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Materials Science & Engineering

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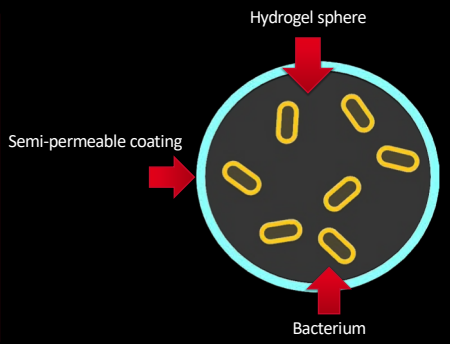
Nanowires for size selective semi-permeable membranes

Background

- Immobilizing cells offers the following advantages
  - Prevents loss of biocatalyst
  - Higher cell densities
  - Prevent contamination of surrounding system
  - Continuous and heightened metabolic activity
  - Protection from the environment
- State of the art
  - Temperature gelation – agar, chitosan, collagen, gelatin, etc.
  - Ionotropic gelation – alginate
  - Synthetic polymers – epoxy resins, polyacrylamides, etc.
  - Precipitation from solvent – cellulose triacetate, polystyrene
- Gaps to be filled
  - Complex, costly, and/or toxic procedures
  - Diffusion barrier
  - Leakage of cells/degradation of carrier

Nanowires can be used to form a membrane with variable pore size, which can then be used to contain microbes inside hydrogel spheres



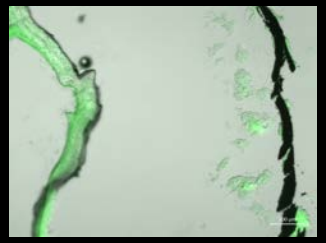
Discussion

This system is designed to be compatible with out lab's transparent soil system. Our intent is to use these beads containing microbes to construct an artificial rhizosphere for research on how microbes affect root structure. The bead system will allow us to place specific colonies in 3D space with the confidence that they will not move. We can only encapsulate a single species or strain in each bead, to ensure that they maintain their composition over time. Modeling shows multiple species in one bead will change composition over time until one species dominates completely.

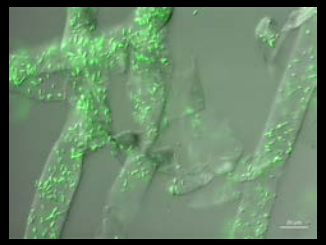
Methods

- Alginate spheres
  - Pros
    - Cheap, easy, common for cell encapsulation
    - Previous work on hydrogel based transparent soil
  - Cons
    - Low mechanical strength
    - Leakage of cells
    - Poor diffusion
- Nanowires
  - Pros
    - Many material options
    - Control of size and shape
    - Contribute to mechanical strength
  - Cons
    - Many require harmful solvents
    - Processing can be difficult for biologists

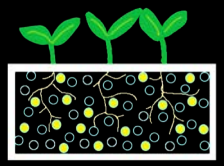
We are still fine tuning the process and hope to file a patent and publish the method once done



GFP *E. coli* suspended in alginate gel with nanowires
20 micron cryotome slice at 10X



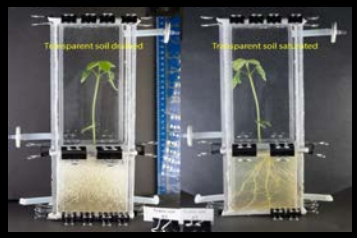
GFP *E. coli* suspended in alginate gel
20 micron cryotome slice at 40X



Model showing encapsulated beads scattered in transparent soil system

Applications

- Food
  - Fermentation
- Waste
  - Wastewater processing
  - Air filtration
- Ecology
  - Bioremediation
  - Rhizosphere
- Biotechnology
  - Enzyme and drug production
- Microbiome Research
  - Plant - bacteria interaction
  - Bacteria – bacteria interaction



Example of the transparent soil system, left shows the drained state, in which plants are grown, right shows it temporarily filled with water for imaging purposes

References

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