附件四、技術說明表

支狀矽/氮化鎵異質結構奈米線之氨氣感測元件

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市場及需求:

現今環境中空氣汙染已經強烈的危害到人們的健康，據市場研究公司 Yole Développement 預測，2021 年全球氣體感測器市場規模將達到 9.2 億美元，未來 5 年的複合年增長率為 7.3%，其中環境監測在所有應用領域中位列第三。而氨氣是一種無色且有毒、具有刺鼻氣味的氣體，其廣泛存在於目前人們的生活之中，因此其監測的元件也具有非常大的商機。氨氣在冷凍冷凝倉儲業是一種有效的製冷劑，因此在此行業中需要長時間監測環境氨氣的濃度且確保其在一個安全工作的範圍值中。還有畜牧養殖業也常因為氨氣濃度而面臨養殖效能的困境，其中美國更是因為高濃度的氨氣造成肉雞產業損失 20~40%，顯著的經濟損失更是超過每年 50 億美元。而現今社會也邁向高齡化的社會結構，因此在醫療體系中長照的需求也是不斷提升，而有臨床研究指出可以透過監測呼吸中氨氣的占比進一步評估其洗腎的成效。更不用說在各種實驗場所中，氨氣感測器的需求更是廣泛。

技術摘要(含成果):

我們利用結合矽以及氮化鎵兩種材料，以兩步驟的方式製成異質結構的奈米線，並利用簡易的方式在樣品上鍍上電極製成電阻式元件。此元件在室溫之下即可以得到很好的氨氣感測效率，室溫下之最低感測極限為 0.1 ppm，同時對於氨氣也有非常好的選擇性，其元件也具有重複性以及不錯的耐久度。且與現今的技術相比，金屬氧化物的材料需要較高的工作溫度，而普遍運用於氨氣感測的矽奈米線則均需要一定的參雜才能達到較低的感測濃度，若需到達 ppb 等級則需要額外對奈米線作處理，例如鍍上金或銀的金屬顆粒或是將奈米線表面變得粗糙或多孔，亦或是將其製成電晶體元件，而上述這些製成步驟均複雜繁瑣。而利用此結構的元件則是製成步驟非常簡單，且在室溫下即可已得到 ppb 等級之感測極限。

優勢:

我們提出的元件可以在室溫下及監測到 ppb 等級之氨氣，而目前普遍市售的氨氣感測器均無法到達此靈敏度，而與更靈敏的感測器相比，我們的元件製程成本也較低廉。再加上我們的元件不容易受到背景氣體的干擾，也具有能夠重複使用的能力，同時我們元件體積小但具有非常大的感測面積，也能夠滿足現今元件微縮的需求。因此以目前市場提供的氨氣感測器以及其各產業的需求來看，我們的元件具有非常大的優勢以及商機。

競爭產品:

所有使用矽/氮化鎵異質結構並應用在氨氣感測的產品和製程方式

專利現況:

本研究團隊具有數年研究經驗

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Si/GaN branched heterostructure nanowires for ammonia

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Market Needs:

The current air pollution poses a significant threat to human health in contemporary society. Based on the findings of a market research, the gas sensor market is projected to attain 920 million dollar by the year 2021. This market is anticipated to exhibit an annual growth rate of 7.3% in the next five years. Ammonia is a colorless and toxic gas with a strong odor that is used as a highly efficient refrigerant in the frozen storage industry. The high concentration of ammonia is one obvious factor contributing to financial losses in the broiler industry in the United States. A loss of 20% to 40% due to this problem has an economic impact of more than 5 billion dollar. As a result, it is essential for the safety of the livestock industry and medical system to monitor the ammonia concentration using ammonia sensors.

Our Technology:

We use a combination of Si and GaN to fabricate a heterostructure nanowire in a two-step method and use a simple method to plate electrodes on the sample to make a resistive device. This device can get great ammonia sensing efficiency at room temperature, the lowest sensing limit at room temperature is 0.1 ppm. At the same time, it also has great selectivity for ammonia and has great repeatability and durability. Compared to recent studies, metal oxide materials require a higher operating temperature, while silicon nanowires commonly used in ammonia sensing require a certain amount of doping to achieve a lower sensing concentration. To reach the ppb level, additional processing of the nanowire is required, such as metal particles plated with gold or silver, or the surface of the nanowire is made rough or porous, or it is made into a transistor device, these preparation steps are complicated and cumbersome. The device using this structure has very simple manufacturing steps, and the sensing limit of the ppb level can be obtained at room temperature.

Strength:

The device we propose can monitor ammonia at the ppb level at room temperature, where currently, ammonia sensors cannot achieve this level of sensitivity. Compared with most of the ammonia sensors, the manufacturing cost of our device is also low. In addition, our device is not easily disturbed by background gas and can be reused. Therefore, judging from the current market of ammonia sensors and the needs of commercial use in the industry, our device has significant advantages, such as being small in size and having a large sensing area, which can also meet the needs of the miniaturization of nowadays devices.

Competing Products:

All products and process methods using Si/GaN heterostructure and applied in ammonia sensing.

Intellectual Properties:

The research team has several years of research experience

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