

Engineered Biosensors in an Encapsulated And Deployable System (eBEADS) for detection of environmental health hazards

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Background

- Long term exposure to low levels of the fungicide, 2-phenylphenol, elicit negative long-term effects on aquatic and human health.
- Existing sensors lack the ability to passively detect trace levels in the environment in real time with high specificity and sensitivity.
- Whole cell biosensors provide a method of passive, real time detection, but require robust biocontainment for field portability.

Objective

Engineered Biosensors in an Encapsulated And Deployable System (eBEADS) was created to demonstrate a portable, passive biosensor for real-time detection of 2-phenylphenol in the environment.

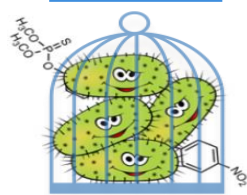
Material Design Criteria

Survivability



Hydrogel supports whole cell sensor viability by allowing gas and nutrient permeability.

Containment



Hydrogel prevents cell leakage into the environment by providing a durable encapsulation

Survivability

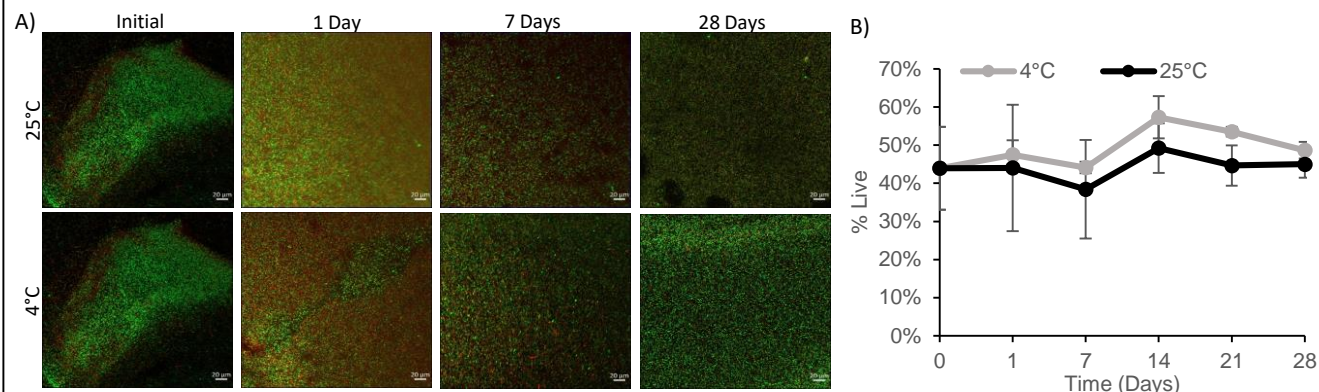


Figure 1: A) The compressed Z stack images of live/dead stained biosensor beads qualitatively illustrate how the viability of biosensor cells is maintained over a month stored at 4°C and 25°C. Scale bars are 20 μm. B) Quantitative image analysis of confocal images confirms steady viability of biosensor cells in microbeads stored at 4°C and 25°C after a month. Error bars are standard deviation between three biological replicates.

Containment

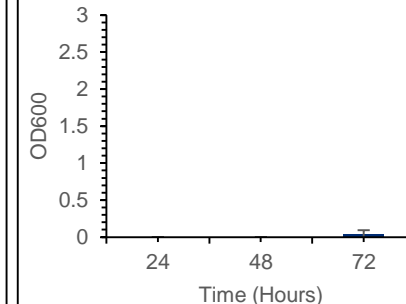


Figure 2: The optical density at 600 nm (OD600) of surrounding media of the immersed polyacrylamide alginate beads containing cells over 72 hours illustrates minimal leakage of cells into growth media. Error bars are the standard deviation of a biological triplicate.

Demonstration of eBEADS

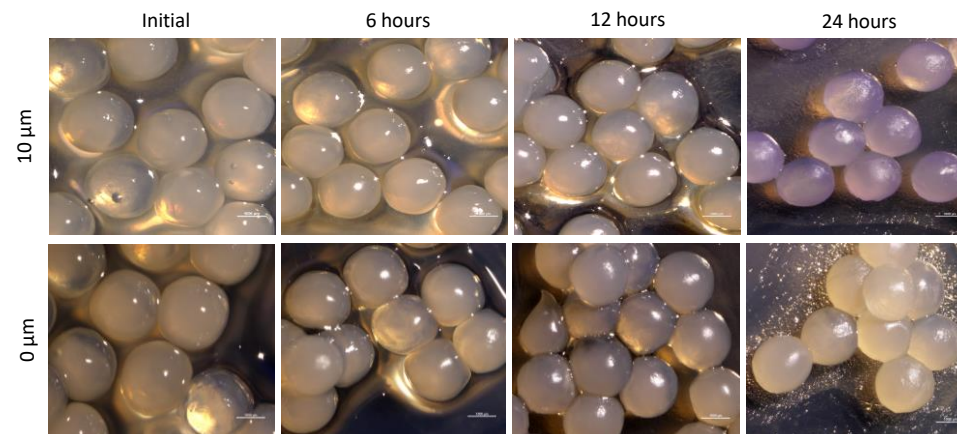


Figure 3: The images show the 2-phenylphenol with amplification circuit biosensor cells encapsulated in the polyacrylamide-alginate microbeads over 24 hours exposed to 10 μM (top panel) and 0 μM (bottom panel) 2-phenylphenol. After 24 hours of exposure, the encapsulated 2-phenylphenol biosensor beads demonstrate a visual color change in response to the analyte's presence.

Conclusions

- The polyacrylamide-alginate hydrogel microbeads provide a matrix to support long term cell viability while preventing leakage.
- The eBEADS can detect 10 μM 2-phenylphenol and produce a visual response within 24 hours.

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