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Application Group

便攜式魚肉生鮮度檢測器
A Portable Fish Freshness Testing System

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作品摘要

臺灣是個海島國家，生鮮海產早已是我們飲食文化的一部分。隨著時代的進步，食品安全日益受到重視。而食用魚肉造成的組織胺中毒，便是常見的食品安全問題之一。發生組織胺中毒的原因，往往是來自魚肉不當的保存。特別是置於 15～20℃的環境中，更容易導致魚表面或腸內細菌繁殖。魚肉腐敗時產生的腥臭味，就來自細菌作用所產生的揮發性鹽基態氮（volatile basic nitrogen, VBN）。這其中的主要成分包含了三甲氨、二甲氨及氨氣等，目前已作為判斷魚肉新鮮度的重要指標。

臺灣農委會針對魚肉 VBN 值的標準檢測方法，需利用鹼反滴定的方式得知揮發性鹽基態氮的總量多寡，藉此判斷魚肉的新鮮程度。然而，此化驗方式相當耗時。我們團隊欲研發一便攜式魚肉生鮮度檢測器，用以檢驗魚肉是否新鮮。相較之下，氣體感測器在操作上更便利，且為即時反應、即時得知氣體濃度。我們利用感測時，半導體元件電流下降的幅度，即可立即判斷魚肉新鮮度。所開發之氣體感測器因具備了無數奈米孔洞結構，大幅提升了靈敏度，可感測之氣體濃度範圍約在 50ppb 至 10ppm 之間。此外，氣體感測器在量測 VBN 小於 20mg/100g（於標準檢測方法中判定為新鮮）的各個樣品時，亦能觀測出些微的差異。顯示出我們的感測器相較於傳統檢測方法更加靈敏。

同時，我們亦考量在實際應用上，若是一個可攜式的檢測系統，方便攜帶至各種場所，便能擴展應用的範圍。舉凡一般顧客在選購生鮮魚貨時攜帶使用，大至魚貨供應商批貨檢測，都能適用。因此，為了改變現有之感測技術多數需要大量儀器或空間的問題，我們致力於發展微型化的感測系統。我們選用 Arduino 電路板進行電流訊號的量測，不僅可以縮小系統體積，亦可達到節省成本的目的。於現階段已將體積控制在長 30 公分、寬 22 公分、高 13cm 可輕易攜帶大小。而於系統操作上，不僅使裝置上能夠更簡便、快速的置換耗材，亦力求按鈕簡單明瞭，使用者因此可輕鬆上手。根據目前實測的結果，感測系統可於短時間內明確區分出新鮮魚肉與腐敗魚肉，並將量測結果上傳至網路或手機。綜上所述，我們以有機半導體感測器為基礎，開發一套可攜式的檢測系統，判斷魚肉新鮮度，並輔以人性化設計，與網路手機結合。我們相信如此可以更有效的掌控食品安全，減少組織胺中毒的發生率，使民眾能夠放心的食用新鮮魚肉。

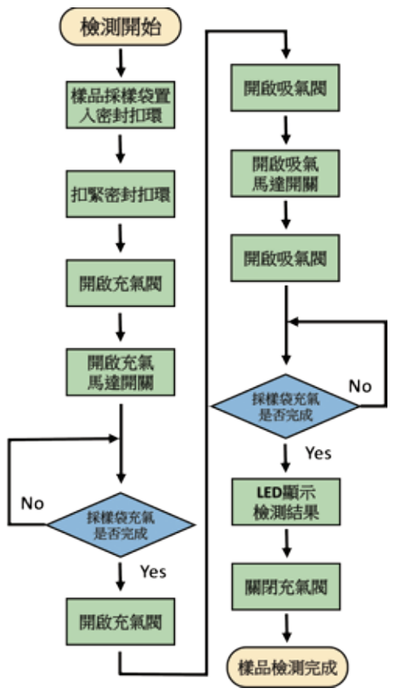

圖 1. 魚肉新鮮度感測流程

Abstract

In Taiwan, an island state surrounded by sea, we heavily rely on fishery and fish has been a popular food in our daily life. When we pay more and more attentions on food safety, the freshness of fish is a fundamental issue in food industry. In addition to bad smell, the spoiled fish causes a wide variety of health problems. Conventionally the freshness of fish is evaluated by the concentration of the total volatile base amine (TVB-N). Volatile basic nitrogen (VBN) mainly includes three kinds of gas molecules, ammonia (NH3), dimethylamine (DMA), and trimethylamine (TMA), which are produced by the spoilage bacteria after the fish dies. Whereas the TVB-N value has been an international standard for fish freshness, its experimental determination is rather time consuming. The conventional titration method for VBN measurement usually takes about 4 hours.

In this work, a portable real-time fish freshness testing system has been developed. We show that the fish freshness can be rapidly detected by an organic semiconductor gas sensor by measuring the concentration of the volatile base amines release naturally into the air. This is in sharp contrast to the conventional titration method which measures the aqueous base amines. First of all, it is superior in applications as the data take-time is shortened to only a few minutes. Second, the solid state gas sensor exhibit a higher sensitivity toward VBN. Besides, the real-time sensing measurement and a portable system make it possible to operate on-site and show the result directly, which far extend the utility. Last but not least, an organic gas sensor could be fabricated by solution processes and result in a mass production, which makes it a low-cost and promising device.

The gas sensor is an organic semiconductor diode with a porous top metal electrode. The current flows vertically to the semiconductor thin film, in contrast to the common structure with horizontal current flow. The gas molecules could pass through the porous top electrode and interact with the underneath sensing layer. Thus, a decrease of current could be observed. These nano-structure greatly increase the surface to volume ratio thus lead to a remarkably high sensitivity. The vertical gas sensor was reported to have a sensitivity of about 100-ppb for ammonia in air. We also design a portable system utilizing an Arduino interface. The electric signal is analyzed based on the voltage divider rule. Depending on the various resistance of the sensor, the system can automatically adjust a reference resistor and hence to provide a suitable voltage on the sensor. This is crucial to obtain an accurate sensing result. Besides, we also put efforts on dealing with noise signal by both programing and electric circuit. On the other hand, the LCD display shows all the information such as the current, the sensing time etc. After 60 seconds of sensing, the system will judge the fish freshness and rank it in different colors of light (LEDs). Meanwhile, the result is also up loaded so user could access it by their own cellphone. The functions mentioned above make the sensing system user-friendly. By using this fish freshness testing system, we successfully differentiate fishes with various kinds of storing conditions. Imagine that, in the future the sensing system is set in the harbors, fish industries, and the fish markets. It is wonderful that everyone could get a clear information of fish freshness, buy a guaranteed fresh fish and avoid the food poisoning.

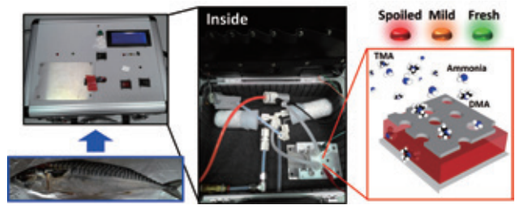

Fig 2. The portable fish freshness testing system and an illustration of the sensing device