Hong Kong Student Science Project Competition 2023

Template of Extended Abstract (Invention)
(Word Limit: 1,600 words, Pages: 3 pages only)

Team Number: JABC274

Project Title: VUCA: nano-Vanadium pentoxide's Usage for Conventional Application

Project Type: Invention

To our best knowledge, there are / are no * ***similar works in the market*****; (if there are,) related product links are as below:**

N/A

I. Background

- Provide background information as to learn about the audience for whom the project is addressing
- Provide highlights of **literature review** and/or related technologies or devices, with the support of pertinent and reliable references
- Provide an overview of work, create a point of view as to define the needs and insights of the audience and mention the **research or technology gap the project is trying to fill**

When seafood goes bad, we may find that they produce a fishy odor. We also often feel sick if we eat those kinds of seafood? All these problems are due to two chemicals, trimethylamine (TMA) and trimethylamine N-oxide (TMAO). In the TMA-lyase of marine animals, bacteria cause choline to oxidize and make TMA, which is one of the volatile amines that are formed by chemical changes when the seafood is being stored in cold environments. Furthermore, TMAO is essential to protect those marine animals from pressure and cold. It is produced enzymatically from the oxidation of TMA by gut microbiota. Both TMA and TMAO may lead to negative health impacts on humans such as nausea, headaches, and irritation. TMAO might even increase the risk of cardiovascular diseases when one eat such unfresh seafood. Moreover, since TMA and TMAO are both colorless, consumers might not be able to identify fresh and unfresh seafood easily. Despite some common ways to identify a fish's freshness such as checking the texture of its skin and shininess of its eyes, they require a lot of experience of the consumer himself. Furthermore, they are somewhat not accurate. Nowadays, many methods that detect the quality of seafood use TMA as a marker. For instance, Yet, time-consuming, arduous TMA extraction steps and troublesome handling of low-molecular-mass amines since they have high water solubility and volatility are disadvantages for many traditional analytical techniques. It is for this reason why we need to design a user-friendly and affordable sensor that uses V_2O_5 to sense TMA emitted by unfresh seafood.

II. Objectives

1. To invent a durable and reusable detector that helps users choose the freshest fish at markets.
2. To prevent consumers being deceived when buying fish.

III. Methodology

- Briefly describe the **approaches** used e.g. use of equipment, materials, tests and experiments
- Explain the selected implementation strategies with the **scientific theory**

1. Equipment and materials used for a single synthesis

Equipment/Materials	Quantity/Specification
Ammonium Metavanadate (s)	0.285 g

Oxalic Acid (s)	0.9077 g
Hydrazine	3 mL
Deionized water	25 mL
Hotplate stirrer	1
Autoclave	1
Oven	1
Glassware	Amount may vary
Ethanol 95% & 99.5%	Amount may vary
Sonicator	1
Centrifuge	1 (max. 4500 rpm)
Glass slide	10
Trimethylamine	Amount may vary
Nickel electrodes	1 pair

Firstly, we would make a solution by adding ammonium metavanadate, oxalic acid, hydrazine and deionized water and stir it with the stirrer. After the redox reaction of the vanadium has taken place, we would perform hydrothermal synthesis by putting the solution in an autoclave then into the oven. Later, we would wash the dark precursors with deionized water and ethanol and evaporate the moisture to dry the dark precursors. Finally we would perform annealing to form V_2O_5 by heating the dark precursors gradually to 400 degree Celsius. After further processes, it can be mixed with absolute ethanol and placed on a glass slide. A closed circuit is also assembled together to test for TMA.

IV. Design of Invention

- Describe the **design** and the **principle** of invention (e.g. The ideation of the projects, the prototypes or creative solution as far as applicable)
- Provide sketches / drawings / photos of the invention

Prototypes:

Our prototypes of the detector could well be a handheld detector which allows users to carry it anywhere conveniently. Arduino will be installed inside the detector to assist users by processing and transforming recorded data to easy-to-read results. We could also try to include a database of different kinds of fish for better result-processing. We will improve the data processing later to make it more user-friendly.

V. Application / Market Need

- Explain the area of **application** and function of invention
- Indicate the market need and impact of invention
- Discuss **limitation** and compare with existing related works (if any)

Area of application and Market Need:

Our gas sensor can be used for assisting users to buy fresh fish by detecting the amount of trimethylamine emitted by it. As there are currently no trimethylamine gas sensors on the market, the

product competitiveness of our gas sensor would be strong if it is released to the market. There would be a large market for inexperienced shoppers or people in need.

VI. If your team will compete 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 project is related to the sustainable development goal 'Good Health and Well-being'.The main goal of our project is to help inexperienced seafood consumer to select fresh seafood using the user-friendly sensor we've designed so as not to buy unfresh seafood that causes different health problems to the consumer, such as headaches, diarrhea and nausea, or even increases the risk of getting cardiovascular disease. Our invention can show if the seafood is fresh or not in an easy way for the users to understand. Therefore, our invention can prevent the consumer from all those negative effects towards our health by eating spoiled seafood while being inexperienced with the signs that show if the seafood is fresh or not. This will greatly improve the health of the people by reducing the risk of buying and eating seafood that have gone bad. Also, the side-product, carbon dioxide, produced during the detection of trimethylamine is nearly harmless to the environment but it can be transformed into oxygen through photosynthesis.

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)***

Our project targets a large variety of target groups including elderly, the disabled and inexperienced shoppers. There are many people who are inexperienced in buying fresh fish at the markets, or people with physical disabilities such as eye defects, and they could not recognize whether the fish are fresh and therefore they are usually deceived by shopkeepers. Our invention could well be a solution for this issue as it detects the amount of trimethylamine given out by the fish to determine the freshness of the fish. We would improve our gas sensor in order to provide a more precise result for the users. Also, our invention will be made user-friendly so that even people who are not familiar with its detection mechanism can still be able to clearly read and understand the results.

VIII. Conclusion

- Make a **<u>data-driven</u>** conclusion of the project and the way forward of the invention process
- Justify if the proposed project meets the objective(s)

Our project has come to a success. From a graph that we have plotted for Current(mA) measured from our sensor against Concentration of TMA in air, we can find a calibration curve and that the currency measured in the sensor has a direct relationship with the concentration TMA is nearby surrounding air. Therefore, our invention is an innovative and promising device as the currency of our invention reacts properly with the concentration of TMA, hence we can easily sense the amount of TMA emitted by seafood and identify the freshness of them.

Currently, we are trying to improve the design of our invention by increasing the reaction time of the sensor with the TMA in air more quickly, reducing the overall size of the gas sensor and using 3D printing technology to create the out-shell protecting the sensor so as to make the overall sensor more compact and lighter. thus enhancing the ease to handle and carry the gas sensor.

Our proposed project has certainly met the objectives, as our invention can detect the concentration of TMA in air effectively. Besides, our sensor can be reused after 28 seconds from the previous detection. Therefore, our sensor can easily test the freshness of a few seafood in a relatively short period of time while being able to last long from wearing.

× Our project is developed based on previous project and the enhancement is below: