

# Hong Kong Student Science Project Competition 2023

Template of Extended Abstract (Invention)

(Word Limit: 1,600 words, Pages: 3 pages only)

**Team Number:**

**Project Title: HAHAHA Biodegradable Waterproof Coating**

**Project Type: Invention**

*To our best knowledge, there are / are no \* similar works in the market*

## I. Background

Due to its long decomposition time—20 to 500 years—and high demand, plastic pollution is acknowledged as a serious anthropogenic problem in coastal and marine ecosystems around the world (Thushari & Senevirathna, 2020).

However, conventional waterproofing sprays include potentially harmful hydrocarbons, posing a serious risk to both humans and their animal friends. The majority of these sprays' principal ingredient is plastic. Chitin is the most abundant aminopolysaccharide polymer and the second most abundant polysaccharide occurring in nature. Globally, between 6 and 8 million tonnes of discarded chitin-containing crab, shrimp, and lobster shells are produced annually as a byproduct in the food-processing industry (Yan & Chen, 2015).

Chitosan, a linear polysaccharide derivative of chitin, has been described as a nontoxic biodegradable polymer. As a biodegradable bioplastic, it might be utilized. Due to its availability, it has thus been the preferred choice for our primary supply of coating.

## II. Objectives

We would like to make a biodegradable waterproof coating using chitosan.

## III. Methodology

### Extraction of chitin

1. Dry the shrimp shells using oven
2. Heat the shrimp shells with 2 wt% NaOH at 60°C for deproteinization for 2 hours
3. Rinse with water until neutrality
4. Dry it in oven
5. Mix the deproteinized shell with 7 wt% HCl for 4 hours at room temperature for breaking down calcium carbonate in the shell
6. Rinse with water until neutrality
7. Dry it in oven

### Conversion of chitin to chitosan

1. Heat chitin with 50 wt% NaOH for 2 hours at 120°C
2. Rinse with water until neutrality
3. Dry it in oven
4. Grind the resulted substance into powder

### **Dissolving chitosan**

We would try to dissolve chitosan in the below solvent to obtain its solution form for coating:

- Acetone
- Alcohol
- 1% acetic acid

### **Testing**

- Waterproof:

Add 5 drops of water to observe if water repulsion applies

- Biodegradable:

Place 1cm x 1cm x 5mm sample inside the soil and wait for 3 days

## **IV. Design of Invention**

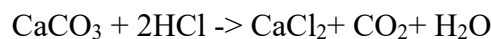
### **Deproteinization**

NaOH, as an alkali, can deproteinize the protein layer and mineral-protein matrix layers.

### **Breaking down of calcium carbonate**

HCl, as an acid, can break down the calcium carbonate to form calcium chloride, carbon dioxide and water.

When calcium carbonate precipitate exists in water, that solution becomes weak basic due to the presence of carbonate ions. When aqueous HCl is added, carbonate is converted to carbon dioxide and alkalinity of the solution decreases.



### **Chitin**

Chitin is a modified polysaccharide that contains nitrogen. In beetles, chitin is a tough, flexible component of a complex matrix of materials that create a passive physical surface barrier to water, which means it is hydrophobic.

Chitin is closely related structurally to the active ingredient chitosan (poly-D-glucosamine), which shows no toxicity to mammals (IGENE Biotechnology Inc., 2001).

### **Chitosan**

Through enzymatic or chemical deacetylation, chitin can be converted to its derivative, chitosan. In acidic conditions, chitosan can be dissolved due to the protonation of free amino groups, while chitin is insoluble. If the acetyl group is absent from N-acetylglucosamine, the resulting polymer of glucosamine is known as chitosan.

### **Coating**

In order to transform Chitosan into a coating, we dissolve Chitosan into an aqueous form.

Chitosan is a natural biopolymer that must be dissolved in an aqueous acetic acid solution to activate its antimicrobial and eliciting properties (Jiménez-Gómez & Cecilia, 2020). Owing to the increased number of free primary amine groups and a lower molecular weight than chitin, chitosan is more soluble in slightly acidic solutions such as acetic acid (Hahn et al., 2020).

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## V. Application / Market Need

### Application/ market need

There are numerous uses for this coating. The coating can be applied to wood, the surgical mask's top layer, the inside of a paper cup, etc. Our HAHABA biodegradable waterproof coating, which is comparatively more environmentally friendly and nontoxic than the conventional waterproof coating, aids in achieving the objectives of sustainable development. Also, given its low cost, it is believed that enterprises may use this coating in their manufacturing process.

Our HAHABA biodegradable waterproof coating, which is comparatively more environmentally friendly and nontoxic than the conventional waterproof coating, aids in achieving the objectives of sustainable development. Nowadays, most countries propose the idea of environmentally-friendly due to the seriousness of global warming. Our HAHABA Biodegradable Waterproof Coating is environmentally-friendly, sticking to this trend.

Also, chitin is the second most common polysaccharide found in nature and the most common aminopolysaccharide polymer, hence it is a cheap substance. Moreover, only inexpensive and widely available acids and alkalis are used to extract chitosan. The waterproof coating is inexpensive all around. It is believed that enterprises may choose to use this coating in their manufacturing process.

### Limitation

Percentage of extraction is low. Only 3.27% can be extracted as chitosan from the shrimp shell.

## VI. If your team will compete for the Sustainable Development Award, please indicate the specific sustainable development goal the project is related to, and provide justification for competing for this award. (Word limit: 300 words)

Our HAHABA Biodegradable Waterproof Coating, with its nontoxic and biodegradability, can achieve the goals of sustainable development – Life Below Water and Ensure Sustainable Consumption and Production Patterns.

## VII. If your team will compete the Social Innovation Award, please list the target group or social issue the project focuses on, and provide justification for competing for this award. (Word limit: 300 words)

Plastic pollution is a serious problem in this modern society. Our HAHABA Biodegradable Waterproof Coating is made by chitosan, which is a biodegradable plastic. This can reduce the plastic waste caused by traditional waterproof coating.

## VIII. Conclusion

Our HAHABA Biodegradable Waterproof Coating is believed to reduce the amount of waste and pollution in the earth. Due to its nontoxic and eco-friendly biodegradability, less hazardous and toxic waterproof coating will be used, achieving the goal of sustainable development — Life Below Water and Ensure Sustainable Consumption and Production Patterns.