手機操控可攜式氮氧化物氣體感測器

AQI氣體感測器服務平台

計畫主持人

林鶴南教授

執行單位

國立清華大學 / 材料科學工程學系

計畫簡述

我們以黃光微影及低溫化學製程，製作具有高靈敏度之奈米複合材料氮氧化物氣體感測晶片，並建構一台可攜式氣體感測器。經由無線通訊模組連接手機，並利用應用程式記錄感測晶片電阻變化，便可得知周圍環境的NO_2氣體濃度。偵測濃度範圍為5 ~ 1000 ppb，解析度為5 ppb，可應用於環境空氣品質監測、空氣汙染偵測、工廠製程監控等等。

計劃亮點

1. 靈敏度高，可測得5 ppb NO_2氣體。
2. 具通訊模組，可用手機操控，可與物聯網連接。
3. 體積小，適合大量佈建。

展品規格

1. NO_2感測濃度範圍5 ~ 1000 ppb
2. 感測誤差 ±25% at < 100 ppb and ±15% at > 100 ppb
3. 工作電壓5 V

產業應用

1. 應用於環境空氣品質監測、空氣汙染偵測、工廠製程監控等等。
2. 可技轉氣體感測晶片製程技術、可攜式氣體感測器全機。

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MOST 科技部
Ministry of Science and Technology
科技部智慧機械創新館

Smart Phone Operated Portable Nitrogen Oxides Gas Sensor

Air Quality Index (AQI) Gas Sensor Service Platform

Principal Investigator

Prof. Heh-Nan Lin

Institution

National Tsing Hua University /
Department of Materials Science and Engineering

Introduction

We use low cost photolithography and low temperature chemical processes to fabricate highly sensitive nanocomposite material chips for nitrogen oxides gas sensing and also construct a portable gas sensor. The sensor is operated by a smart phone via a wireless module. The resistance change of the sensing chip due to NO_2 gas is recorded in an APP program and the gas concentration in the surrounding environment can be obtained. The sensing range is 5 ~ 1000 ppb with a resolution of 5 ppb. The gas sensor can be used for environmental air quality monitoring, air pollution detection, manufacturing process monitoring, etc.

Highlights

1. High sensitivity with a resolution of 5 ppb NO_2 gas.
2. Equipped with a wireless module and operated by a smart phone.
3. Small volume and ease of mass-deployment.

Specification

1. NO_2 sensing range 5 ~ 1000 ppb
2. Sensing error ±25% at < 100 ppb and ±15% at > 100 ppb
3. Operating voltage 5 V

Industrial Applications

1. Environmental air quality monitoring, air pollution detection, manufacturing process monitoring, etc.
2. Technology transfer of gas sensing chip fabrication and the whole device of portable gas sensor.

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科技部智慧機械創新館

基於AQI之氣體感測器數據標準化暨大台南地區AQI大數據分析平台建構

AQI氣體感測器服務平台

計畫主持人/共同主持人

王振興教授 / 張守進教授、李俊璋教授

執行單位

國立成功大學 / 電機工程學系

計畫簡述

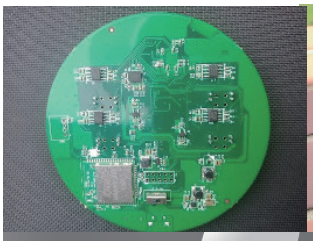
本計畫發展之室外空氣品質偵測模組將可運用自主開發之氣體感測元件，偵測空氣中臭氧（O_3）、一氧化碳（CO）、二氧化氮(NO_2)及二氧化硫（SO_2）濃度，應用服務具有四項特色：1)靈敏，透過自主研發之感測元件可精準偵測所在空間的空氣品質汙染指數；2)即時，空汙超標時APP主動推播空汙旗警告通知，學童免受空氣汙染；3)雲端，全天候監測儲存空氣品質，家長於遠端亦可隨時了解學童所處校園的空氣品質狀況；4)分析，可查詢歷史偵測資料以及透過AQI大數據分析平台，掌握空氣品質可能的變化趨勢。

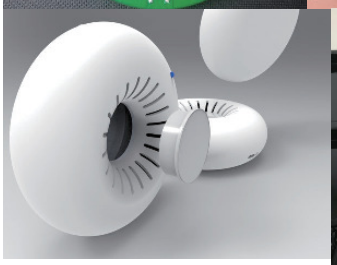
計劃亮點

1. 可測得低濃度(ppb)與反應速率快
2. 具備通訊與物聯網整合技術
3. 可大量生產及價格親民

展品規格

1. 臭氧（O_3）：可偵測0.01~10 ppm
2. 一氧化碳（CO）：可偵測0.01-100 ppm
3. 二氧化氮(NO_2)：可偵測0.1-1000 ppm
4. 二氧化硫（SO_2）：可偵測0.1-1000 ppm





產業應用

未來應用預計整合市售高準確度之PM2.5、PM10及溫/溼度偵測模組，以上述偵測到的數值，進行符合行政院環保署定義的即時空氣品質指標(AQI)計算，並依照台南市環保局及教育局制訂的空汙旗綠色(AQI 0-50)、黃色（AQI 51-100）、紅色（AQI 101-200）及紫色（AQI 201-500）分別給予各校即時且準確的空汙旗幟，提醒學生可外出活動或避免戶外活動。

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MOST 科技部
Ministry of Science and Technology
科技部智慧機械創新館

Data Standardization of AQI Based Air Quality Monitoring Sensor and Construction of AQI Big Data Analysis Platform in Great Tainan Area

Air Quality Index (AQI) Gas Sensor Service Platform

Principal Investigator / Co-PI

Prof. Jeen-Shing Wang / Prof. Shoou-Jinn Chang, Prof. Ching-Chang Lee

Institution

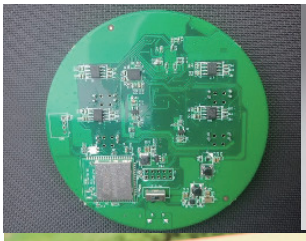
National Cheng Kung University / Department of Electrical Engineering

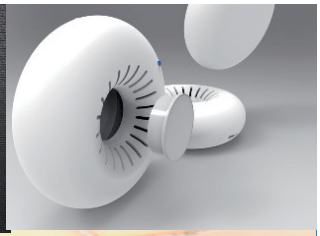
Introduction

The outdoor air quality detection module developed by the project will be able to detect the concentration of ozone (O_3), carbon monoxide (CO), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) in the air using self-developed gas sensing components. The application service has four characteristics: 1) Sensitive, through the self-developed sensing components it can accurately detect the air quality pollution index of the space; 2) Instant, when the air pollution exceeds the standard, the APP actively pushes the air pollution flag warning notice, the student can be exempted from air pollution; 3) Clouds, monitoring the air quality around the clock, parents can also know the air quality status of the school where the children are located; 4) Analysis, user can query historical data through the AQI big data analysis platform.

Highlights

1. Can measure low concentration (ppb) and fast reaction rate
2. Communication and IoT integration technology
3. Can be mass produced and the price is affordable





Specification

1. Ozone (O_3): can detect 0.01~10 ppm
2. Carbon monoxide (CO): can detect 0.01-100 ppm
3. Nitrogen dioxide (NO_2): can detect 0.1-1000 ppm
4. Sulfur dioxide (SO_2): can detect 0.1-1000 ppm

Industrial Applications

Future applications are expected to integrate commercially available high-precision PM2.5, PM10 and temperature/humidity detection modules to perform the instantaneous air quality index (AQI) calculations defined by the Environmental Protection Agency of the Executive Yuan. According to the air pollution flag, green (AQI 0-50), yellow (AQI 51-100), red (AQI 101-200) and purple (AQI 201-500) formulated by the Tainan Environmental Protection Bureau and the Education Bureau, the schools are given instant and accurate air pollution banner to remind students to go out or avoid outdoor activities by the above-mentioned detected values.

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MOST 科技部
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科技部智慧機械創新館

應用於工廠煙道環境之即時光學空氣品質監測系統

AQI氣體感測器服務平台

計畫主持人/共同主持人

邱裕中教授 / 余兆棠教授、李大輝教授、張萬榮教授、胡偉文教授、李志清教授

執行單位

南臺學校財團法人南臺科技大學 / 電子工程系

計畫簡述

我們研究團隊計劃開發一應用於工廠煙道環境之即時光學空氣品質監測系統。此系統由帶通光檢測器、雷射及220公分光路傳輸組成。帶通光檢測器的吸收波長預計為390nm到420nm。二氧化氮的檢測目前初估已達約5ppm。必須強調，相較於傳統的氣體感測器，本團隊開發的系統無需替換感測器頭，更為環保。

計劃亮點

1. 反應速度快、3秒內快速偵測
2. 不用耗材

展品規格

1. 體積小，適合不同載具或空間
2. 不用耗材

產業應用

工廠煙道環境監控、大型鍋爐燃燒排放監控或醫療院所PM2.5監控。

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MOST 科技部 Ministry of Science and Technology

科技部智慧機械創新館

Real-Time Optical-Type Air Quality Index System Application in Industrial Flue Gas

Air Quality Index (AQI) Gas Sensor Service Platform

Principal Investigator / Co-PI

Prof. Yu-Zung Chiou / Prof. Chao-Tang Yu, Prof. Da-Huei Lee, Prof. Wan-Rong Chang, Prof. Wei-Wen Hu, Prof. Chih-Ching Li

Institution

Southern Taiwan University of Science and Technology / Department of Electronic Engineering

Introduction

Our team manufacture and design of the real-time optical-type air quality index system application in industrial flue gas. The system consists of a band-pass photo-detector, a laser and a 220 cm light path. The wavelength of absorption of the band-pass photodetector is forecasted from 390nm to 420nm. The detect limit of nitrogen dioxide is estimated to be approximately 5ppm. We have to emphasize that there is no need to replace sensor head in our system as compare to the traditional gas sensor.

Highlights

1. Quick reaction and detect for 3 seconds
2. There is no need to replace any consumptive materials.

Specification

1. It is small and can fit anywhere.
2. There is no need to replace any consumptive materials.

Industrial Applications

It can monitor factory smoke, steam boilers or be used in medical institutions.

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科技部智慧機械創新館

以奈米功能性氧化物建構高性能固態二氧化硫氣體感測器

AQI氣體感測器服務平台

計畫主持人

方冠榮教授

執行單位

國立成功大學 / 材料科學與工程學系

計畫簡述

目前，二氧化硫是污染空氣的主要物質之一，檢測空氣中的二氧化硫是空氣檢驗的一項經常性工作。根據調查顯示二氧化硫感測器目前以光學式、化學螢光或紅外線吸收光譜之光譜分析儀為主，但因其複雜的分析流程與二氧化硫感測器所安裝於高溫與高污染之處，未能符合現今所需的即時監測原則。本團隊所開發之固態二氧化硫氣體感測器具有發展潛力，因為其感測元件在低溫下仍有良好的靈敏性、應答時間和選擇性，而主要關鍵為固態電解質與電極材料之特殊功能性，並依序進行各層材料的圖案化設計與規劃，開發出符合業界使用優良產品，以符合未來市場之需要。

計劃亮點

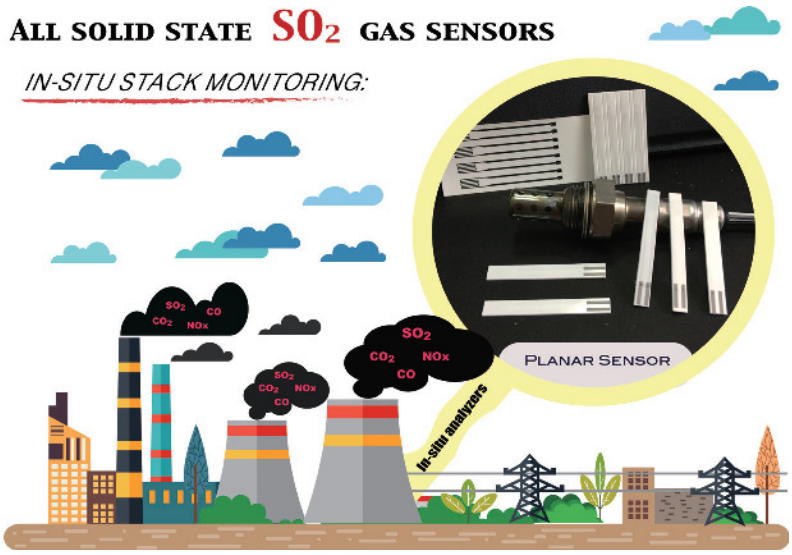
本案所開發之全固態二氧化硫氣體感測器元件，具有高穩定性、氣體選擇性高與可量產等優點，與市售之液態二氧化硫氣體感測器元件比較，更可直接於高溫惡劣工作環境下運作（應用情境：火力發電廠或工廠煙道）且並無漏液問題發生。

展品規格

1. 氣體靈敏性10(nA/ppm)~200(nA/ppm)
2. 可偵測濃度範圍100ppm~500ppm
3. 運作溫度低於500度

產業應用

二氧化硫感測器主要分析排放氣體成分的氣體傳感器允許通過反饋控制系統調整其控制參數（例如，燃料/空氣化學計量和燃燒溫度）來優化燃燒過程，從而減少排放，提高能源效率並降低運營成本。二氧化硫感測器於產業應用中也跨足許多的領域，其中包括汽車，航空航天，玻璃，陶瓷，石化和食品加工等行業，這些場域中，其感測器所放的位置皆為惡劣環境（如高溫，高壓，腐蝕性環境， 排氣的高空間速度等）。為了在高溫下實現即時監控汙染排放的功能，對許多感測技術來說是一個挑戰。本案所開發的全固態二氧化硫氣體感測器，可於在高溫下實現即時監控汙染排放應用，在未來將可透過部分的修正，應用於各式可攜式電子產品或空氣汙染監測系統上。



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MOST 科技部
Ministry of Science and Technology
科技部智慧機械創新館

High Performance Solid State SO_2 Sensor Using Nano-Structured Oxides

Air Quality Index (AQI) Gas Sensor Service Platform

Principal Investigator

Prof. Kuan-Zong Fung

Institution

National Cheng Kung University /
Department of Materials Science and Engineering

Introduction

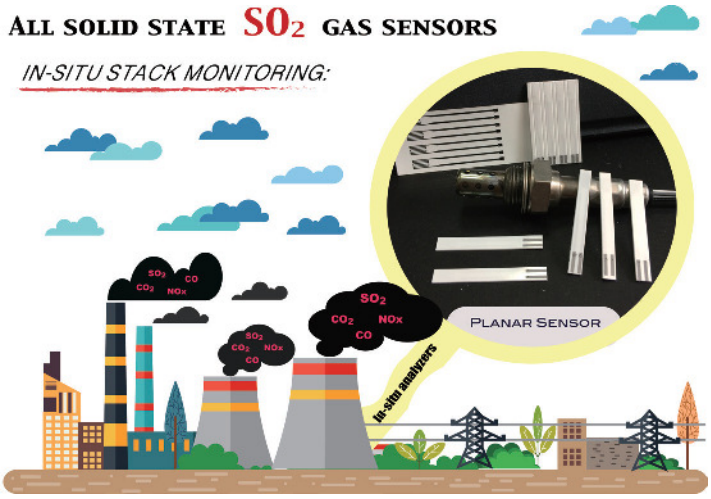
Sulfur dioxide is one of the main substances that pollute the air. The detection of sulfur dioxide in the air is a regular work of air inspection. According to the survey, the sulfur dioxide sensor is currently based on optical, chemical fluorescence or infrared absorption spectrum analyzer. However, due to its complicated analysis process and the installation of sulfur dioxide sensors usually in high temperature and high pollution, it does not meet the immediate monitoring required today. Therefore, the main objective of this project is to develop high-performance sensor with enhanced gas sensitivity properties and enlarged surface area based on solid-state electrolytes. The key technology is the special functionality of solid electrolyte and electrode materials and sequentially the layer material to the patterned design and planning. To develop new innovative products for future material sensing applications.

Highlights

A novel all-solid-state sulfur dioxide gas sensor was presented with emphasis on the development of suitable electrolytes and sensing materials with good thermal stability and sensing performance in harsh environments (e.g., power generation, petrochemical industries, corrosive environments, etc.).

Specification

1. Sensitivity of SO_2 sensor is 10 (nA/ppm)~200(nA/ppm)
2. Detectable concentration range between 100ppm~500ppm
3. Operating temperature lower than 500°C



Industrial Applications

Gas sensors that analyze the composition of emission gases allow the combustion process to be optimized by adjusting their control parameters (e.g., fuel/air stoichiometry and combustion temperature) via feedback control systems, thus resulting in reduced emissions, improved energy efficiency and lower operating costs. Industries such as the power generation, automotive, aerospace, glass, ceramic, petrochemical and food-processing industries, which are heavily associated with combustion processes, require these sensors to work in harsh environments (e.g., high temperatures, high pressures, corrosive environments, high spatial velocity of exhausts, etc.). In order to achieve the in situ monitoring of combustion gas components at high temperature for process optimization, the gas composition needs to be determined directly in the high temperature environment, which is a challenge for many sensing technologies.

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科技部智慧機械創新館

開發高靈敏度SO_2和NO_2晶片氣體感測器在戶外環境的應用

AQI氣體感測器服務平台

計畫主持人/共同主持人

薛丁仁教授 / 方得華教授、
王志強教授、許瓊文教授

執行單位

國立高雄科技大學 / 電子工程系

計畫簡述

本計畫所開發的NO_2與SO_2感測器是藉由台灣最強的IC製造基礎，以可大量生產之真空鍍膜技術為主，提高可靠度與量產性，再整合MEMS晶片型氣體感測器技術，研製高靈敏度SO_2和NO_2晶片氣體感測器。

計劃亮點

1. 快速響應
2. 高靈敏
3. 高穩定性

展品規格

1. 感測NO_2氣體達120 ppb 解析度為每10ppb。
2. 感測SO_2氣體達250 ppb 解析度為每10ppb。

產業應用

室內及室外空氣品質監測應用

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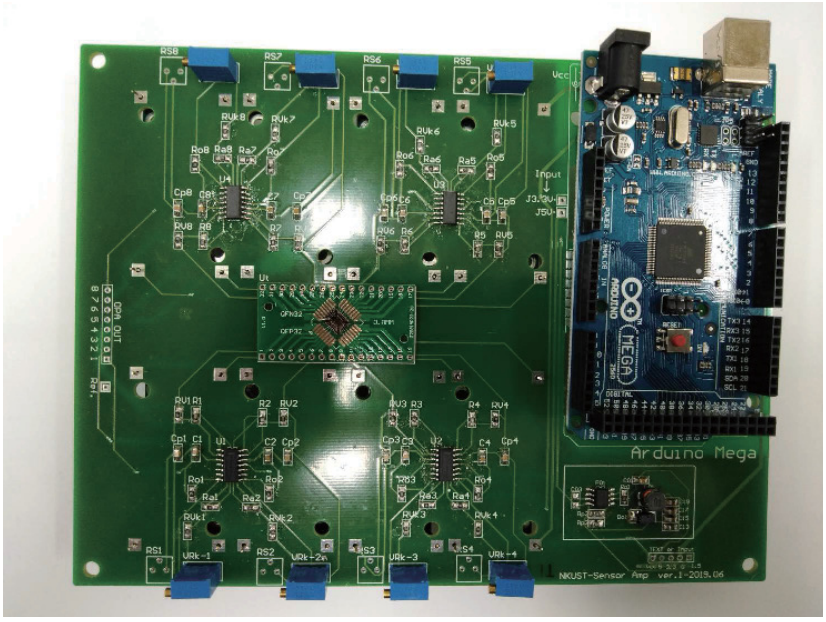


MOST 科技部
Ministry of Science and Technology
科技部智慧機械創新館

Development of High Sensitivity SO_2 and NO_2 Chip Gas Sensors and Their Application in Outdoor Environments.

Air Quality Index (AQI) Gas Sensor Service Platform

Principal Investigator / Co-PI

Prof. Ting-Jen Hsueh / Prof. Te-Hua Fang,
Prof. Chih-Chiang Wang,
Prof. Chiung-Wen Hsu

Institution

National Kaohsiung University of Science and Technology /
Department of Electronic Engineering

Introduction

The NO_2 and SO_2 sensors developed by the project are based on Taiwanese IC manufacturing base to improve reliability and mass production, and then integrate MEMS technology. Development of high sensitivity SO_2 and NO_2 chip gas sensors and their application in outdoor environments.

Highlights

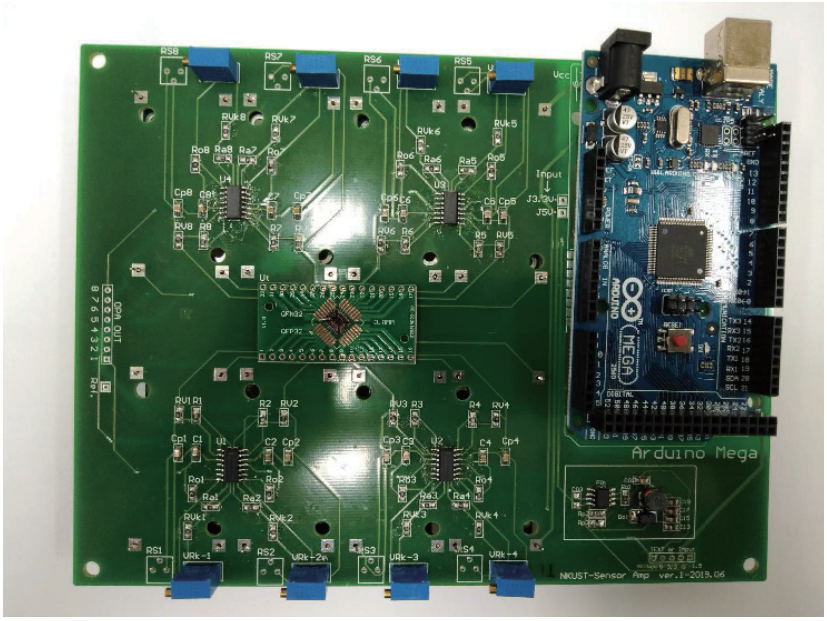
1. Quick response
2. High sensitivity
2. High stability

Specification

1. NO_2 gas sensor ≦120ppb, resolution 10 ppb
2. SO_2 gas sensor ≦250ppb, resolution 10 ppb

Industrial Applications

Indoor and outdoor air quality monitoring applications



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MOST 科技部
Ministry of Science and Technology
科技部智慧機械創新館

光學式PM2.5濃度及成份辨識系統

AQI氣體感測器服務平台

計畫主持人/共同主持人

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執行單位

南臺學校財團法人南臺科技大學 / 電子工程系

計畫簡述

本團隊採自行開發帶通型光檢測器來偵測PM2.5濃度，感測器靈敏度及抗雜訊力更高，更精準地呈現PM2.5濃度。另增設新功能為可辨識PM2.5成份組成，短時間蒐集懸浮微粒用光學式進行分析，經內建database比對，短時間內辨識微粒主要成份，環保署及市面產品尚無此技術功能。

計劃亮點

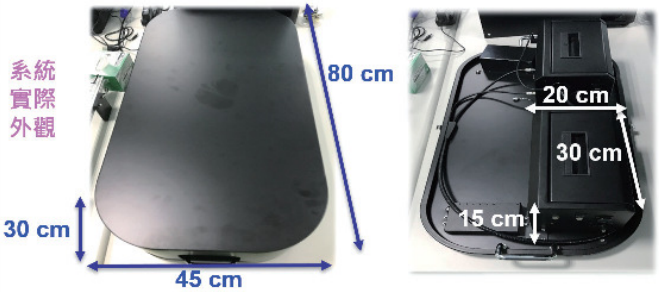
1. 自行開發帶通型光檢測器，可偵測特定LED或LD光源，靈敏度高以及抗雜訊能力強。
2. 可快速辨識PM2.5成分元素，判斷出可能汙染源。

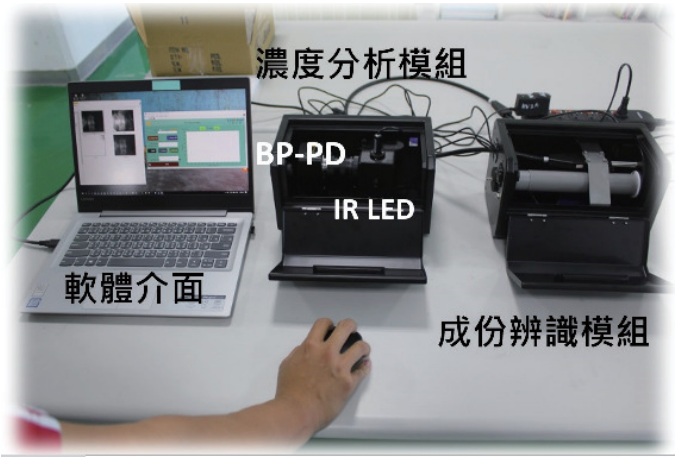
產業應用

針對PM2.5濃度較高的區域進行濃度的監控以及成分的偵測，並推斷出可能主要的汙染源。讓民眾可以直接知悉該區域主要的PM2.5汙染元凶，使得政府相關單位能進一步地對該區採取有效地改善措施。

展品規格

1. 帶通型光檢測器偵測850 nmLED或LD光源。
2. 偵測出PM2.5之水溶性陰陽離子成份。





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MOST 科技部 Ministry of Science and Technology
科技部智慧機械創新館

Optical-Type PM2.5 Concentration and Composition Identification System

Air Quality Index (AQI) Gas Sensor Service Platform

Principal Investigator / Co-PI

Prof. Chun-Kai Wang / Prof. Da-Huei Lee, Prof. Chao-Tang Yu, Prof. Wan-Rong Chang, Prof. Wei-Wen Hu, Prof. Chih-Ching Li

Institution

Southern Taiwan University of Science and Technology / Department of Electronic Engineering

Introduction

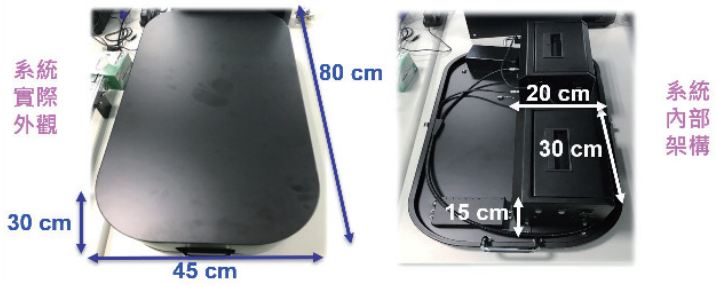
Our team develop a band-pass photodetector for application in PM2.5 concentration detection. Our designed sensors have a high sensitivity and low S/N ratio, and can detect PM2.5 concentration more accurately. Another new function of our system is added to identify the composition of PM2.5. The PM2.5 is collected in short term, and then analyzed by our designed optical system. The built-in database is compared to identify the main components of the PM2.5 in a short time. The EPA and the market products do not have this technical function.

Highlights

1. Develop a band-pass photodetector with high sensitivity and low S/N ratio to detect LED or LD light source.
2. Identify the main components of the PM2.5 in a short time, and infer possible sources of pollution.

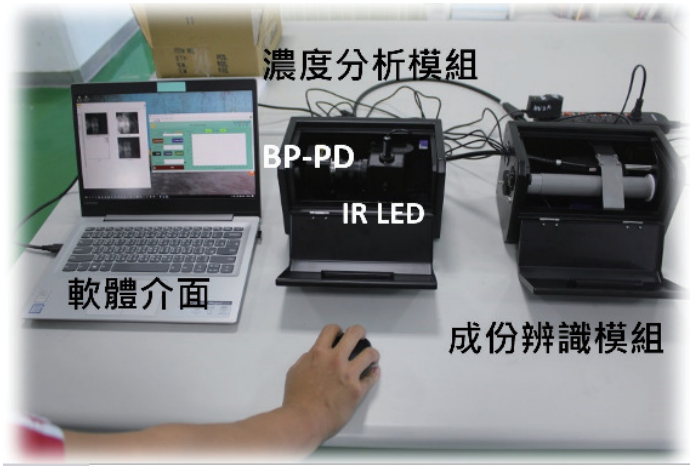
Specification

1. Band-pass photodetector detect 850 nm LED or LD light source.
2. Identify the water-soluble anion and cation ions of the PM2.5



Industrial Applications

PM2.5 Concentration monitoring and component detection were performed and inferred possible major sources of contamination. Let the public can know the main PM2.5 pollution culprit, and relevant government units can further take effective measures to improve the pollution.



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工廠空氣中無機酸與臭氧之檢測器開發

AQI氣體感測器服務平台

計畫主持人/共同主持人

蕭育仁教授 / 林儒禮教授、
林克默教授、王聖璋教授

執行單位

南臺學校財團法人南臺科技大學 / 機械系

計畫簡述

選用低成本且具有高訊號/雜訊比與高敏感度的表面聲波元件(SAW)作為氣體感測之用。當元件受到外界因素影響時，本身的震盪頻率會產生偏移，目前量測儀器如計頻器，其解析度可達1Hz，可偵測微小的頻率變化量，可發展陣列式感測晶片，在室溫下做檢測，建立簡易的辨識資料庫。

計劃亮點

1. 無論在氣體、液體，或是生物方面的檢測都SAW已有相當優勢。
2. 具有高靈敏度、結構簡單及信號容易取出等優點。
2. 使用不同的薄膜就可以對不同的氣體分子或液體分子進行偵測。

展品規格

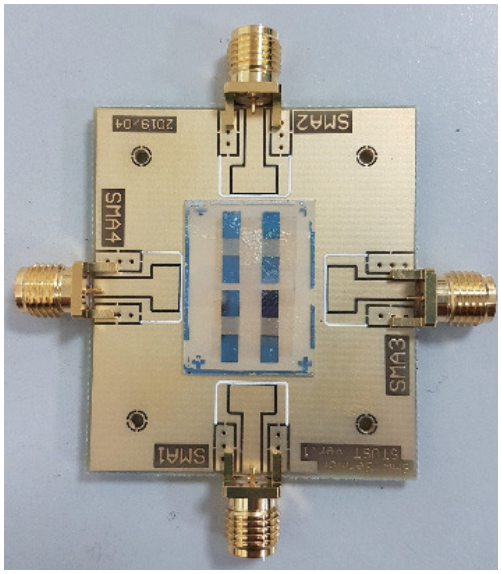
感測架構及氣體辨識概念

1. 可偵測氯鹽(Cl^-) 0-10 $\mu g/m^3$
2. 可偵測臭氧(O_3) 0-150 ppb

產業應用

1. 工廠廠務無機酸排放檢測。
2. 室外空氣汙染氣體檢測，如O_3、NO_2、SO_2等
3. 工業廢水檢測

表面聲波氣體感測器則是利用氣體分子在表面聲波元件表面造成質量或介電性的變化，使的相位及波速造成改變，進而影響輸出頻率的變化。設置此類感測器成本亦較低。除了成本外，因SAW 之偵測速度快，並可利用選擇性吸附氣體之特性，對監測場所之特定異味可優先選擇性偵測，相對其他如離子層析儀(Ion Chromatography)而言，表面聲波氣體感測器在各場所裝置安裝的實用性及針對污染形態而組合之感測薄膜多樣性皆比前者高。使用離子層析儀做為相同情境之市售「感測器」作比較。SAW可測氣體種類、選擇性、精準度等有較佳優勢。



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Ministry of Science and Technology
科技部智慧機械創新館

Development of Detectors for Inorganic Acids and Ozone in Factory Air

Air Quality Index (AQI) Gas Sensor Service Platform

Principal Investigator / Co-PI

Prof. Yu-Jen Hsiao/ Prof. Ru-Li Lin,
Prof. Keh-Moh Lin,
Prof. Sheng-Chang Wang

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Introduction

A low-cost surface acoustic wave element (SAW) with high signal/noise ratio and high sensitivity is selected for gas sensing. When the component is affected by external factors, its own oscillation frequency will be offset. At present, the measuring instrument such as the frequency detector can have a resolution of less than 1 Hz, and can detect a small frequency variation, and can develop an array sensing chip. Test at room temperature to create a simple identification database.

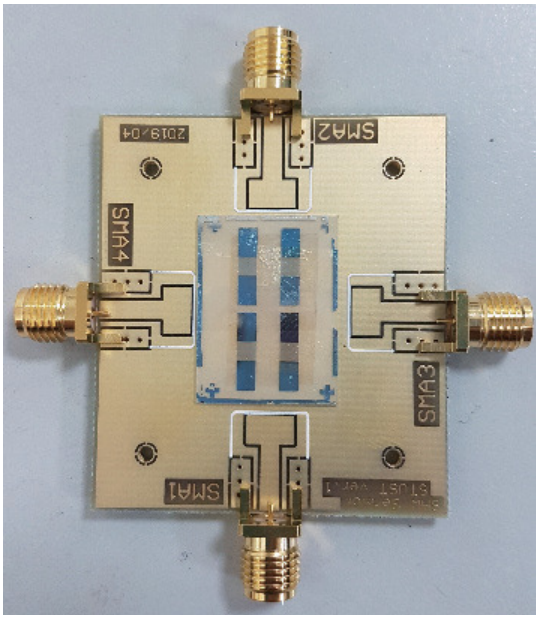
Highlights

1. SAW has considerable advantages in gas, liquid, or biological testing.
2. It has the advantages of high sensitivity, simple structure and easy signal removal.
3. Different gas molecules or liquid molecules can be detected using different films.

Specification

Sensing architecture and gas identification concept:

1. Detectable chloride salt (Cl^-) 0-10 $\mu g/m^3$
2. Ozone detection (O_3) 0-150 ppb



Industrial Applications

1. Factory factory inspection of inorganic acid emissions.
2. Outdoor air pollution gas detection, such as O_3, NO_2, SO_2, etc.
3. Industrial wastewater testing

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