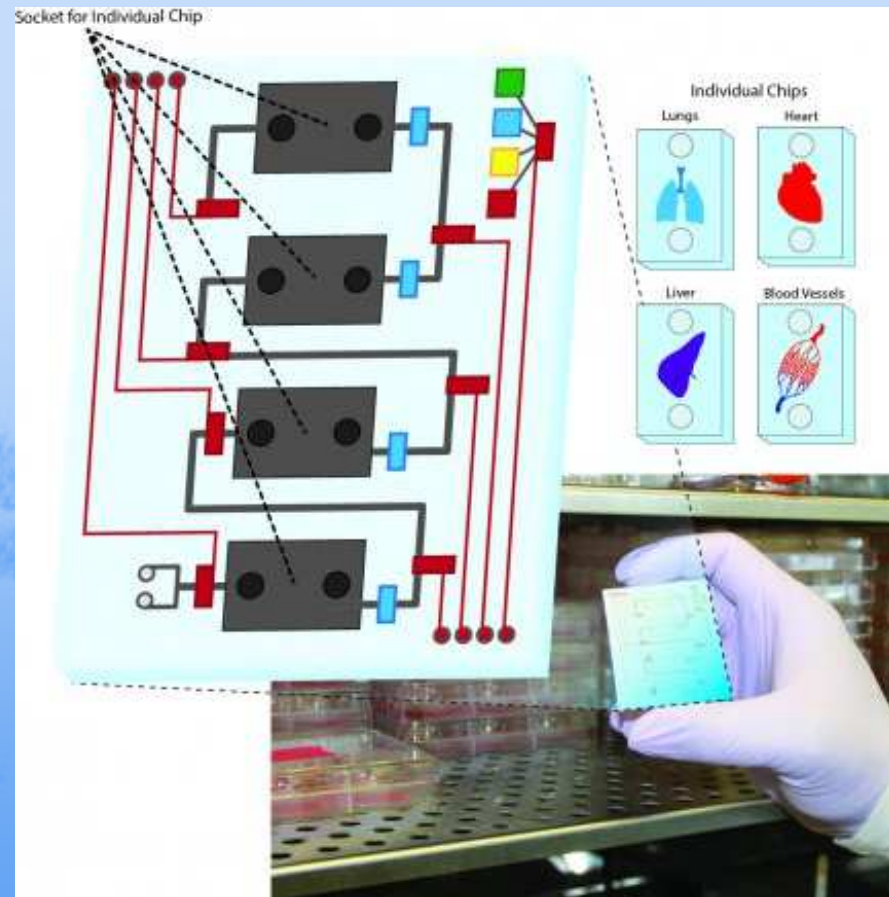
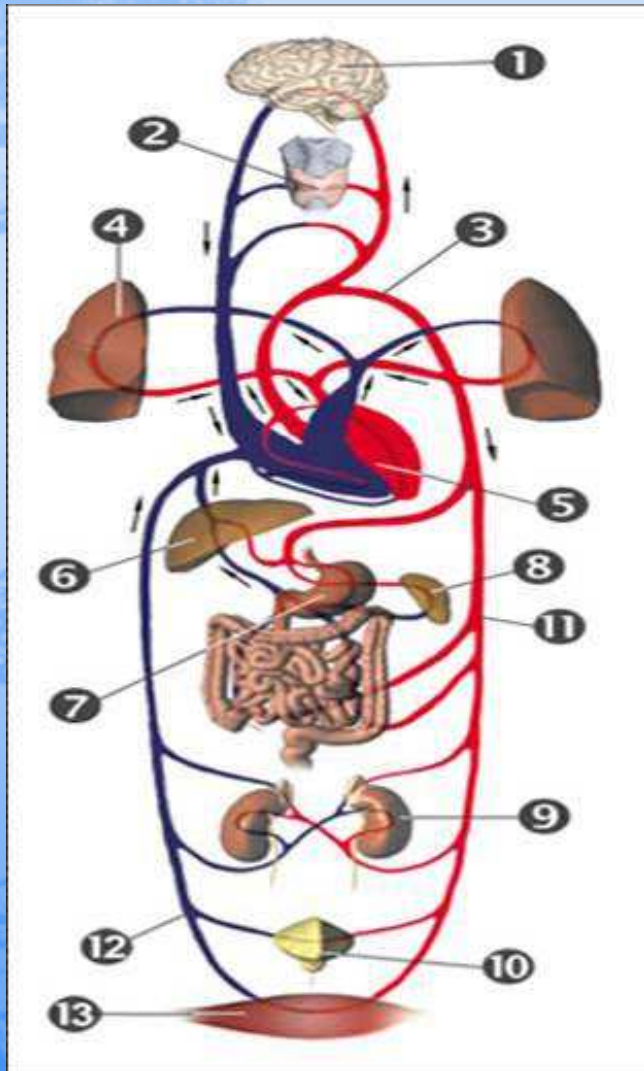
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29 Sep 2015

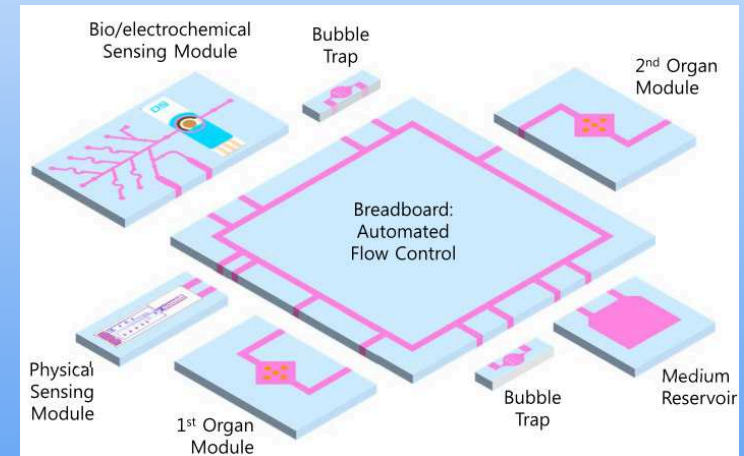
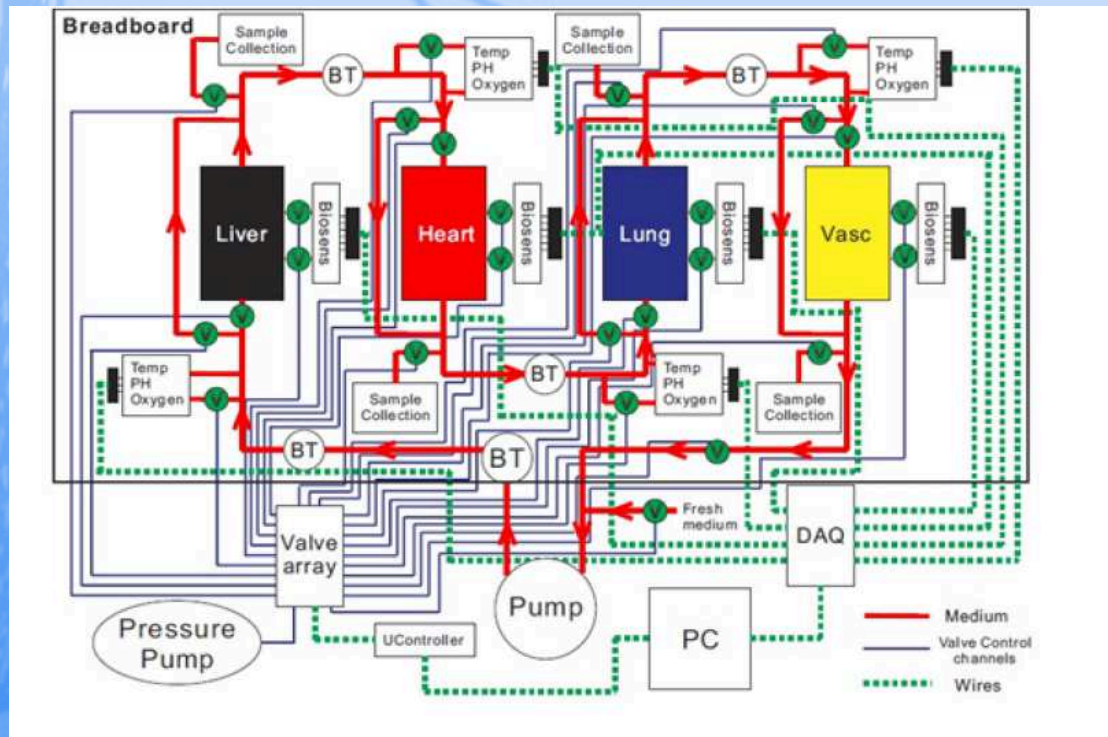
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Human/Organ on Chip



Organ on Chip

- ❑ Bio-Inspired microfluidics for development of organs-on-chip platforms
- ❑ Drug discovery and disease model applications



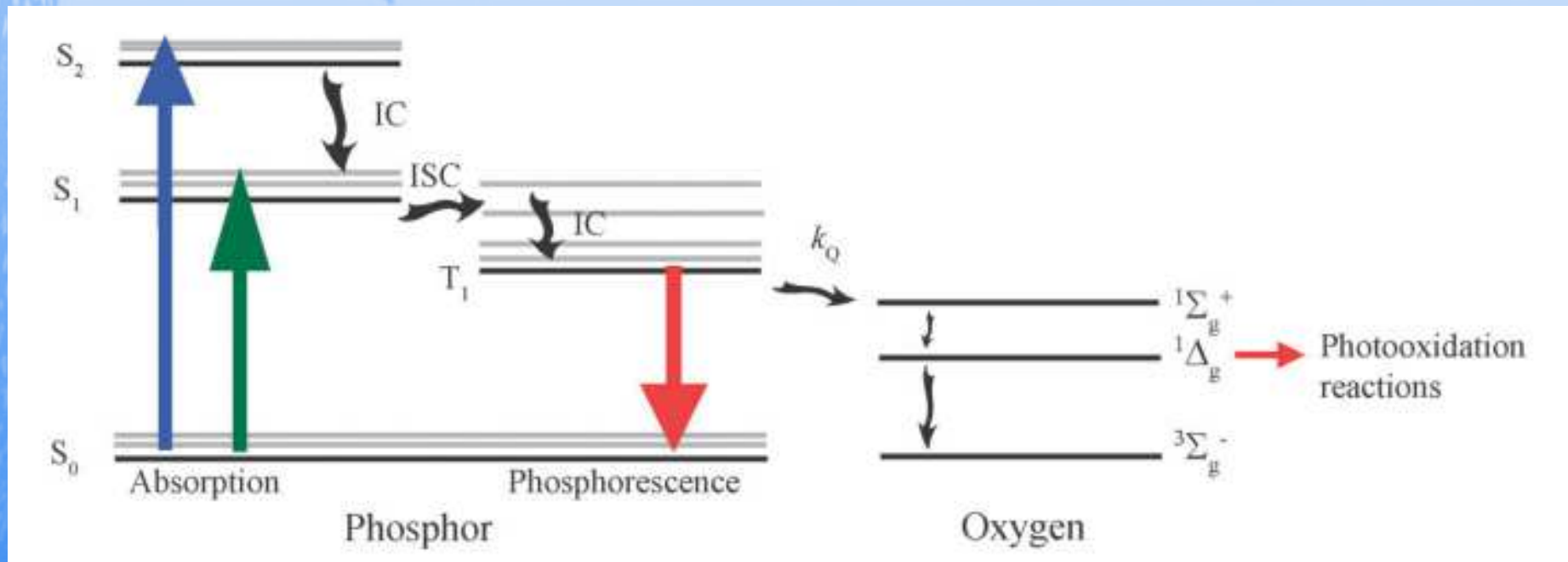
Importance of oxygen sensors

- ❑ Monitoring function of engineered organ
- ❑ Hypoxia and Hypoxemia
- ❑ Drug metabolism
- ❑ Electrical-based versus optical-based O₂ sensors



Principles of optical-based oxygen sensing

- ❑ Quenching of oxygen sensitive dye
- ❑ Phosphorescence (delayed fluorescence)

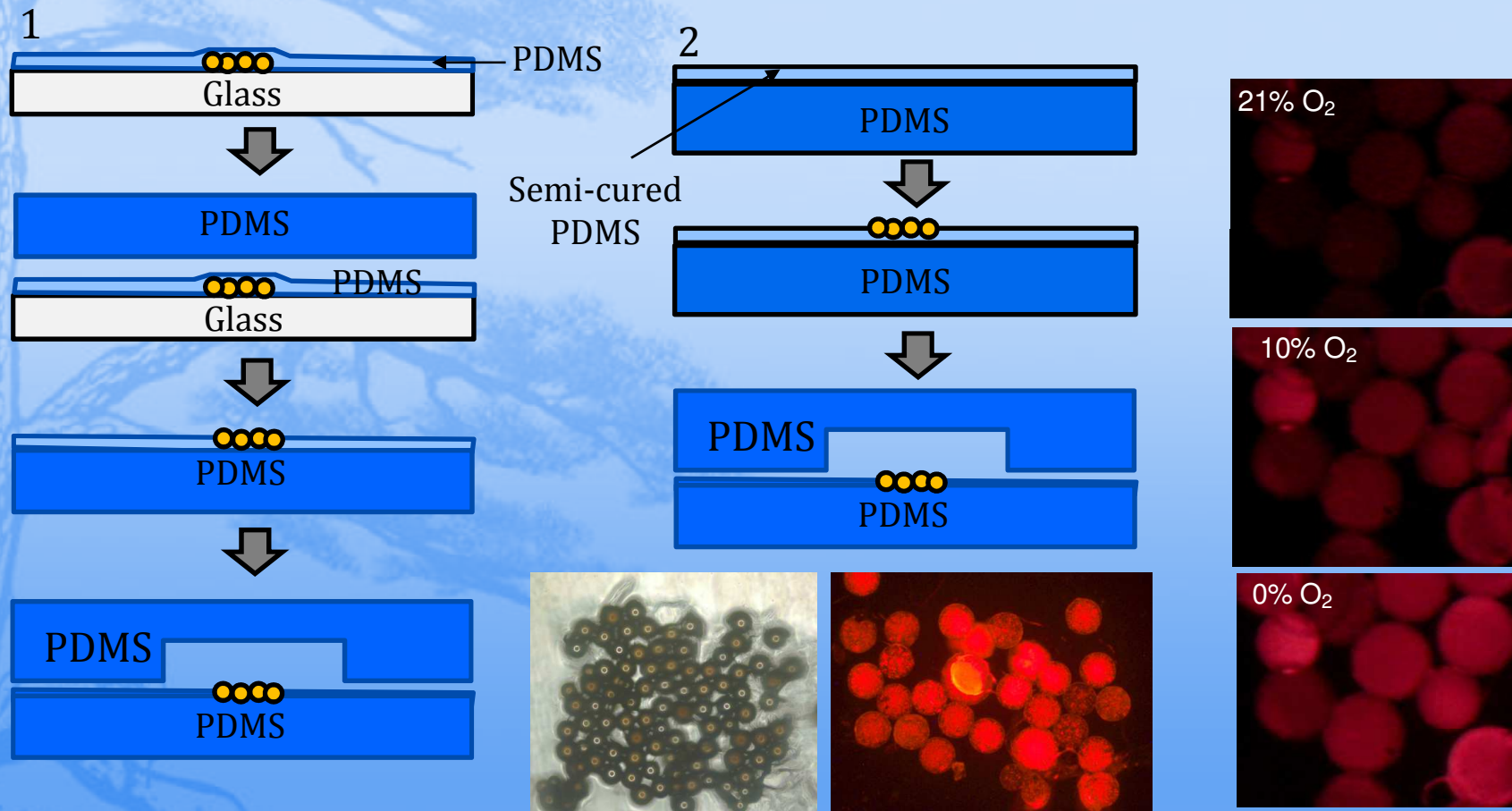


Principles of optical-based oxygen sensing

- ❑ Quenched-phosphorescence of O₂ detection
- ❑ Direct, non-chemical, reversible sensing
- ❑ Photochemical process of collisional quenching
- ❑ Excited state indicator dye molecules by molecular oxygen

Ruthenium -based oxygen sensitive PDMS beads

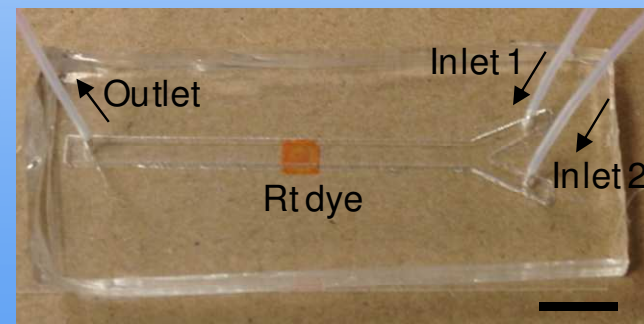
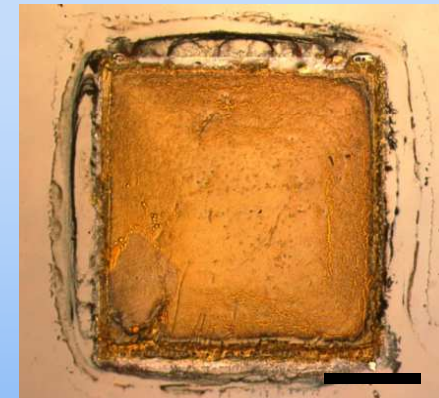
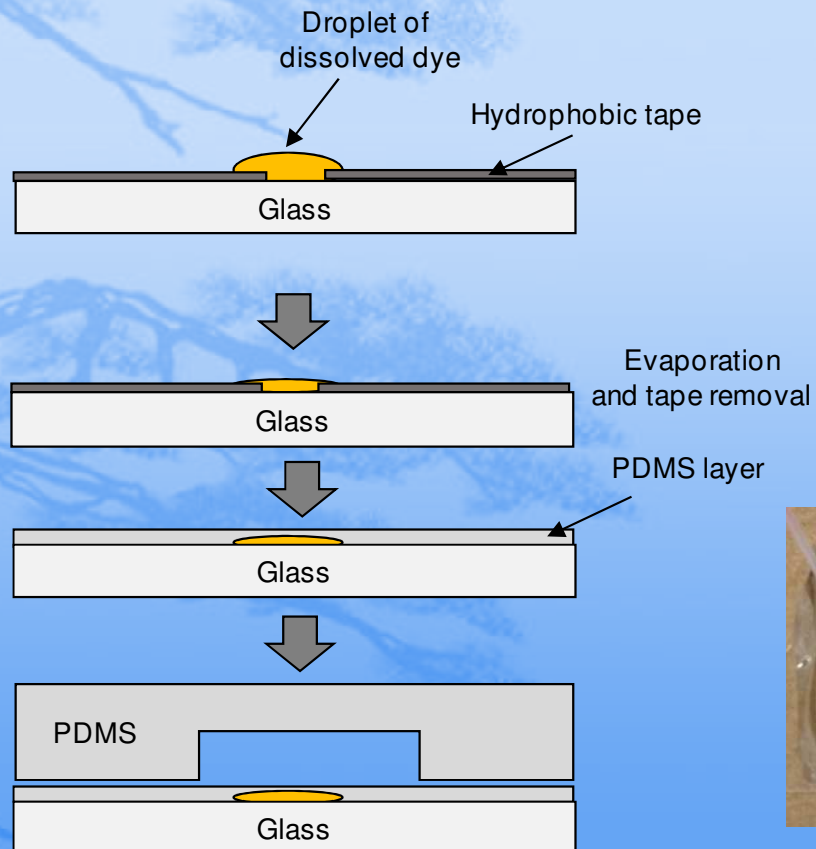
- Permissible PDMS beads with encapsulated Ruthenium dye are sensitive to oxygen concentration



Patterning Rt-dye layer within microchannel

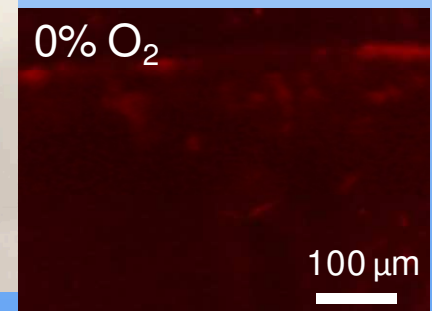
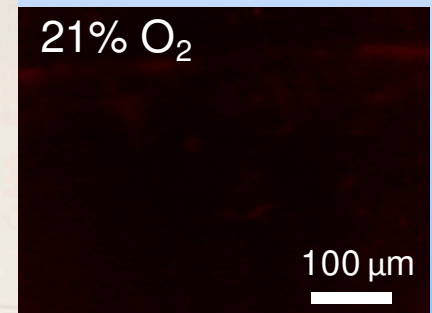
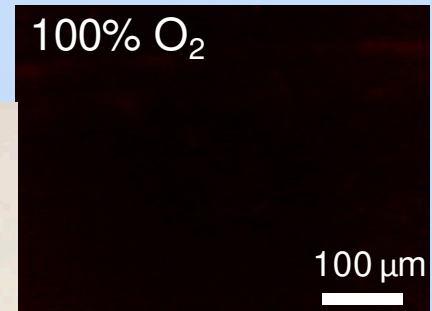
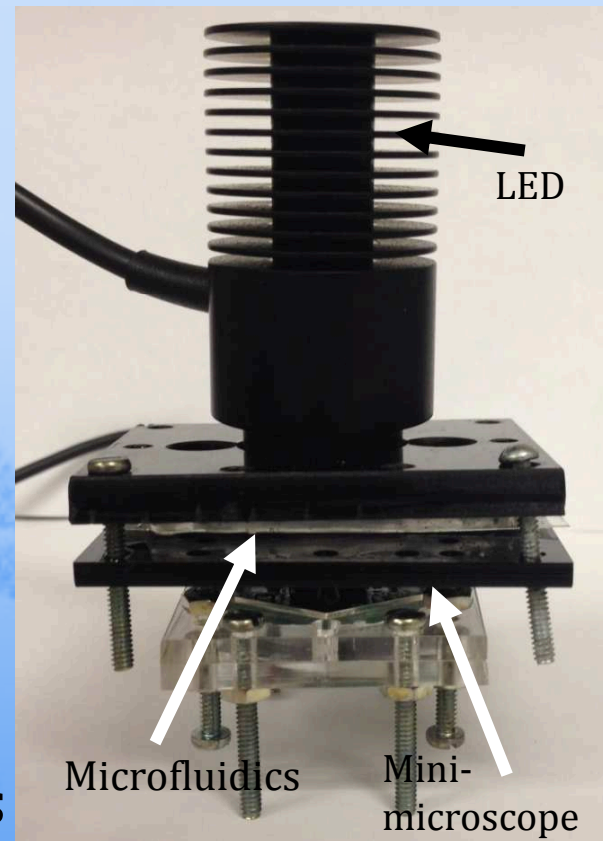
❑ Patterned Rt-dye versus Rt PDMS beads

❑ Reproducibility and higher sensitivity



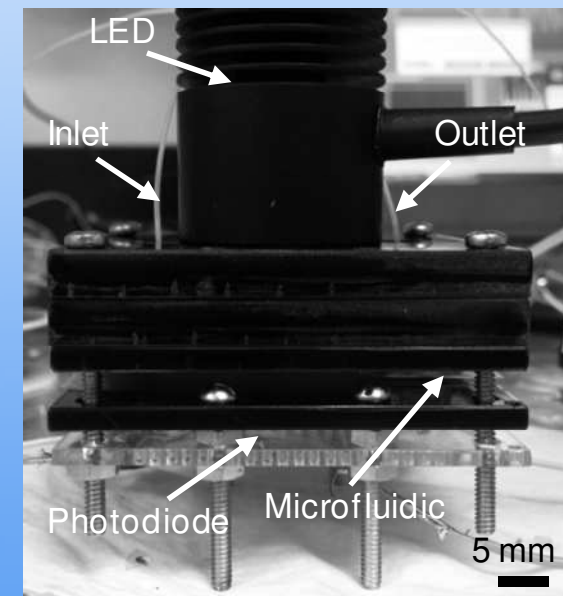
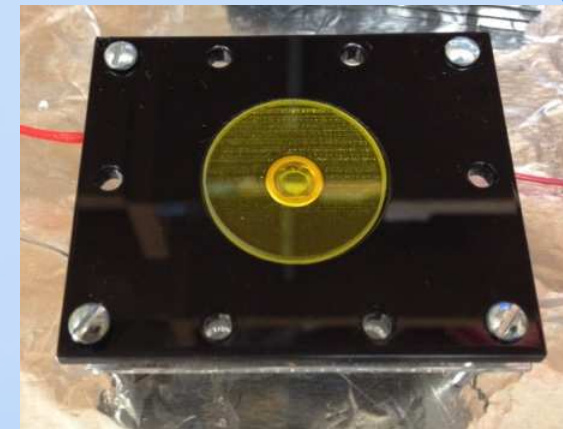
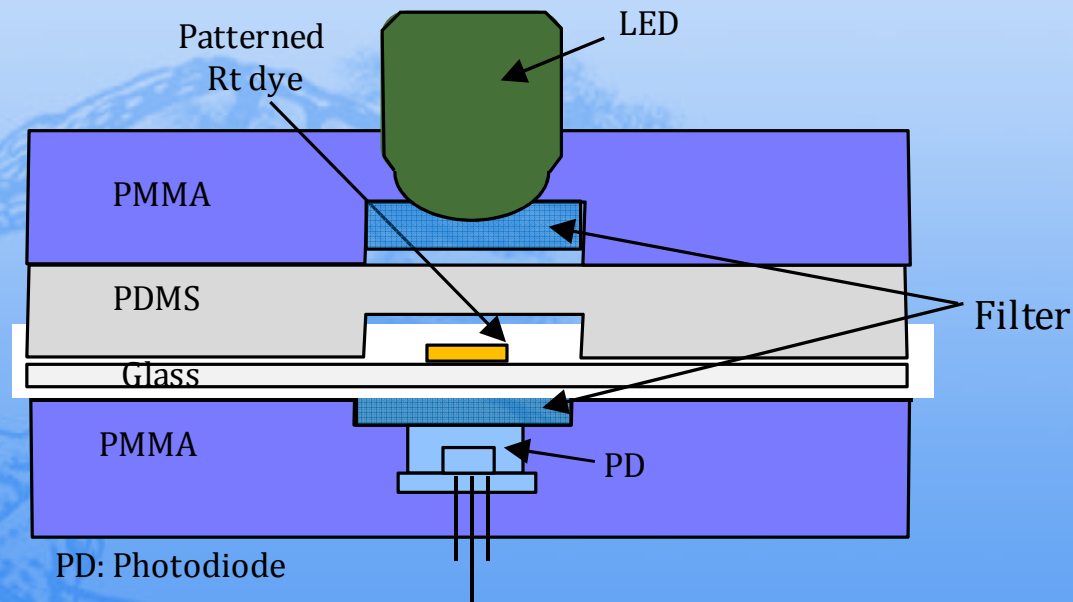
Integrated Mini-microscope

- ❑ Mini-microscope integrated with microfluidics and illumination system to detect dissolved O_2
- ❑ Image processing is needed to detect dissolved O_2 concentration
- ❑ Is not compatible with long-term detection
- ❑ Is dependent on parameters of image processing



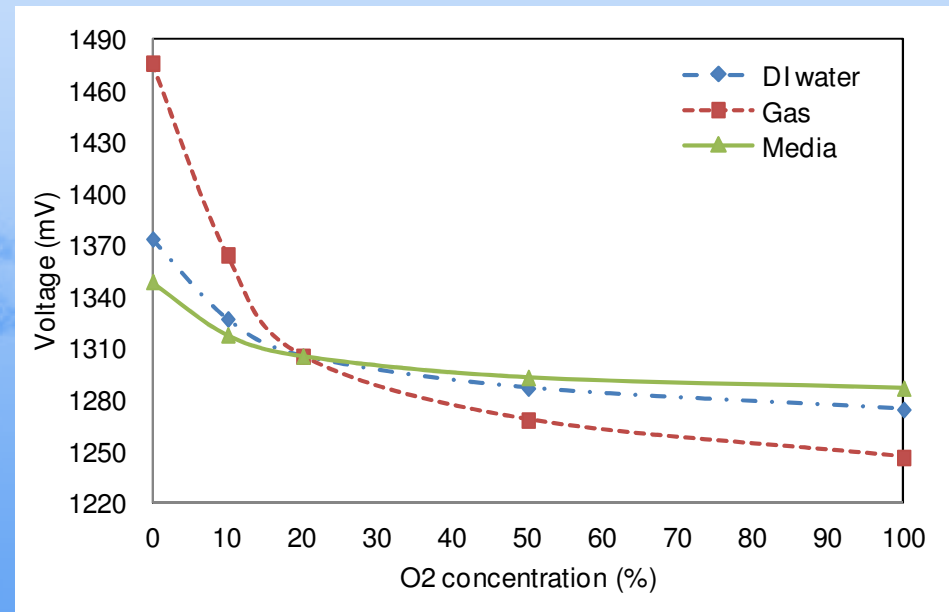
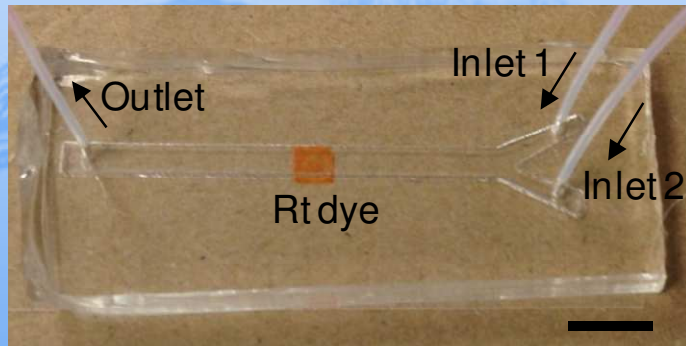
Integration of electronic detection to optical sensor

- The light illuminated from oxygen sensitive dye is collected and detected by photodiode.



O₂ sensor electric read-out

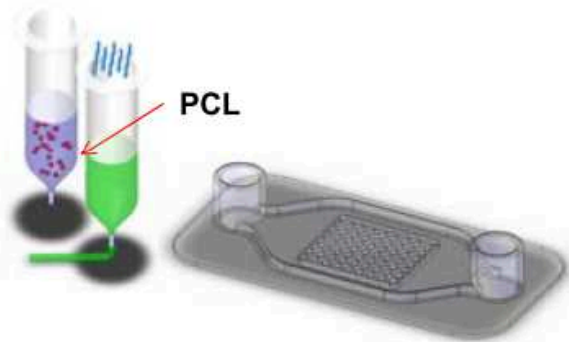
- ❑ Tested with mixed O₂-N₂ gases, DI water, and cell culture media
- ❑ High sensitive to O₂ gas and less sensitive to dissolved O₂ in media



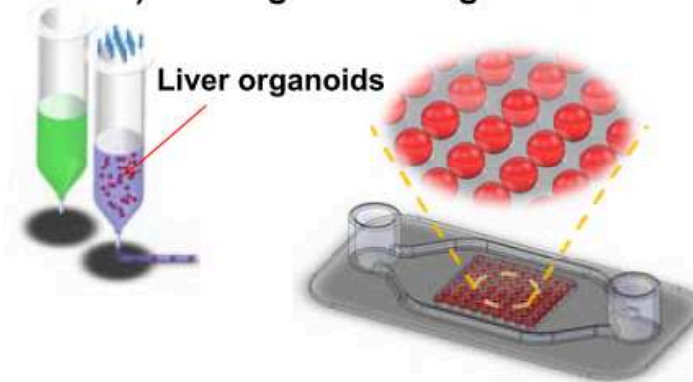
Liver bioreactor

□ Tissue Bioprinting, Organoids

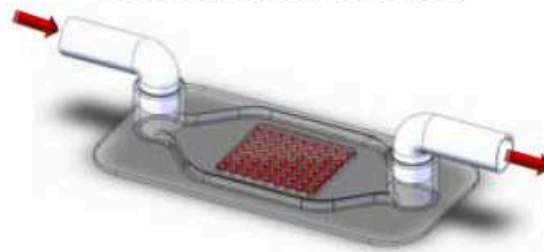
1) Printing of structural material



2) Printing of liver organoids

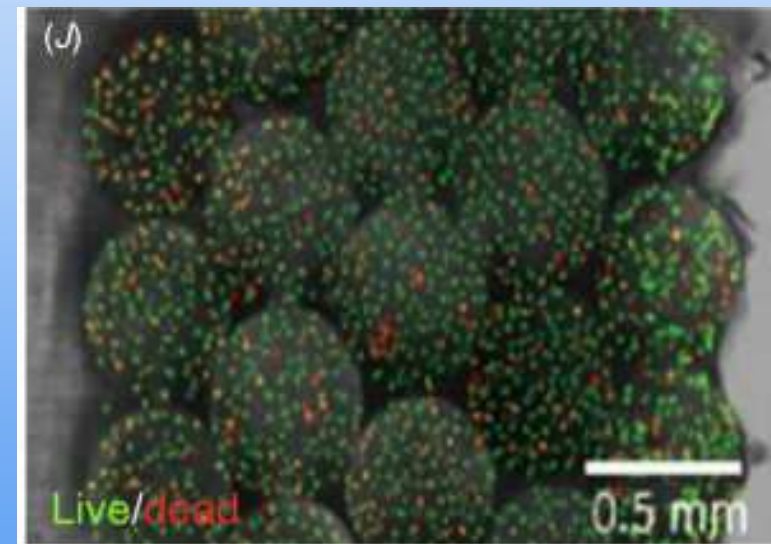
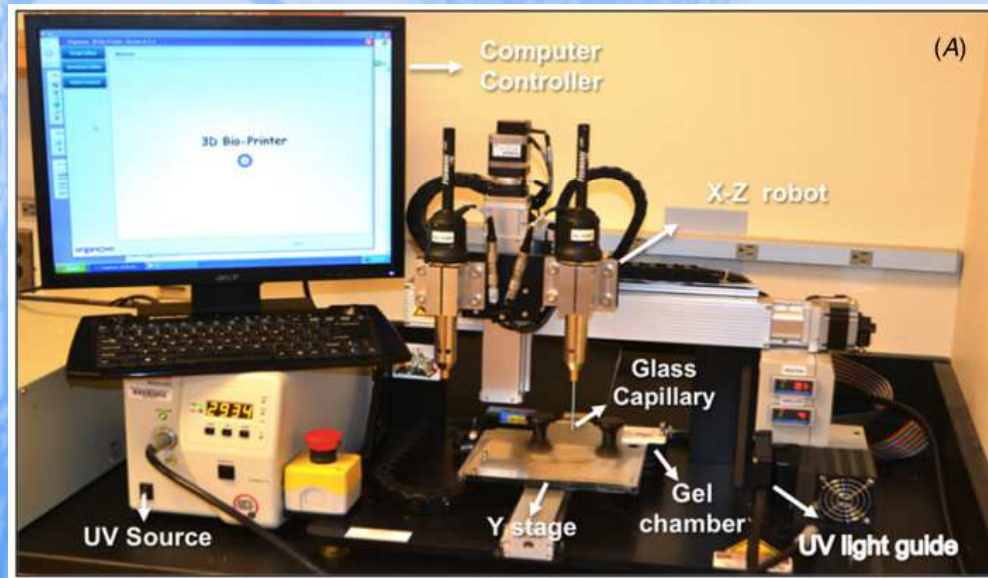


3) Microfluidic device



Bioprinting liver cells

- ❑ Bioprinting HepG2 cells in GelMA hydrogel for long-term cell culturing



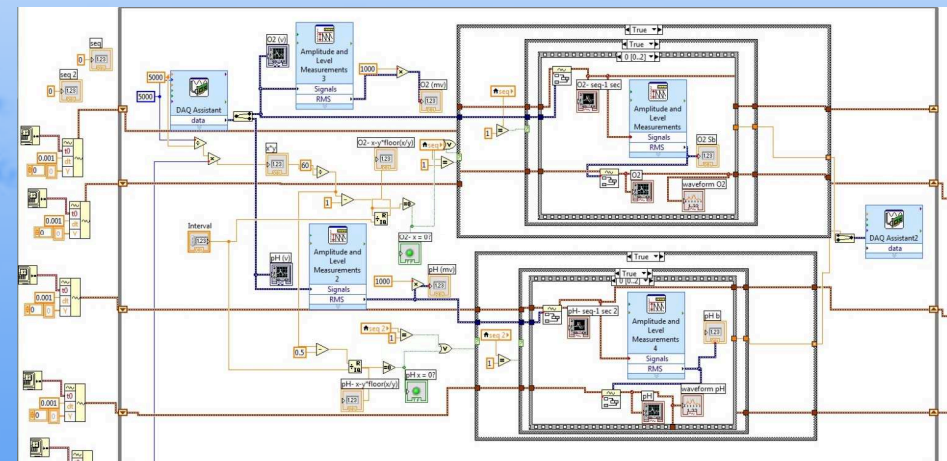
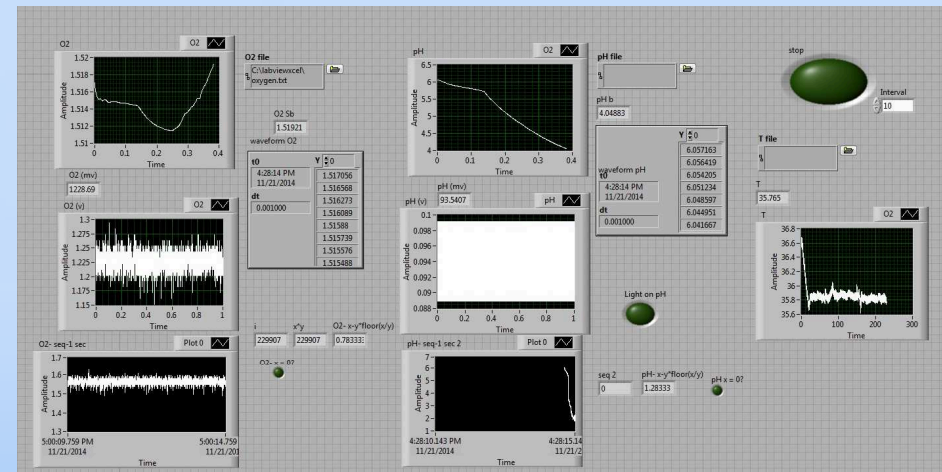
Integration of O₂ sensor to bioreactor

❑ Real-time and long-term monitoring of dissolved O₂ in liver bioreactor

❑ Sampling every 10 min

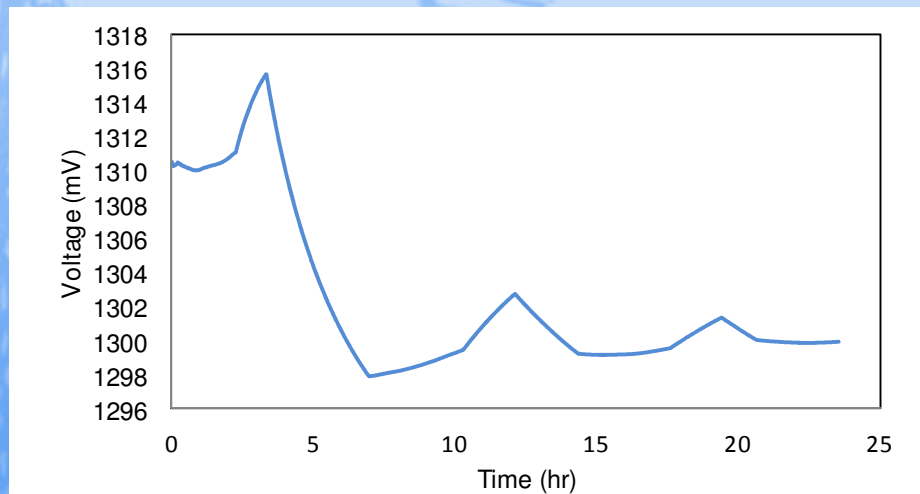
❑ 3 Sec laser on

❑ 1 Sec recording

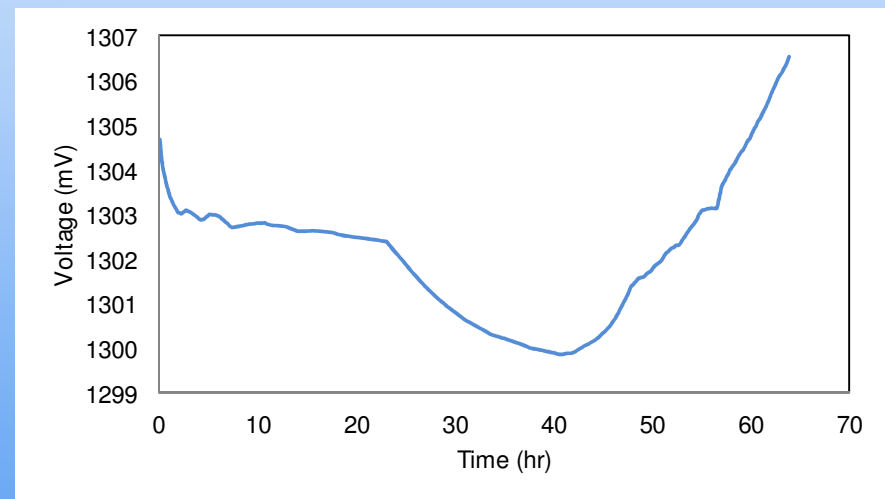


Long-term response of oxygen sensor

- ❑ Stability and high sensitivity in long-term O₂ detection
- ❑ Bioreactor with no cells



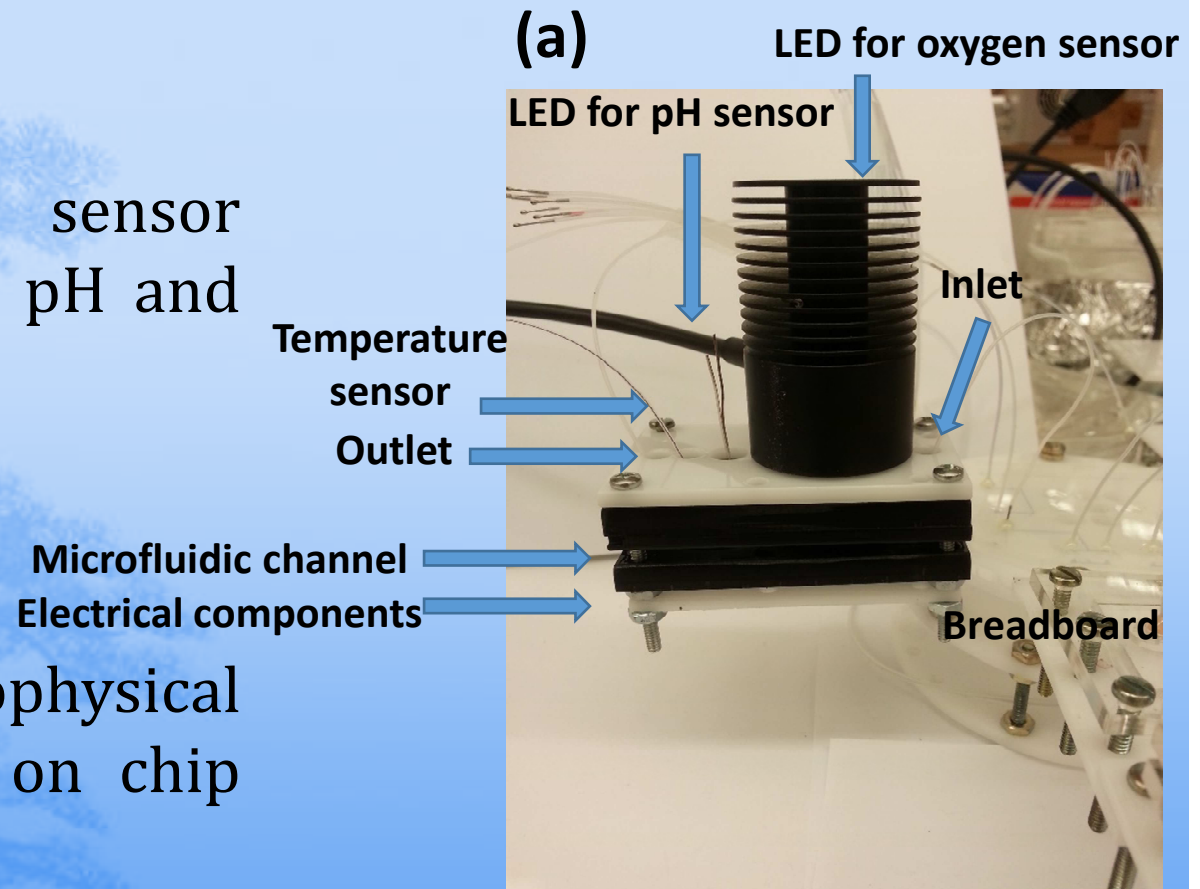
- ❑ Bioreactor with HepG2 cells



Integration of O₂ sensor to the organ-on-chip platform

□ Integration of O₂ sensor with other biophysical pH and Temp sensors

□ Assembly of biophysical sensors to the organ on chip platform





Questions?

