GENERATION OF AN ACCESSIBLE AND VERSATILE MICRO-HYPOXIA CHAMBER

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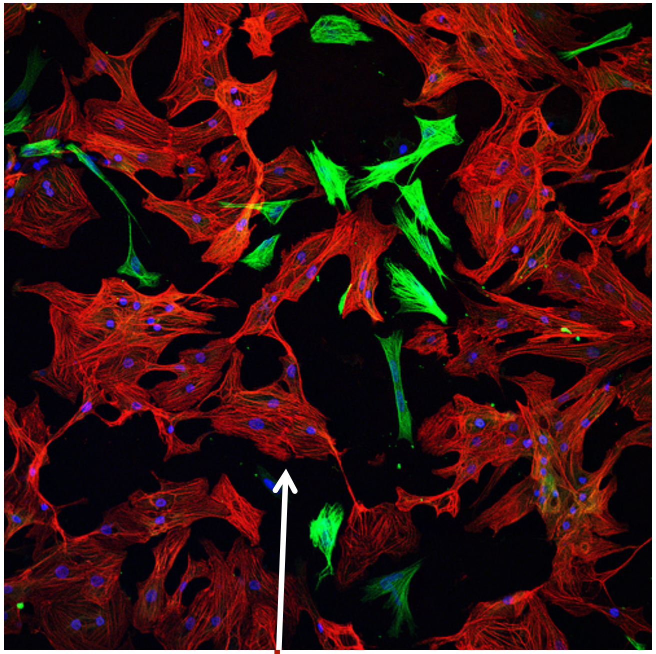
Overview

- Background
- Problem Identification and Statement
- Product Design Specifications
- Previous Work, Current Technology
- Design Alternatives
- Design Matrix
- Future Work
- Acknowledgements and Questions

Background: Hypoxia and the Heart

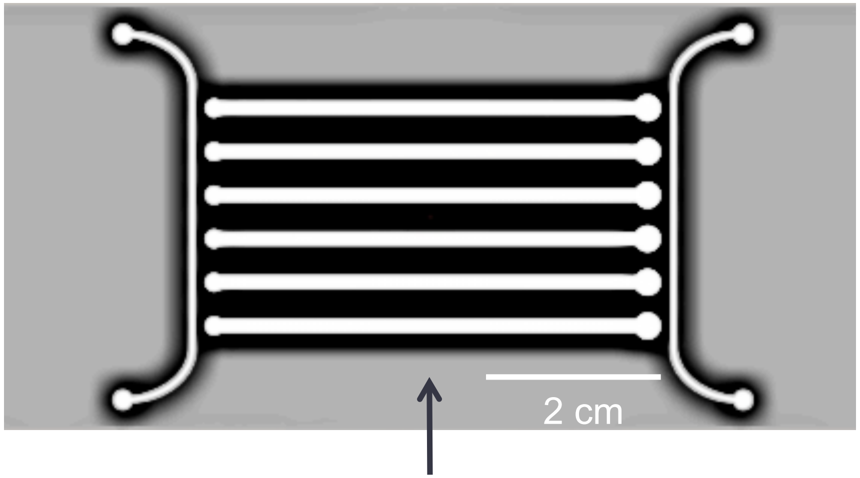
- Heart attack is the number one cause of death in the United States
- A proposed treatment for heart attacks is stem cell fusion with damaged tissue. This occurs primarily in hypoxic conditions



A cardiomyocyte[1]

Hypoxia: phenomena where regions of tissue are deprived of necessary oxygen

Background: Microfluidics in Hypoxia



Microfluidic device capable of maintaining concentration gradient

- Devices made of PDMS, which is gas permeable
- Microfluidic devices can easily create oxygen gradients
- Allows use of limited cells and reagent: low cost

Problem Statement

- Microfluidic device has been developed to mimic hypoxia in heart
- Goal is to create oxygen sensor to monitor oxygen gradient in real time in device

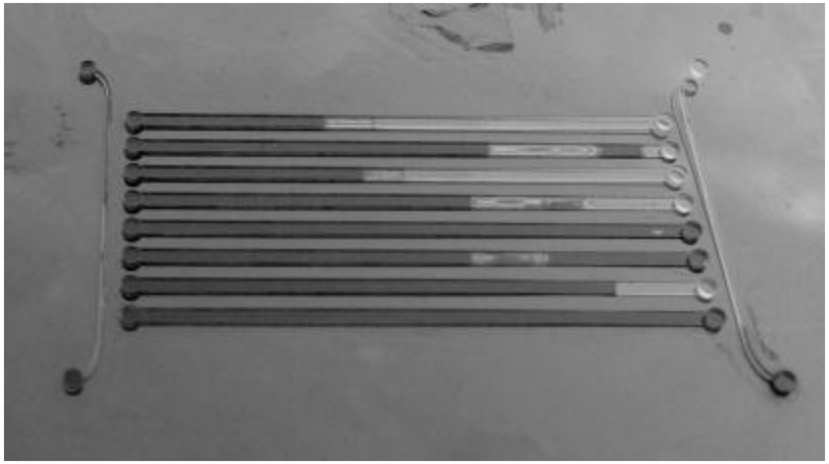
Product Design Specifications

- Detect O_2 from 1% to 20% concentrations with 2% accuracy
- Does not impede microscopy
- Small fabrication time
- Stable in incubator
- Under 50 grams
- Integrate with current PDMS device
- Not cytotoxic to cells of interest
- Projected Cost $500

Previous Work

Spring 2012

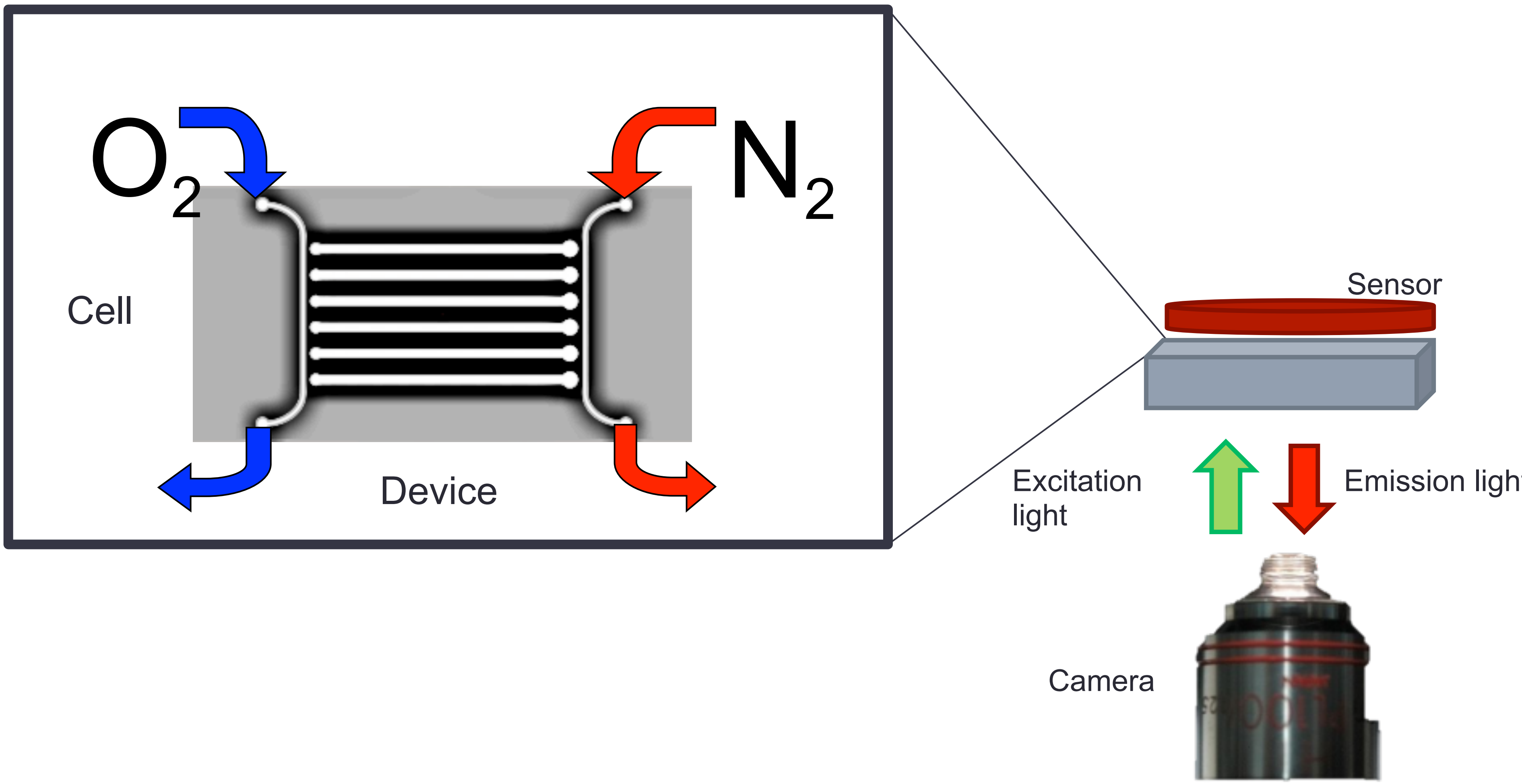
- Master Template



Fall 2012

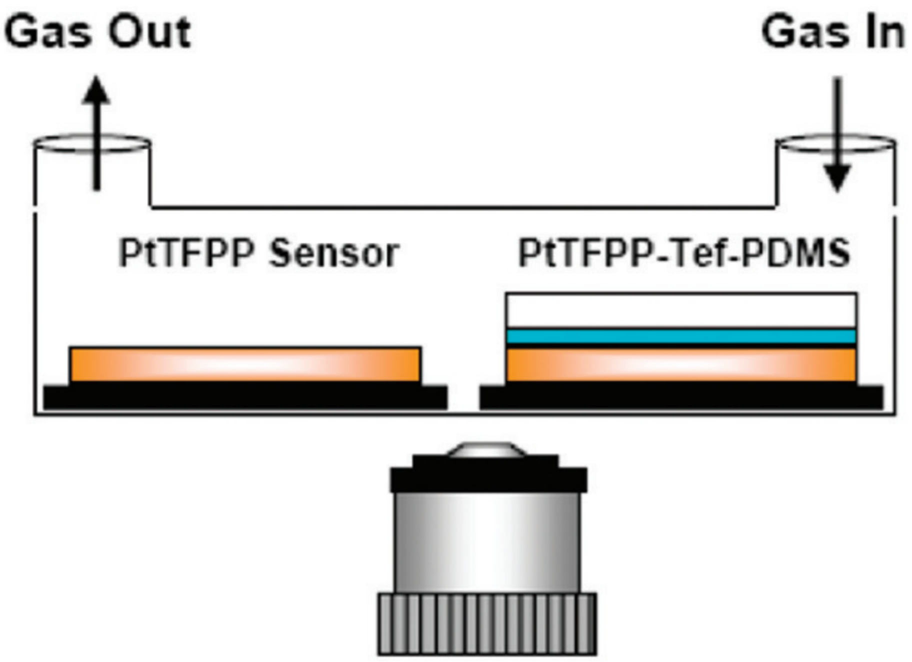
- PtOEPK sensor
  - Fluorescent porphyrine molecule
  - 96 – well plate
  - Testing in progress

Previous Work: Operational Theory



Current Technology

- University of Wisconsin PtTFPP – Teff – PDMS sensor
- University of Michigan thin sensor film



Model of PtTFPP – Teff – PDMA sensor[2]

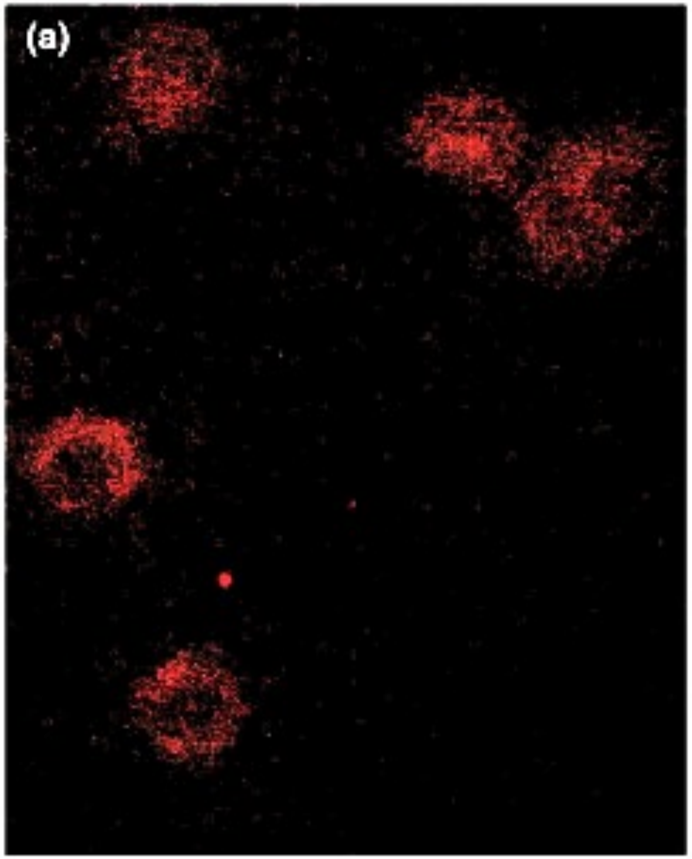
Design Alternative: PtOEPK

Advantages

- High O_2 Sensitivity
- No leaching effects
- Repeatable
- Low Cost

Disadvantages

- Biological nature leads to variability
- Non-standard emission wavelength



PtOEPK in use as an optical sensor[3]

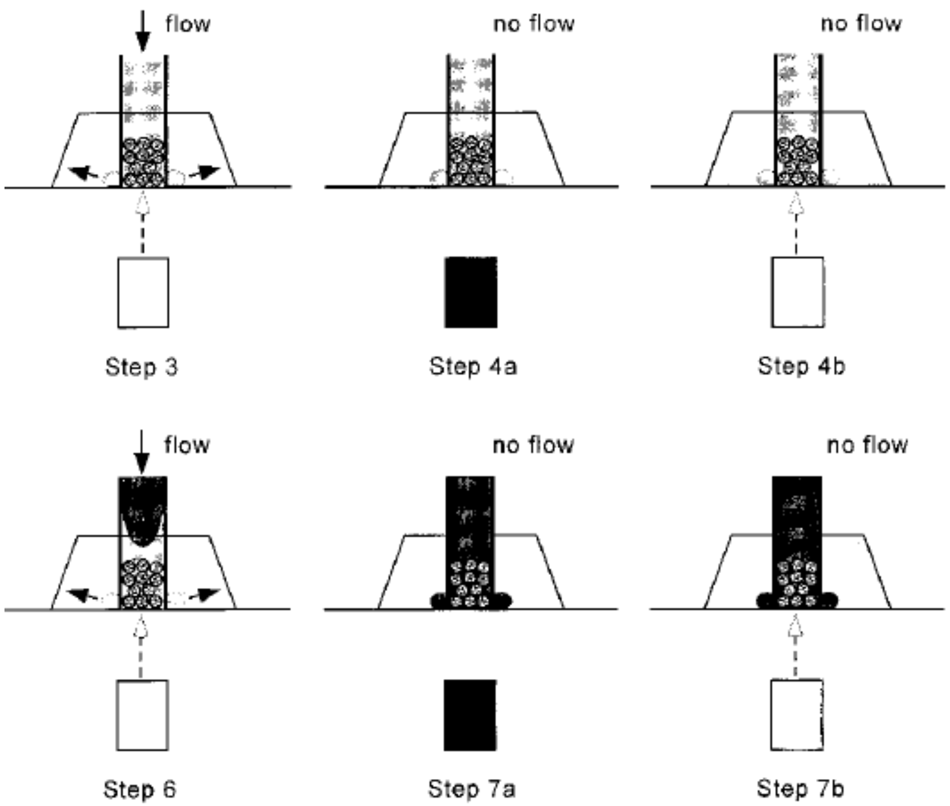
Design Alternative: Bead Injection Spectroscopy

Advantages

- O_2 – dependent quenching of the phosphorescence of a Pt – porphyrin complex immobilized
- Fast response: minutes
- Renewable sensor surface

Disadvantages

- Consumes O_2
- Can be easily affected by surrounding media
- Limited success in previous literature



Bead Injection process[4]

Design Alternative: Electrical Sensor

Advantages

- Has strong basis in fiber optics
- Accurate and sensitive
- Produces discrete quantitative data
- Potentially reusable

Disadvantages

- Requires multiple detector units
- Introduces new system (electrical vs. biological)
- Larger initial investment

Fiber optic sensors[5]

Design Matrix

Category	PtOEPK	Bead Injection Spectroscopy	Electrical Sensor
Sensitivity (25%)	4	2	4
Accuracy (25%)	3	2	4
Integration (15%)	4	3	2
Ease of Fabrication (10%)	4	5	1
Response Time (10%)	4	4	3
Cost (15%)	3	3	2
Total	72	56	60

Future Work and Expectations

- Aim one:
  - Purchase material
  - Testing and calibration curve

- Aim two:
  - Design and integrate the sensor onto the device
  - Calibration experiment with cells
  - Protocol writing

Future Work

Sensor made 96-well plate

↓

Secure the sensor plate under hypoxia chamber

↓

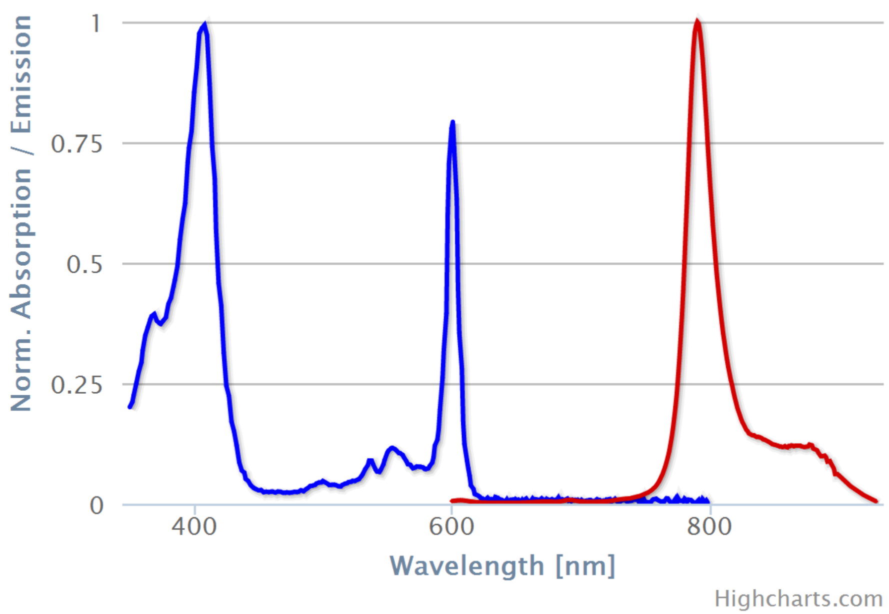
Adjust oxygen concentration (20% to 5%)

↓

Measure the intensity of light

Response

- The PtOEPK based sensor responds to excitation light of wavelengths 408 & 601 nm and has emission at a non-standard wavelength of 791 nm



Overview

Absorption λ_{max}

408 nm, 601 nm

Emission λ_{max}

791 nm

Solvent

toluene

Molar Abs. Coefficient

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Acknowledgements

- Dr. John Puccinelli
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- Previous groups

References

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QUESTIONS?