Innocell Cancer Inactivation System (Innocell CIS)

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Introduction

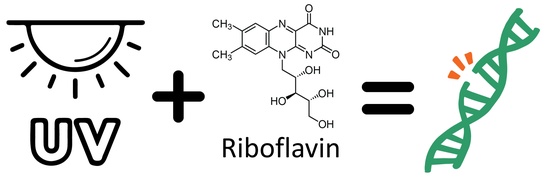
- Cancer accounts for one of every four deaths in the United States
- Average cumulative cost of lung cancer chemotherapy treatment was $200,580 in 2017 – $7,700 for those with insurance
- CAR-T immunotherapy can cost as much as $375,000 for one treatment
- Goal: Provide a personalized cancer immunotherapy that is more effective while reducing treatment time, cost, and harsh side effects

Process overview

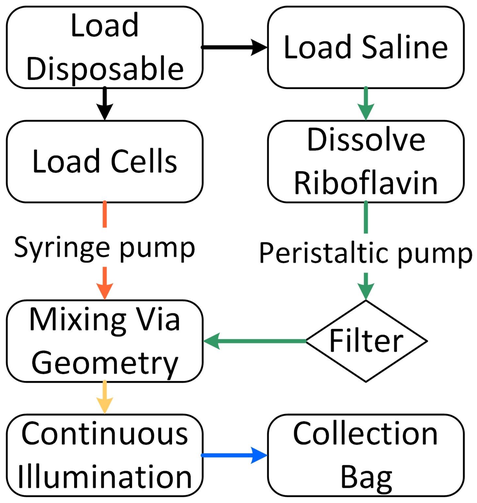
Design Improvements from Mirasol PRT

Mirasol PRT	Innocell CIS
Fluorescent Bulbs	High Powered LEDs
Supersaturated Saline Solution	Powdered Riboflavin
Batch Process	Continuous Flow Process

Inactivation Process[1]



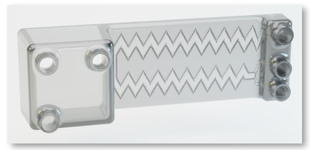
Process flow



Prototype – Design

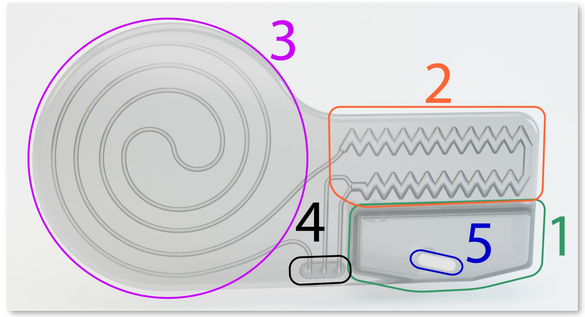
Illumination Cassette Design

Initial Cassette Design



Stir Bar with Riboflavin

Final Cassette Design

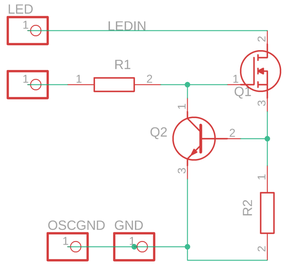


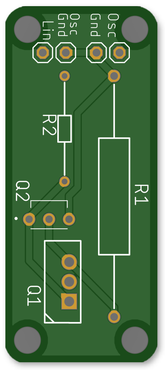
1- Riboflavin Mix Chamber 2- Mixing Geometry
3- Illumination Path 4- Connection Ports
5- Stir bar preloaded with Riboflavin

Illumination Circuit Design

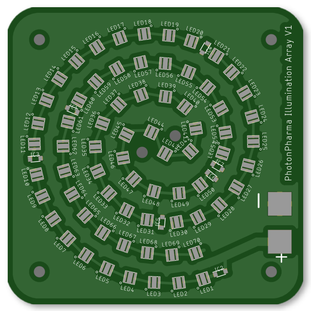
Initial Design – Constant-current LED driver

- Transistors control current through LEDs
- Expensive and space intensive for multiple in parallel





Final Design – Current Limiters

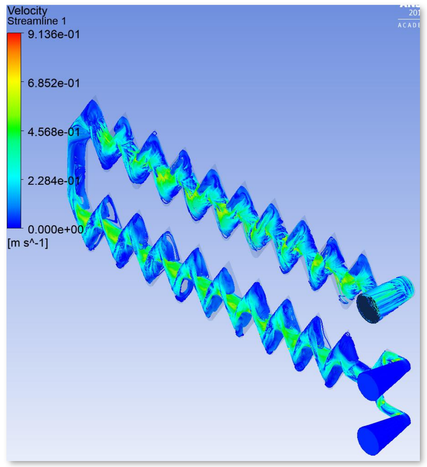


7 sets of 10 LEDs running in parallel, each with a 20mA current limiter

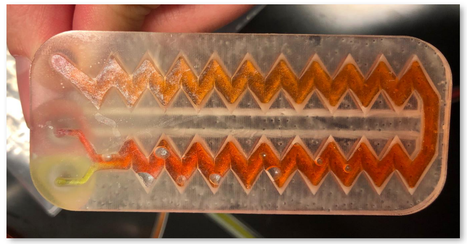
With a transistor and oscillator to control the LED power output

Prototype - Verification

Riboflavin Mixing Geometry



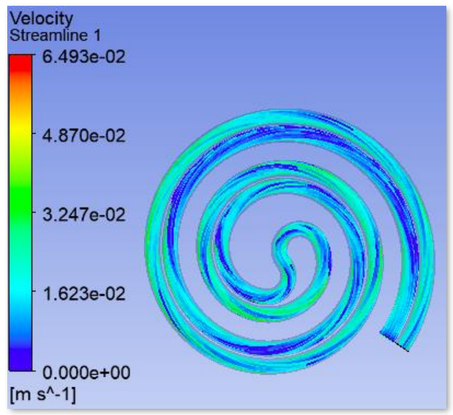
A CFD model was created to show the vortices formed due to the shape of the mixing geometry that combines the two fluid streams to form a fully mixed output[2]

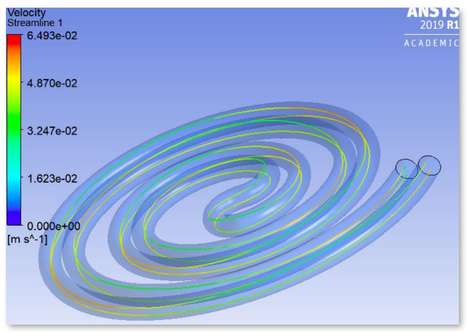


A physical test was performed to ensure the CFD model was feasible

Illumination Mixing Path

A CFD model was created to determine if the geometry would allow for uniform illumination

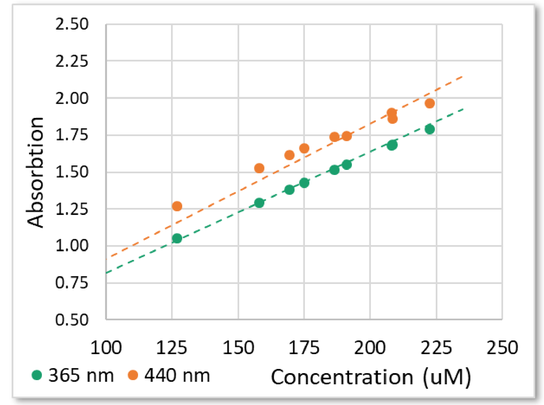




Illustrates that particulate won't stagnate, ensuring a homogeneous distribution and exposure during the illumination process[3]

Results[4]

Riboflavin Solubility in Saline with Calibration Curve



- Beer's Law: $A = \varepsilon l c$
- Workable riboflavin concentration
  - Up to ~275 µM
- 200 µM:
  - 365 nm: 172.19 ± 11.89 µM
  - 440 nm: 176.52 ± 10.25 µM
- 300 µM:
  - 365nm: 207.45 ± 12.96 µM
  - 440 nm: 203.30 ± 10.66 µM

Conclusions and Future Work

- Additional proof-of-concept testing:
  - Spectrophotometry analysis of mixing
  - Riboflavin illumination spectrophotometry analysis
- Based on current proof-of-concept testing and future testing, this design will move forward to testing with live cells

References

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3. Mandal, M. M., Aggarwal, P., & Nigam, K. D. P. (2011). Liquid–liquid mixing in coiled flow inverter. *Industrial & engineering chemistry research*, *50*(23), 13230-13235.
4. Bartzatt, R., & Follis, M. L. (2014). Detection and Assay of Riboflavin (Vitamin B2) Utilizing UV/VIS Spectrophotometer and Citric Acid Buffer. *Journal of Scientific Research & Reports*, *3*(6), 799-809.