Research Plan

Name(s)

Proposed Title:

3A. Rationale:

3B. Hypothesis(es), Research Question(s), Engineering Goal(s), and Expected Outcomes:

3C.

Procedures

- Bulleted detailed sections

Risk and Safety: Hazardous Chemicals

Materials and Chemical Name (each chemical has a separate section)

- Potential Risk
- Safety Precautions
- Disposal

Data Analysis

1) **Human Participants**
2) **Vertebrate Animals**

3D. Bibliography

Post Addendum Summary:

NO ADDENDUMS EXIST (depends on project)

Research Plan SAMPLE

Julie Doe

Bacterial Cellulose Membrane for the Use of Air Filtration Masks

3A. Rationale:

As cities quickly industrialize, there is a rapid increase in overall air pollution in larger industrious urban areas, such as Beijing or Shanghai. This increase in air pollution poses as a threat to the well being of the local population which lives in these cities Particulate matter (PM) or smog that is produced as a result of the increase in air pollution can damage the respiratory system, possibly causing emphysema, asthma, bronchitis, or even lung cancer. As a result, it is important to provide some sort of means to protect against this threat to our urban population. Most masks that are used to combat the air pollution are composed of cotton or paper material, and aren't very effective at filtering out the PM and smog from the city air. As a result, it is imperative to create an affordable, easy to make membrane to properly filter air for an air mask.

3B. Hypothesis(es), Research Question(s), Engineering Goal(s), and Expected Outcomes:

Research Question: Can bacterial cellulose-based nanofibers be used to create a three dimensional membrane for the use of air filtration?

Expected Outcomes and Hypothesis(es): Expected Bacterial cellulose (BC) nanofibers are a certain kind of cellulose nanofibers (CNF) that are produced by bacteria of the *Acetobacter* genus. The nanofibers tend to be two orders of magnitude thinner than CNF extracted from wood pulp, and can be produced in layers. As a result, the BC membranes produced from the bacteria

are more three-dimensional, much more porous, and will have smaller pores than CNF extracted from wood pulp. The BC nanofibers, however, must be crosslinked together with crosslinkers such as glutaraldehyde in order to make sure the nanofibers themselves do not form in such a way so that no pores form. Because of the smaller pore size, the BC membrane should be able to reject smaller particulates from the air than there are in water (appr. <2.5 μm in diameter). Additionally, the higher porosity will result in a membrane more suitable for human use, as it will porous enough to allow normal breathing to occur.

3C. Procedures, Risk and Safety, Data Analysis, and Discussion of Results and Conclusions

The experiment(s) will be performed at Stony Brook University under the supervision of Professor Benjamin Chu, Professor Benjamin Hsiao, and Dr. Hongyang Ma.

(i) Procedures:

The experiment(s) will be performed at Stony Brook University under the supervision of Professor Benjamin Chu, Professor Benjamin Hsiao, and Dr. Hongyang Ma.

Preparation & Cleaning of Bacterial Cellulose

- Bacterial Cellulose will be stored in water.
- The water will be replaced three times daily to properly clean the bacterial cellulose.
- After 3 days in the water, the bacterial cellulose will be prepared for drying/testing.

Crosslinking Gluturaldehyde (GA) to the Bacterial Cellulose

- 0.01M Hydrochloric acid will be added to 500 mL of water until the solution is thoroughly mixed and reads a pH of 1.
- 100 mL of GA will be added to the acidic solution (pH = 5.5). A magnetic bar stirrer will be used to thoroughly mix the solution for about 30 minutes.

- A piece of bacterial cellulose (appr. 100 cm^2 in area) will be placed in the solution and left to crosslink for about 12 hours.

Freeze Drying Bacterial Cellulose

- Bacterial Cellulose (appr. 100 cm^2 in area) will be placed onto a sheet of polyethylene terephthalate (PET).
- The PET-BC sheets will be frozen in 1 liter of liquid nitrogen for about half of an hour.
- The frozen PET-BC sheets are placed in a bottle and connected to a freeze-drying machine.

Scanning Electron Microscope Imaging and Analysis of Bacterial Cellulose and PM Filters

- Dried Crosslinked BC and plain BC will be imaged using the SEM.

Total Organic Carbon Analysis

- Carbon-based particles of varying sizes are suspended in a water solution.
- The homogenous water mixture will be passed through a bacterial cellulose membrane using a pressurized tank, and the permeate will be collected.

Risk and Safety:

- A senior supervising scientist before experimentation will assess certain risks, such as ingestion, inhalation, or any other dangerous contact with hazardous chemicals associated with experiments performed.
- Some chemicals (1M glutaraldehyde, 0.01M epichlorohydrin, 0.01M hydrochloric acid) used are corrosive and are not considered DEA controlled substances.
- During the course of experimentation, gloves, goggles, and a lab coat will be worn.

- A fume hood will be used when working with chemicals that emit dangerous fumes, such as 0.01M hydrochloric acid, 1M glutaraldehyde, 0.01M epichlorohydrin, ethanol, or acetone.
- Chemicals and sharp tips will be disposed of in proper waste containers and will be removed by the Environmental Safety and Health Group at Stony Brook University.
- Materials Safety Data Sheets (MSDS) for all chemicals being used during experimentation will be read and reviewed before experimentation.

Data Analysis

SEM Imaging

- SEM images will provide information on the pore size, and overall effectiveness of the crosslinking process.

Fourier Transform Infrared Spectroscopy

- A Fourier Transform Infrared (FT-IR) Spectroscopy Analysis will be used on dry BC to determine at which wavenumbers infrared rays transmit through the bacterial cellulose.
- Based off of the wavenumbers, one can determine chemical properties of the tested material.
- The FT-IR Analyses of the plain bacterial cellulose and crosslinked bacterial cellulose will be compared to see if the crosslinking worked.

Total Organic Carbon Analysis

- A Total Organic Carbon Analysis will measure the total carbon concentration in the permeate and in the original mixture. Based off of the concentrations and the particle diameter, a rough estimate for pore size can be determined.

D. Bibliography

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