化學科展研究主題選擇及優秀作品賞析

臺灣大學化學系　何國榮

選擇研究主題

原則：適合學生的程度

與生活有關

材料容易取得

實驗方法簡單

不需要昂貴的器材

符合安全標準

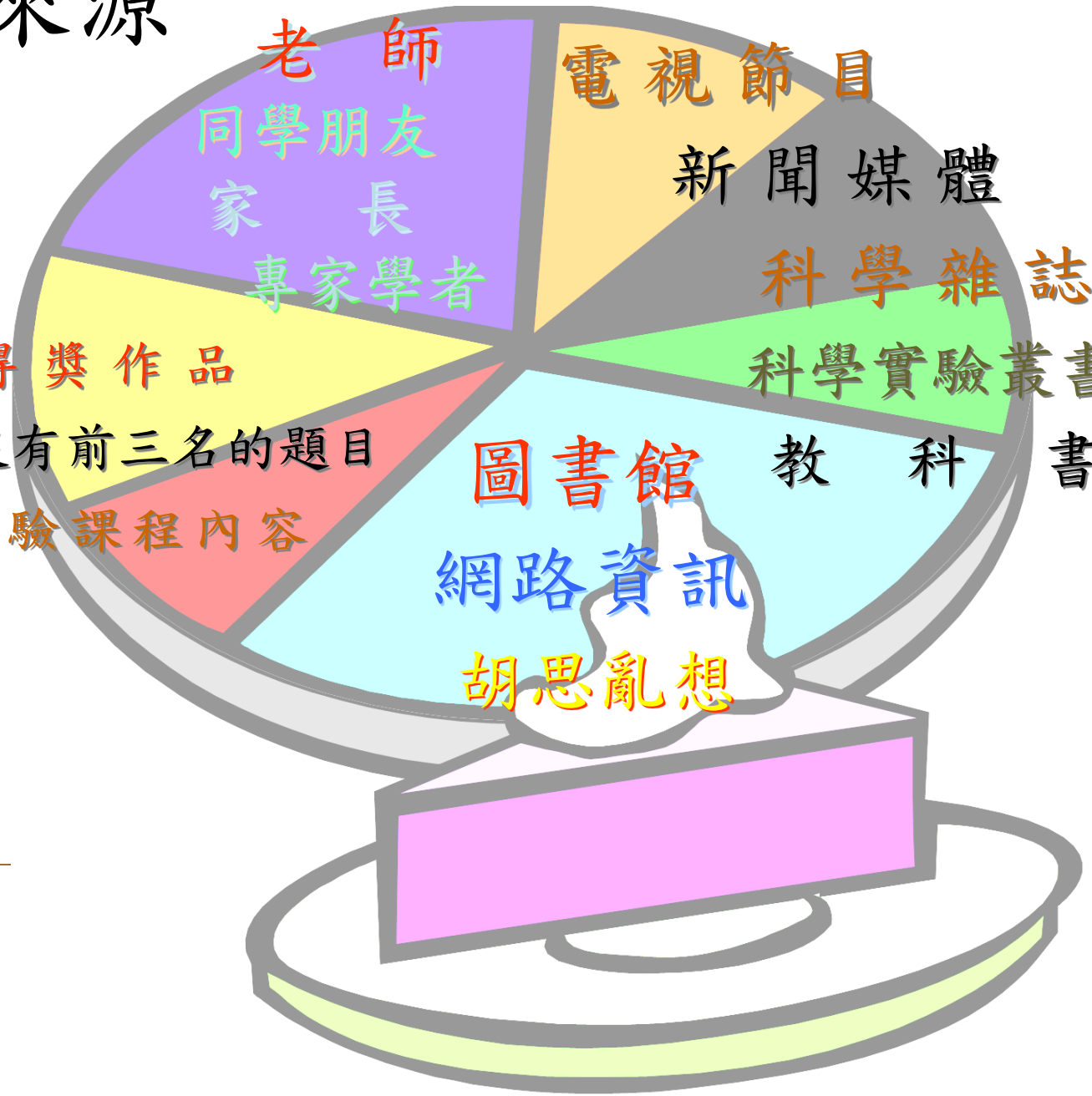
來源：1. 在**日常生活(周圍環境)**中尋找

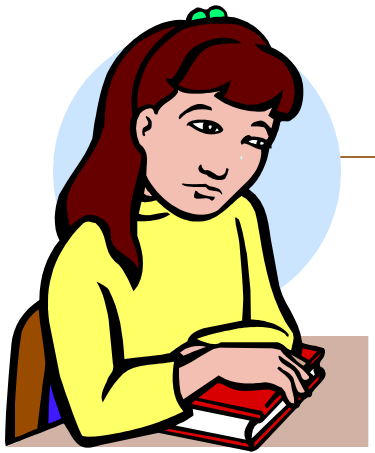
2. 從**熱門話題**(時事、新聞、**網路資訊**)中尋找題目

3. **課程**中尋找

4. 看**科展作品**尋找靈感（深入、補充、部份修改）

主題的來源


老師
同學朋友
家長
專家學者
電視節目
新聞媒體
科學雜誌
科學實驗叢書
教科書
圖書館
網路資訊
胡思亂想
歷屆得獎作品
人做過沒有前三名的題目
大學實驗課程內容



兩種典型的學習途徑

- **Learning by reading or listening to lectures**
  閱讀或聽講式的學習
- **Learning by working on problems or projects**
  探索或研究式的學習

奧林匹亞競賽

著重於化學知識的比賽，比賽的內容較偏重於既有化學知識的了解與運用。

ISEF 科學展覽

重點為新知識競賽，強調經由研究所獲取“新知識”及其潛在的價值。因此“創新性”就成為化學科展最為重要的一個項目。

The Importance Of Research- Why We Do Research

Research is the result of advancing knowledge created in the past.

Research is designed to solve a particular existing problems so there is a much larger audience eager to support research that is likely to be profitable or solve problems of immediate concern.

Criteria for winning a Nobel prize

by Unwirklich VinZant

The Nobel Prize awards “those who during the preceding year have conferred the greatest benefit on mankind” as instructed in Alfred Nobel’s will.

Grand Awards Judging is conducted using a 100-point scale with points assigned to creative ability, scientific thought, thoroughness, skill, and clarity.

I.Creative Ability (Individual - 30, Team - 25)

1.Does the project show creative ability and originality in the questions asked?

1.The approach to solving the problem, the analysis of the data, the interpretation of the data?

2.The use of equipment, the construction or design of new equipment?

2.Creative research should support an investigation and help answer a question in an original way.

3.A creative contribution promotes an efficient and reliable method for solving a problem.

Intel Science Talent Search

Inspiring Innovators of Tomorrow

Inspiring innovation

Each year, approximately 1,800 seniors attending American high schools conduct original research projects and present their work in the country's oldest, most prestigious pre-college science competition: the Intel Science Talent Search, a program of Society of Science & the Public.

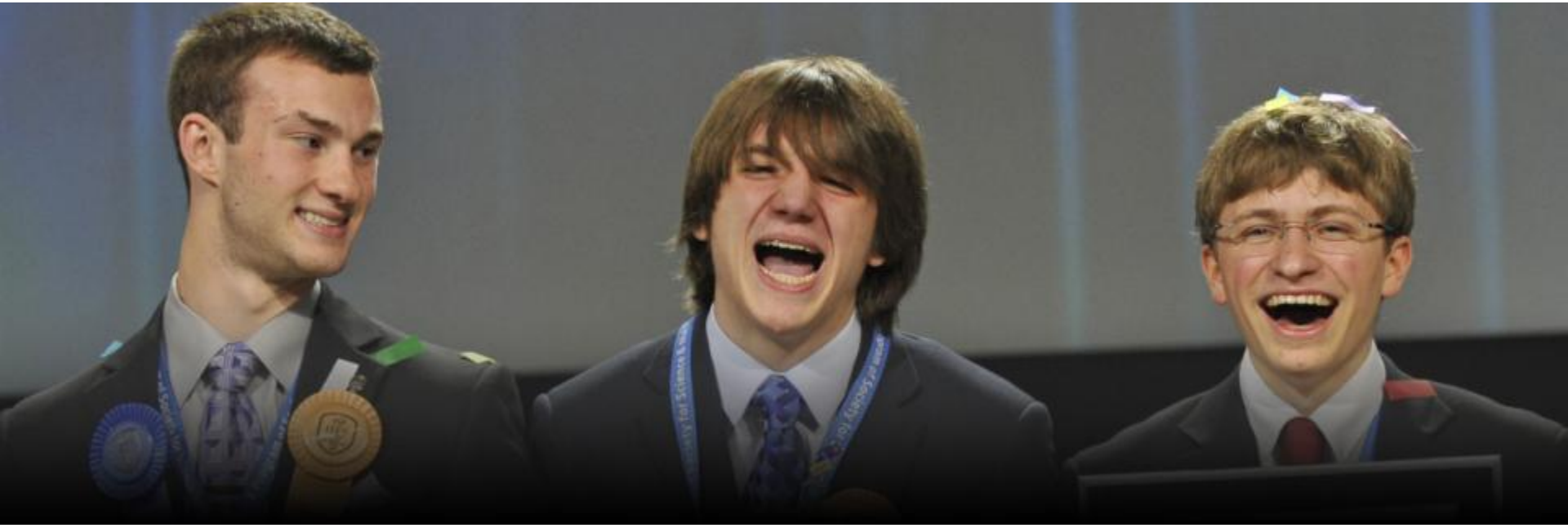
Forty of these young innovators are chosen as finalists and invited to participate in a nearly week-long event in Washington, D.C., where they compete for over USD 1.25 million in awards and scholarships

Intel STS alumni have achieved some of the world's most prestigious honors: Eleven have won MacArthur Foundation "Genius" grants, six have won the National Medal of Science and the National Medal of Technology, and seven have won the Nobel Prize.

Top winners of Intel STS 2016

Amol Punjabi, 17, of Marlborough, Massachusetts Amol developed software that could help drug makers develop new therapies for cancer and heart disease.
Paige Brown, 17, of Bangor, Maine . Paige studied the water quality of six environmentally impaired local streams with high *E. coli* and phosphate contamination levels.
Maya Varma, 17, of Cupertino, California, Maya used $35 worth of hobbyist electronics and free computer-aided design tools to create a low-cost, smartphone-based lung function analyzer that diagnoses lung disease as accurately as expensive devices currently used in medical laboratories.

Intel International Science and Engineering Fair (ISEF)



Inspiring innovators from around the world

The Intel International Science and Engineering Fair is the world's largest pre-college science fair competition.

Those who do progress to regional, state, and national competitions. Ultimately, the select few—1,500 promising young innovators—are invited to participate in Intel ISEF.

Rewarding Scientific Discovery and Innovation

At Intel ISEF, awards are based on students' abilities to tackle challenging scientific questions, use authentic research practices, and create solutions for the problems of tomorrow.

The Gordon E. Moore Award
This “best of the best” honor and a prize of USD 75,000 is awarded to the top Best of Category winner(s) for outstanding and innovative research, as well as the potential impact of the work.

The Intel Foundation Young Scientists Award
Two Gordon E. Moore Award runners-up, selected from the Best of Category winners, are awarded USD 50,000 each.

Dudley R. Herschbach SIYSS Award
Three finalists are selected to receive all-expenses-paid trips to attend the Stockholm International Youth Science Seminar (SIYSS), including attendance at the Nobel Prize ceremonies in Sweden.

Intel ISEF Best of Category Awards
Best of Category projects, selected from the competition’s 17 categories.

Intel ISEF Grand Awards
The Intel Foundation provides Grand Awards for first, second, third, and fourth places in each category.

Top winners of Intel ISEF 2016

2:17PM, May 13, 2016

Han Jie (Austin) Wang, 18, of Vancouver, Canada is the recipient of the first place Gordon E. Moore Award and US$75,000 for developing microbial fuel cells (MFCs) that more efficiently convert organic waste into electricity.

Syamantak Payra, 15, of Friendswood, Texas, received one of two Intel Foundation Young Scientist Awards of US$50,000, for developing a low-cost electronically-aided knee brace that allows an individual with a weakened leg to walk more naturally.

Kathy Liu, 17, of Salt Lake City, Utah, received the other Intel Foundation Young Scientist Award of US$50,000 for developing an alternative battery component that could significantly improve battery performance and safety.

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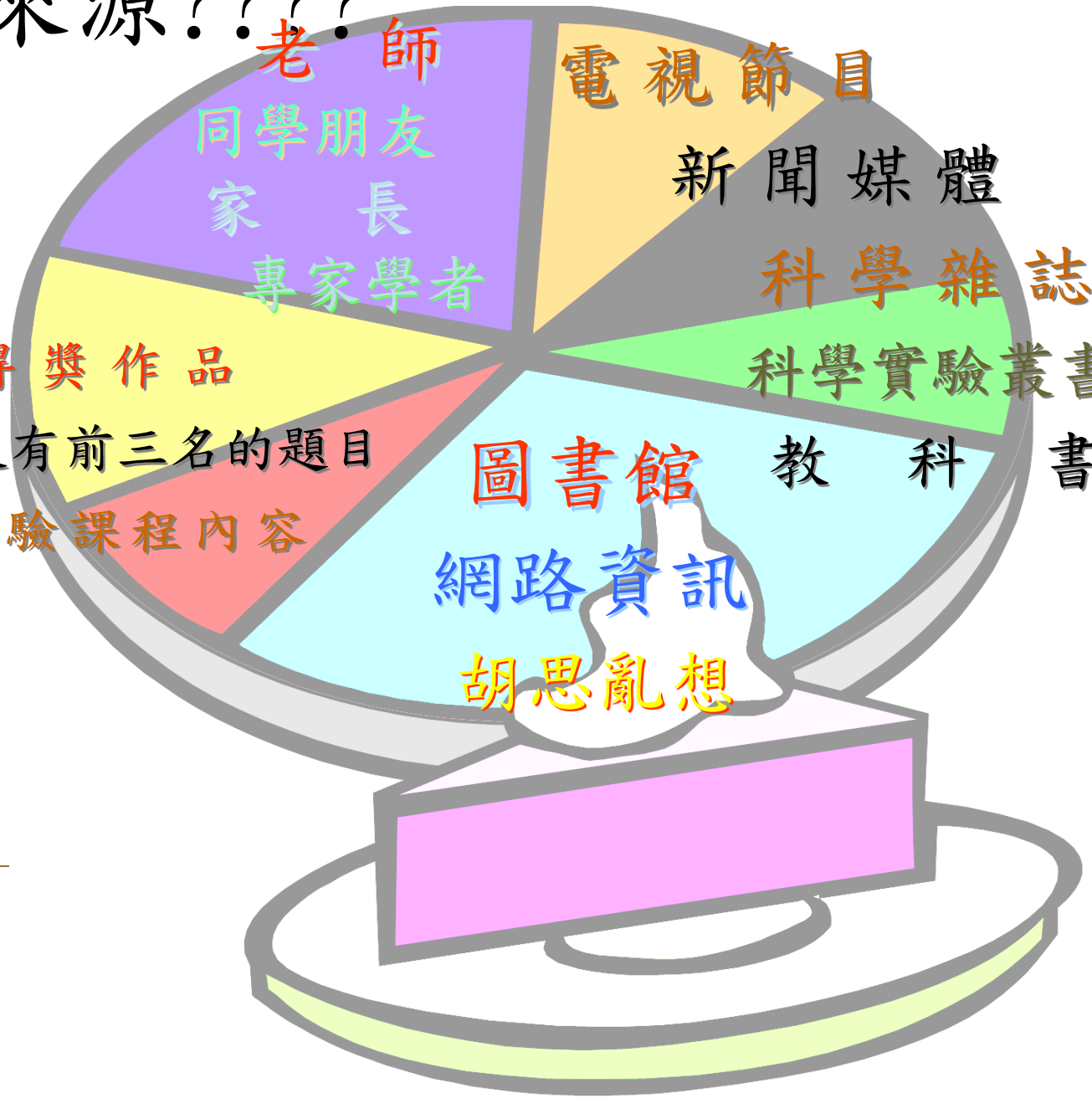
主題的來源????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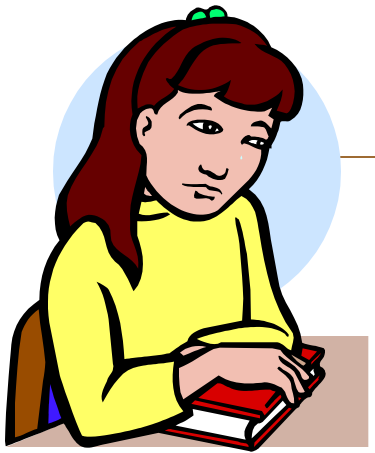


選擇研究主題

原則: 有創意、 有貢獻 、可提升學生程度、 材料容易取得
實驗方法簡單　符合安全標準

來源: 看**科學文章**尋找靈感 在**日常生活**(周圍環境)中尋找
從**熱門話題**(時事、新聞、網路資訊)中尋找題目

選擇研究主題

原則: 有創意、 有貢獻 、可提升學生程度、和有設備實

驗室合作, 符合安全標準

來源: 看**科學文章**尋找靈感 在**日常生活**(周圍環境)中尋找

從**熱門話題**(時事、新聞、網路資訊)中尋找題目

找先進實驗室討論

May 14 Sat 2011 01:11

我當Intel ISEF國際科展大賽的評審經驗

Instituional v.s. home projects

每年，評審們都會面臨一種難題。在參賽的作品當中，有些是「institutional」，也就是這些作品所需要的儀器、設備，是遠超過家庭和高中實驗室所提供。因此，這些作品通常都是在專業實驗室、有研究生或是教授的指導。

這一類的作品，評審很重要的工作之一，就是試圖找出參賽者親身參與的部分。比如說，主題是如何發想的? 遇到什麼樣的困難，遇到困難時是如何解決的? 實驗是誰操作的? 實驗結果是誰分析的？　參賽者本身對於相關的知識有多少理解？　教授在作品發展的過程中扮演多重要的角色？

我必須說，在這次國際科展中遇到的instituional的作品，很多都有碩士論文的水準，甚至有少數幾乎是一個博士論文的部分。參賽作品的程度之高，可以想見。

另一部分的作品，是孩子們憑一己之力，在家裏或是學校，以簡單的設備完成的。這兩種作品很難相提並論、互相比較。雖然大會並沒有對此提出評審的準則，但是討論中，大部分的評審都是傾向獎勵孩子們自發的科學實驗、資料搜尋的過程、獨自進行的科學進程。也因此，對於主題有意思、科學方法正確的、分析完善的home projects，評審們通常都會給予特別的討論與加分。

在我自己來說，我覺得這種project 才是科展真正的精神。可惜，這種作品要能達到與instituional作品競爭的程度，而來到此科展總決賽，是愈來愈難得了。

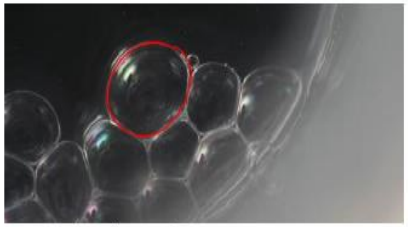
2009年台灣國際科展

名次	作品名稱	就讀學校	取材類別
化學科大會獎第一名 突尼西亞正選代表: 2009 年突尼西亞國際科學博覽會	Technical Revival of Traditional Blue Dyeing through Zeolite Catalysis and Electrolysis	國立臺南第一高級中學	生活 催化電解
化學科大會獎第二名 加拿大正選代表: 2009 年加拿大科學展覽會	當無機遇上有機—中孔洞非均勻相對掌催化劑合成與反應性之探討	臺北市立中山女子高級中學	熱門課題 奈米催化
化學科大會獎第二名 候補作品:	Fe 對銅系觸媒應用於甲醇重組製氫反應影響之探討	臺北市立第一女子高級中學	熱門課題 能源
化學科大會獎第三名 美國正選代表: 美國第60 屆國際科技展覽會	來去自如的氣體分子—氣體穿過氣泡的行為研究	國立嘉義女子高級中學	生活

化學科大會獎第三名 美國正選代表: 美國第60 屆國際科技展覽會	來去自如的氣體分子—氣體穿過氣泡的行為研究	國立嘉義女子高級中學	生活

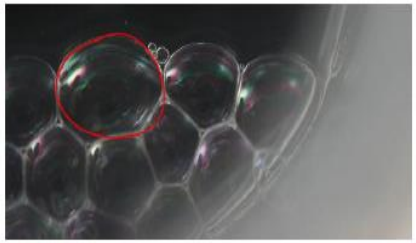
國立嘉義女子高級中學林育惠同學以「來去自如的氣體分子─氣體穿越氣泡的行為研究」作品獲大會化學科四等獎

3. 「溶解－擴散」機制



氣泡外部環境：100% CO_2

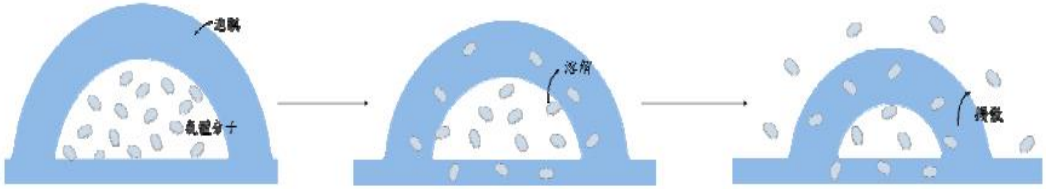
一般空氣所形成的氣泡 t=0s



t=5s

氣泡明顯變大

在充滿二氧化碳的環境中打入由一般空氣形成的氣泡，發現由一般空氣所形成的氣泡在這樣的環境下會明顯變大。因為觀察到這個現象，我們推論二氧化碳分子可以自由進出泡膜兩端，而不只是溶進泡膜裡。



在地區科展時沒有得到評審教授的青睞，無法進入全國科展

終於，在去年十一月，育惠因為這個作品得到旺宏科學獎的金牌獎，今年年初國際科展的得獎，對育惠來講，也只是擁有更多留在資源教室裡面的自由。獎金和出國的資格

所以，在取得科學教育館的研究補助之後，育惠第一時間就去氣體行很大方的買了原本都買不下手的氣體，把氦氣、氬氣、氧氣、笑氣的鋼瓶通通搬回實驗室，連同原本的二氧化碳和乙炔鋼瓶，然後還上網搜尋了一些比較冷門的氣體，終於讓她找到一公升就要六千塊的二氧化硫，二話不說就下訂單請人家寄過來。

使用鋼瓶裡的氣體做實驗比起自己置備的要容易許多，而且比較不用擔心純度的問題，但是就在二氧化硫的鋼瓶到的那個下午，育惠很震驚的發現，這一年來的實驗中，有一個環節錯了！讓整個原本的討論通通垮下來。

2011年台灣國際科展

名次	作品名稱	就讀學校	取材類別
化學科大會獎第一名 美國正選代表: :美國第62屆國際科技展覽會	Emitting Gold Nanodots Synthesized via Protein Templates	臺北市立第一女子高級中學	熱門課題 奈米
化學科大會獎第二名 新加坡正選代表:2011年新加坡科技展覽會	燃料電池用之磺酸化SEBS-奈米粒子複合膜製備與性質研究	臺北市立麗山高級中學	熱門課題 奈米能源
化學科大會獎第三名	醣的真「本氏」—自製儀器探討還原醣與本氏液的反應過程	高雄市立高雄女子高級中學	課程內容
化學科大會獎第四名	質子交換膜燃料電池中氣體擴散電極之電催化效能探討	國立內壢高級中學	熱門課題 能源
化學科大會獎第四名	葉綠素a碟狀聚集體與染料敏化電池之研究	國立臺中女子高級中學	熱門課題 能源
化學科大會獎第四名	光動力化合物的合成及分析	國立臺中女子高級中學	熱門課題 能源

51屆(2011)全國科展

名次	作品名稱	學校名稱	取材類別
第一名	DCPIP變色比一比	國立羅東高級中學	課程內容
第二名	胺能辨魚新鮮否？—金奈米之胺類分子檢測研究	國立臺中女子高級中學	熱門課題 奈米
第三名	磁控!! 布丁的吸水敏感性	國立科學工業園區實驗高級中學	課程內容
第三名	翻滾吧！小水滴—超疏水表面製備及應用	國立臺南第一高級中學	課程內容
佳作	氫「氣泡」燃料電池	國立屏東高級中學	熱門課題 能源
佳作	塑膠袋生氣了--氣體生成反應的研究	國立嘉義高級中學	課程內容
佳作	醇水之蒸	國立武陵高級中學	課程內容

2012年台灣國際科展

名次	作品名稱	就讀學校	取材類別
化學科大會獎第一名 美國正選代表: 美國第63屆國際科技展覽會	對平面結構的石墨烯修飾並應用於直接甲醇燃料電池	臺北市立第一女子高級中學	熱門課題 奈米能源
化學科大會獎第二名	刑案現場大發現-那是血嗎？	臺北市私立薇閣高級中學	熱門課題 奈米
化學科大會獎第三名	利用路易士酸催化合成含氧螺旋化合物	臺北市立第一女子高級中學	課程內容
化學科大會獎第三名	光動力化合物的合成及應用	國立臺中女子高級中學	熱門課題 能源
化學科大會獎第四名	不同氮源的氮氧化鈦可見光光觸媒之製備與性質探討	臺北市立麗山高級中學	熱門課題 光催化
化學科大會獎第四名	酒石酸配位掌性聚合物之自組裝合成、結構與特性研究	臺北市立建國高級中學	課程內容
化學科大會獎第四名	DCPIP變色比一比	國立羅東高級中學	課程內容

中華民國 第54屆中小學科學展覽會
大會獎 高中組 化學科 得獎作品名冊

編號	作品名稱	學校名稱	地區別	作者	指導教師	名次
040214	新式光觸媒奈米磁鐵(TiO_2 @ Fe_3O_4) 分解玫瑰紅染料之研究	高雄市立高雄女子高級中學	高雄市	高二 鄭雅云 高二 吳芃蓁 高二 王雨莉	游宗穎 蘇政宏	第一名
040211	青青紫「金」—染料敏化太陽能電池之效能分析	臺北市立第一女子高級中學	臺北市	高二 吳欣芳 高二 許天鈞 高二 陳容妡	江慧玉 張永佶	第二名 最佳創意獎
040203	以氧化聚合法將聚3,4 -二氧乙基噻吩修飾於不同奈米材料並應用在直接甲醇燃料電池	國立武陵高級中學	桃竹苗區	高二 詹崴仁 高二 劉玟慶	林勝立	第三名
040207	「磷光」乍現—自製時間解析裝置及其應用	國立臺中第二高級中學	中區	高二 黃國修 高二 陳昱安 高二 周為成	蔡旺璋	第三名
040205	參透滲透	南投縣立旭光高級中學	中區	高二 李昀真 高二 洪袖凌 高二 陳政群	陳英田 陳怡仁	佳作
040213	天長『碲』久—碲奈米線材料之開發及其抗菌活性的探討	臺北市立第一女子高級中學	臺北市	高二 黃昭瑄 高二 楊紫筑	張永佶 江慧玉	佳作
040215	又「吸」又「溶」—探討甲殼素的吸附與溶解	臺北市立中山女子高級中學	臺北市	高二 李有儀 高二 李宜芸 高二 陳穎潔	鄭琪玟	佳作
040202	歡「螢」「光」臨—烯、炔化合物對螢光發光效率的影響	國立羅東高級中學	北基宜區	高二 溫立先 高二 賴勁愷 高二 方澄祐	李建勳 林兆駿	最佳團隊合作獎
040208	硝魂使者—NO2性質探討與偵測	國立北港高級中學	雲嘉區	高二 楊家乘 高二 吳郁芬 高二 陳怡穎	陳建志	最佳(鄉土)教材獎

2015 化學科

040201	電雙層電容器電極碳材性質之探討	國立臺南第一高級中學	佳作
040202	碘食呈經～澱粉碘液呈色及穀物分解探討	臺中市私立明道高級中學	
040203	酸鹼反應誘發之中空微球釋放一氧化氮用於克服細菌抗藥性問題之研究	國立新竹女子高級中學	最佳創意獎
040204	「鈣」有「旋」機	高雄市立高雄女子高級中學	第三名
040205	醣化學研究－有機合成木通苯乙醇苷A類似物	國立新竹女子高級中學	第二名
040206	晶球世紀	國立臺中第二高級中學	
040207	蛋膜通透銅錯離子	國立花蓮高級中學	佳作
040208	探討葡萄糖氧化吸光度之化學動力學研究	國立斗六高級中學	佳作

040209	膜擬，行凍，創鋅─自製半透膜代替鹽橋之果凍化新型鋅銅電池	新北市立新北高級中學	
040210	就塑要你硬-PC板增硬膜之研究	國立岡山高級中學	最佳(鄉土)教材獎
040211	反應結束了嗎？	國立金門高級中學	
040212	『薑』湖傳說薑黃素光降解特性之研究	國立臺中文華高級中學	第三名
040213	黃金超級電容	國立嘉義高級中學	第三名
040214	無毒萬靈丹-過碳酸鈉的過人之處	國立馬祖高級中學	最佳團隊合作獎
040215	以水活性值作為食品水分含量和水溶液濃度估算之快速量測工具	國立臺南女子高級中學	第一名
040216	甜蜜來「靛」--靛胭脂的氧化還原反應	臺北市立第一女子高級中學	佳作
040217	從⊓到⊔的旅行－由電子的傳遞理解反應速率與化學平衡	國立宜蘭高級中學	
040218	一「碳」究竟	國立臺灣師範大學附屬高級中學	

2016 全國科展

050203 不同型態鈀奈米觸媒對直接乙 醇燃料電池的應用 屏東縣立枋寮高級中學 *高屏澎 區 高一 陳映沂 高一 陳姿鳳 李承典 張簡琦麗* 第一名

050209 自製高效率簡易水解發酵裝置 將纖維素轉化為生質酒精之新 製程 高雄市立高雄女子高級中學 高雄市 高二 朱子賢 高二 邱靚綸 高二 廖采濛 蘇政宏 游宗穎 第二名

050208 奈米碳管複合粒子形成穩定皮 克林乳液之研究與應用 臺北市立第一女子高級中學 臺北市 高一 程嘉瀅 高一 翁詩涵 江慧玉 第三名

050210 水中嬌龍-奈米金水(AuNT water)創新應用 臺北市私立復興實驗高級中學 臺北市 高二 黃楷晴 高二 李玟締 高二 陳品洋 馬瑪宣 張閎勛 第三名 最佳創意獎

050201 微量過氧化氫之檢測 國立臺中女子高級中學 中區 高二 吳宜亭 高二 蔡承臻 吳榮修 佳作

050204 奈米金應用於潛指紋檢測之研 究 國立臺灣師範大學附屬高級中學 臺北市 高二 王愷 高二 林文心 陳昭錦 佳作

050211 ±10℃的秘密 南投縣立旭光高級中學 中區 高三 黃俊翰 高二 林育暟 高二 黃韋傑 李佩樺 陳英田 佳作

050213 環保回收廢金法與鉛離子檢測之研究 國立臺南第一高級中學 臺南區 高一 林隆軒 高一 楊承遠 陳立偉 楊志鴻 最佳團隊合作獎

050214 自製簡易吊白塊檢測試紙 國立彰化高級中學 中區 高二 楊昌峻 高二 蕭培均 周文釗 最佳(鄉土)教材獎

臺灣二００三年國際科學展覽會

科　　別：環境科學科

作品名稱：吸〝氣〞大法-QCM 對有機氣體之吸附與偵測

得獎獎項：環境科學科第一名

英特爾環境健康與安全獎

美國第五十四屆國際科技展覽會

學　　校：國立桃園高級中學

作　　者：林庭年、劉亭均

The Development of a Simple Microbalance for Detecting Volatile Organic Compounds in Chemistry Laboratory

Ting-Nien Lin and Ting-Chun Liu
National Taoyuan Senior High School, Taiwan

Introduction

Organic solvents such as methanol, acetone, etc., are often used in high school chemistry laboratory. These solvents can be easily absorbed by human body through breathing and/or skin contact, and thus may cause serious adverse impacts on students' health.

Piezoelectric crystals such as quartz are known to be sensitive to pressure on their surface. The vibrational frequency of an oscillating piezoelectric crystal decreases as adsorption of a foreign substance onto its surface. As shown in Sauerbrey's equation $\Delta f = -2.3 \times 10^6 f_0^2 (\Delta M/A)$, the variation of vibrational frequency is related to the mass of adsorption materials. This relationship and the theoretical resolution detection limit of oscillating quartz crystals make them ideal choices as gas sensors. Furthermore, the quartz based sensors are often inexpensive and easy to fabricate.

Piezoelectric quartz crystals coated with polymer, e.g. polystyrene and polyacrylonitrile, have been extensively studied. In this study, a simple microbalance based on a commercial quartz crystal and polyaniline adsorbent was developed. The characteristics of the polyaniline coated quartz crystal and its ability in detecting organic vapor in chemistry laboratory are presented.

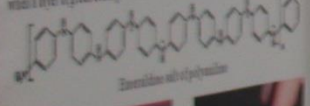
Experimental

1. Chemicals

All chemicals were obtained from Shimakyo's pure chemicals (Japan).

2. Fabrication of polyaniline coated quartz crystals

Piezoelectric crystals used were commercial AT-cut, plano-plano quartz crystals, each 0.22 cm with a basic frequency of 10 MHz and silver-plated metal electrodes on both sides (Tai Tien Electric Co., Ltd., Taiwan). The cost of each crystals is less than 0.5 US dollar each. The crystals were coated with polyaniline via electrochemical means. Before coating, the metal case of the quartz crystal was removed by using a hammer (Fig. 1). Coating solution of aniline was prepared in 2 M HCl solution. Coating was conducted in a home-made polycyclic electrolysis cell as shown in Fig.2. The volume of the cell was less than 1 ml. The voltage was set at 0.8 volt during electrolysis and the reaction was stopped when a layer of green coating was observed.



Emeraldine salt of polyaniline

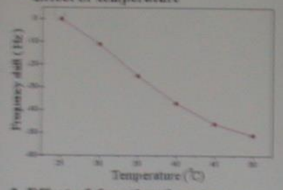
Fig. 1 Quartz crystals
(1) Before removing the metal case
(2) After removing the metal case
(3) After coating with polyaniline

3. Setup of the gas sensor

Results and Discussion

1. Piezoelectric system

Effect of temperature



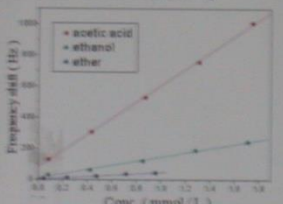
Stability of the system

- With clean air, the variation was found to be 2 Hz in a period of ten minutes at 30°C.
- Using n-butanol as the test solvent, the within-day and between-day reproducibility were found to be 2.6 % and 3.4 % respectively.

Fig. 4 Various temperatures on frequency shift

- Frequency was found to be very sensitive to temperature.

2. Effect of functional group



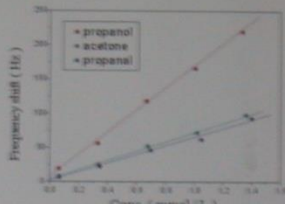


Fig. 5 Various organic solvents on frequency shift

- Frequency shift is proportional to the polarities of the functional groups.
- Coulombic interaction and hydrogen bonding between polyaniline and the test molecules were the major reasons for the greater frequency shifts.

3. Effect of chain length

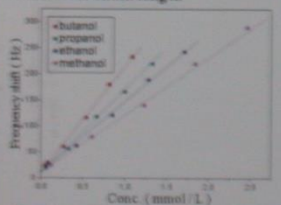


Fig. 6 Alcohols of different chain length on frequency shift

- Greater frequency shifts were observed for alcohols of higher molecular weight.
- Larger frequency shifts are most likely due to the greater mass per adsorbed molecule.

4. Effect of steric hindrance

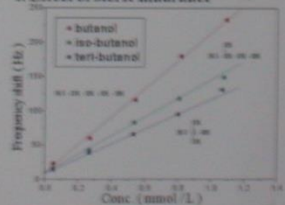


Fig. 7 Butanol isomers on frequency shifts

- Linear molecule exhibited a greater frequency shift than branched molecule.
- The horizontal adsorption of linear molecule provided more efficient adsorption and thus greater frequency shift.

5. Effect of π electrons

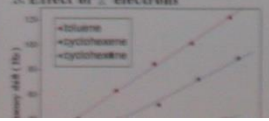


Fig. 8 Organic solvents with different π electrons on frequency shifts

- π - π interaction appeared to enhance the adsorption of alkenes and aromatic molecules.

Intel ISEF 名人堂

蔡辰葳

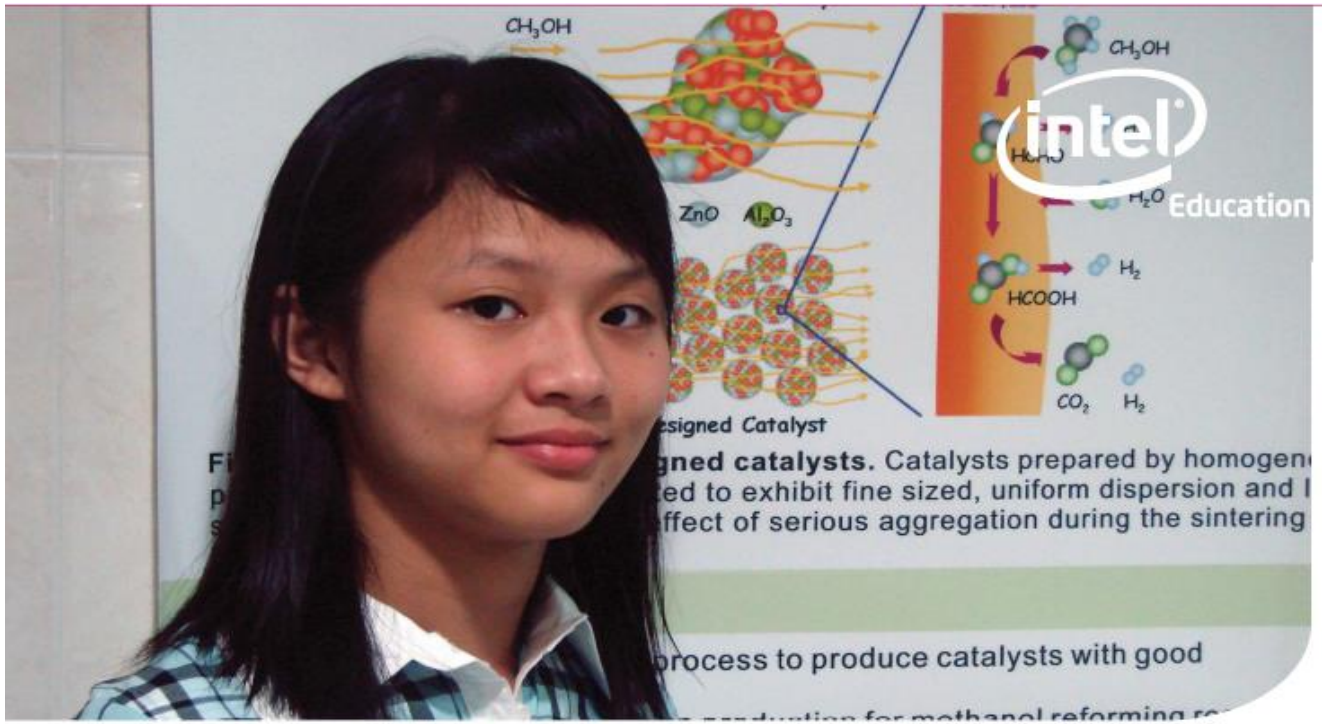
瓦斯熱水爐一氧化碳觸媒轉化器之研究

Optimizing a catalyst fo

得獎年度：2006年　　科別：化學科

大會化學科最傑出獎 | 大會化學科一等獎

參展時就讀學校：國立高雄師範大學附屬高級中學



Intel ISEF 名人堂

Searching the gene esse

蘇意涵

均相沉澱法製備CZA觸媒之探討－

Efficient Hydrogen Production Using Cu-Zn-Al Catalysts Prepared by Homogeneous Precipitation Method

得獎年度：2008年　　科別：化學科

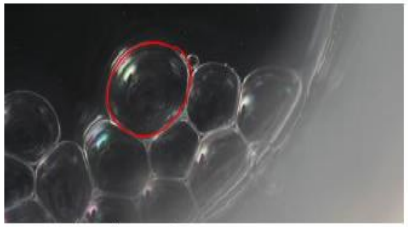
英特爾青年科學家獎、大會化學科最傑出獎、大會化學科一等獎

參展時就讀學校：臺北市立第一女子高級中學

化學科大會獎第三名 美國正選代表: 美國第60 屆國際科技展覽會	來去自如的氣體分子—氣體穿過氣泡的行為研究	國立嘉義女子高級中學	生活

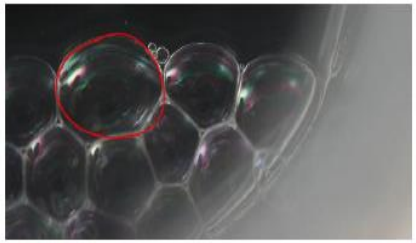
國立嘉義女子高級中學林育惠同學以「來去自如的氣體分子─氣體穿越氣泡的行為研究」作品獲大會化學科四等獎

3. 「溶解－擴散」機制



氣泡外部環境：100% CO_2

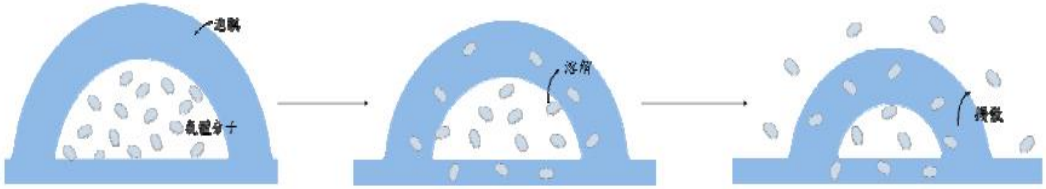
一般空氣所形成的氣泡 t=0s



t=5s

氣泡明顯變大

在充滿二氧化碳的環境中打入由一般空氣形成的氣泡，發現由一般空氣所形成的氣泡在這樣的環境下會明顯變大。因為觀察到這個現象，我們推論二氧化碳分子可以自由進出泡膜兩端，而不只是溶進泡膜裡。



北一女中學生洪瑀、林季潔，是以「**FeSe**奈米顆粒製成與物性分析」參賽，獲得評審青睞。

Iron-Selenium was found to be a new toxicity-free superconductor, which has a simple crystal structure. Recent publications[2] indicate that turning superconductors into nanoscale particles may enhance their superconducting critical temperature (Tc). Therefore, in our project, we found three effective chemical routes to synthesize FeSe into nanocrystals and found that the tetragonal FeSe1-x shows a Tc (40 K) that is higher than that of their bulk form (7 K) [1] .

化學科 (Chemistry)
Intel ISEF大會獎第三名 (Third Place Grand Award)，獎金1,000美元
作品：Lighting Insulin with Gold Nanodots
簡韻真，女，臺北市立第一女子高級中學

簡韻真

美國化學學會 (American Chemical Society)
Intel ISEF 特別獎 - 美國化學學會獎優選
作品：對平面結構的石墨烯修飾並應用於直接甲醇燃料電池
王聖槐，女，臺北市立第一女子高級中學　2012

國立臺灣科學教育館（簡稱科教館）選拔2名學生1件作品代表我國參加美國國際永續發展3E科技競賽（International Sustainable World Energy Engineering Environment Project Olympiad，簡稱I-SWEEEP）」，由臺北市立第一女子高級中學高廷瑋、何芷寧同學以「量子點敏化太陽能電池中光電極應用於水裂解之產氫」為題，奪得大會能源類科銀牌，為國爭光。 2013

Intel ISEF 大會獎第三名 (Third Place Grand Award)，獎金 1,000 美元
作品：含雙尿素螢光分子之自組裝與能量轉移行為研究
胡婷，女，臺北市立第一女子高級中學
劉馥瑄，女，臺北市立第一女子高級中學　2013

化學科 (Chemistry)
Intel ISEF 大會獎 – 化學科第四名 (Forth Award)，獎金 500 美元
作品：可重複使用之新型固體酸在藥物合成與生質能的催化應用
沈玉宣，女，臺北市立第一女子高級中學　　2014

化學科 (Chemistry)
第四名，獎金500美元
作品：氧化亞銅奈米複合材料於非酵素型葡萄糖感測器之應用
王琳嘉，女，17歲，台北市立第一女子高級中學
林依萱，女，16歲，台北市立第一女子高級中學　　2015

化學科（Chemistry）
大會獎第三名（Grand Awards – Third Award），獎金 1,000 美元
作品：吸收紫外光之透明有機薄膜太陽能電池
林承霈，女，16 歲，台北市立第一女子高級中學

CHEMISTRY
Intel will present Best of Category Winners with a $5,000 award. Additionally, a $1,000 grant will be given to their school and the Intel ISEF Affiliated Fair they represent.
Intel ISEF Best of Category Award of $5,000

CHEM006T - *The Effect of Carbon on Iron Nickel Bimetallic Nanoparticle Degradation of Orange G*
Kathryn Anna Lawrence, 17, Fairview High School, Boulder, Colorado
Katherine Afton Younglove, 18, Fairview High School, Boulder, Colorado

First Award of $3,000

CHEM006T - *The Effect of Carbon on Iron Nickel Bimetallic Nanoparticle Degradation of Orange G*
Kathryn Anna Lawrence, 17, Fairview High School, Boulder, Colorado
Katherine Afton Younglove, 18, Fairview High School, Boulder, Colorado

CHEM009 - *Effect of Jahn-Teller Distortions on Relaxation Dynamics*
Archana Verma, 16, Jericho High School, Jericho, New York

Second Award of $1,500

CHEM048 - *Versatile, Efficient, and Facile Functionalization of Poly(p-phenylene oxide) via Azide-Alkyne "Click" Chemistry*
Kailash Raman, 16, Sandra Day O'Connor High School, Phoenix, Arizona

CHEM057 - *Preventing Urushiol (Poison Oak) Induced Dermatitis by Deactivating the Allergen*
Amy Dunphy, 15, The Harker School, San Jose, California

CHEM059 - *Combating Viral Outbreaks: Rapid and Selective Detection of Viruses Using Inexpensive Polymer Films*
Anjini Karthik, 17, Saint Francis High School, Mountain View, California

Third Award of $1,000

CHEM023 - *Nickel Oxy-hydroxide Thin Films as Efficient Electrocatalysts for Dye Wastewater Treatment*
Yuhang Wang, 19, National Junior College, Singapore, Singapore

CHEM027T - *Superparamagnetic Iron(II,III) Oxide Silver Cysteine Complex Nanoparticles (SISCCN) in Metal Ions Adsorption and Chiral Recognition*
Kwun Wing Thomas Li, 16, King's College, Hong Kong, China, Hong Kong Special Administrative Region Pak Hei Chu, 18, King's College, Hong Kong, China, Hong Kong Special Administrative Region Tat Ngai Davis Chan, 17, King's College, Hong Kong, China, Hong Kong Special Administrative Region

CHEM029 - *UV-Light Sensitive Transparent Organic Solar Cells*
Cheng-Pei Lin, 17, Taipei First Girls High School, Taipei City, Taiwan

CHEM036 - *A Highly Efficient and Economically Profitable Electrocatalytic Conversion of Carbon Dioxide using Nanostructured Electrodes*
Nikhil Murthy, 16, Catlin Gabel School, Portland, Oregon

CHEM044T - *Potential Anticancer Complexes from Platinum and Clove Basil Oil (Ocimum grastissimum L.)*
My Ha Nguyen, 17, High School for Gifted Students, Hanoi National University of Education, Hanoi, Viet Nam
Long Quang Nguyen, 18, High School for Gifted Students, Hanoi National University of Education, Hanoi, Viet Nam

II.Scientific Thought (Individual - 30, Team - 25)

1. Is the problem stated clearly and unambiguously?
2. Was the problem sufficiently limited to allow a plausible approach? Good scientists can identify important problems capable of solutions.
3. Was there a procedural plan for obtaining a solution?
4. Are the variables clearly recognized and defined?
5. If controls were necessary, did the student recognize their need and were they correctly used?
6. Are there adequate data to support the conclusions?
7. Does the finalist or team recognize the data's limitations?
8. Does the finalist/team understand the project's ties to related research?
9. Does the finalist/team have an idea of what further research is warranted?
10. Did the finalist/team cite scientific literature, or only popular literature (local newspapers, Reader's Digest).

What is about Science

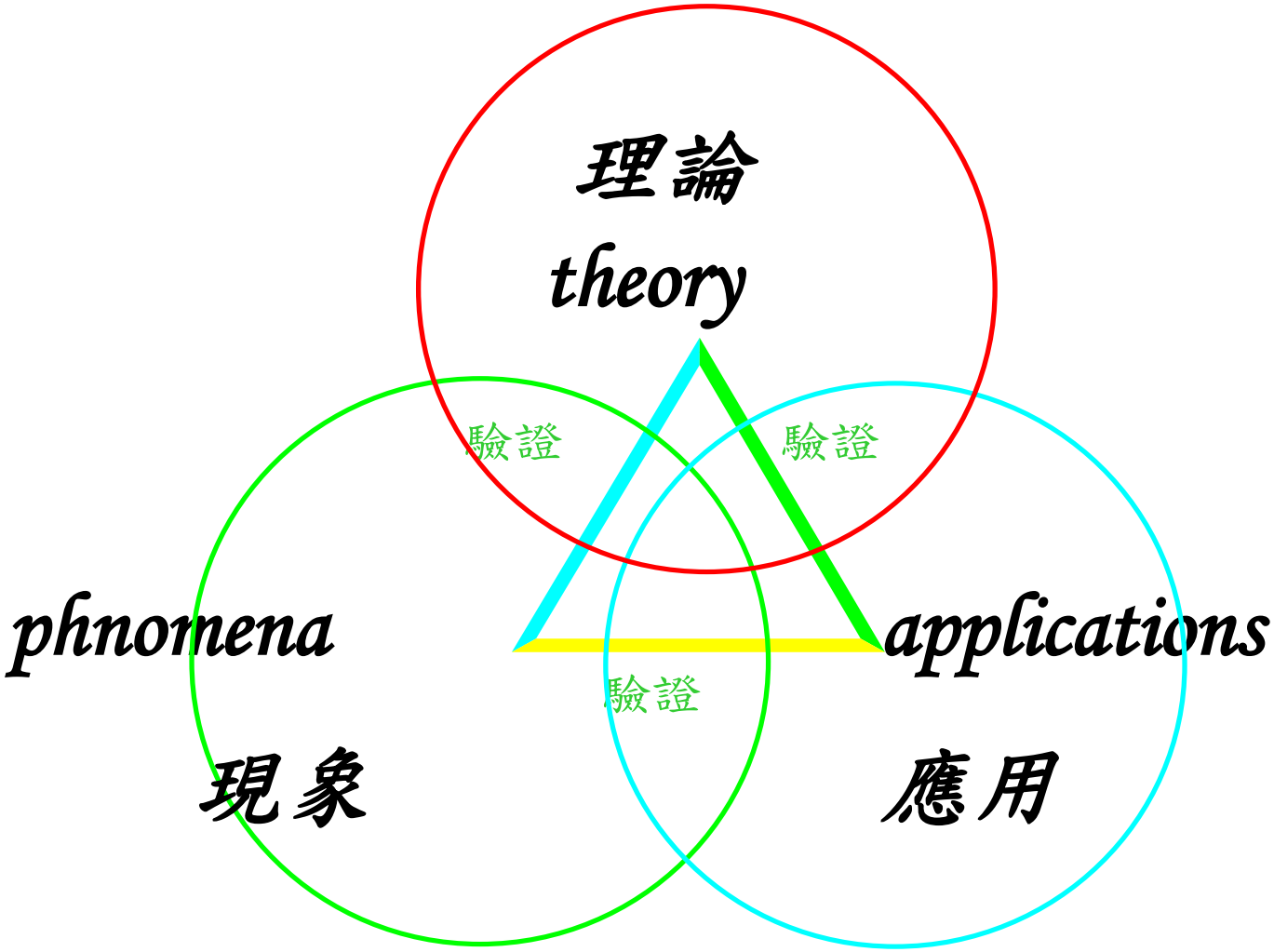
科學引向學與知
Science is to learn and to know.

科學促進理性思維
Science is a process of rational thinking.

科學要求實証
Science requires hard evidence.

陳竹亭

近代科學的要素



陳竹亭

三毛與ＵＦＯ

兩次見UFO

一個偶然的機會，三毛兩次看見UFO。

天文物理學家沈君山很專心地聽完三毛的敘述，然後以連珠炮般的訓戒口吻肯定三毛沒有看見UFO，而只是看見海市蜃樓。

“三毛小姐是感性而直覺的，我則理性而分析的，……科學精神很重要的一點是：不能因為結果吻合了，就去相信”。

看到鬼　現象

是否相信? 過程需合理

看到變出錢　現象

是否能解釋?

魔術

化學 科展

化學研究過程中常需要找尋最佳的條件，影響最佳條件的因素可能不止一個，因此會探討各變因對數據的影響。探討各因素對結果的影響時，千萬別忘記了所從事的是化學研究而不只是各參數最佳化探討。例如氫離子濃度對實驗結果的影響。研究人員應說明為何要探討氫離子濃度對實驗的影響 ，並能根據化學的學理，解釋實驗的結果。

科學雖然未必代表真理，但是必須可以理解且經得起檢驗；科學鼓勵想像與創意，但是仍然服膺證據與邏輯推理；科學抗拒威權，但仍應尊重社會的共識價值，並持守人類基本倫理道德的同理心。

陳竹亭

The Development of a Simple Microbalance for Detecting Volatile Organic Compounds in Chemistry Laboratory

Ting-Nien Lin and Ting-Chun Liu
National Taoyuan Senior High School, Taiwan

Introduction

Organic solvents such as methanol, acetone, etc., are often used in high school chemistry laboratory. These solvents can be easily absorbed by human body through breathing and/or skin contact, and thus may cause serious adverse impacts on students' health.

Piezoelectric crystals such as quartz are known to be sensitive to pressure on their surface. The vibrational frequency of an oscillating piezoelectric crystal decreases as adsorption of a foreign substance onto its surface. As shown in Sauerbrey's equation $\Delta f = -2.3 \times 10^6 f_0^2 (\Delta M/A)$, the variation of vibrational frequency is related to the mass of adsorption materials. This relationship and the theoretical resolution detection limit of oscillating quartz crystals make them ideal choices as gas sensors. Furthermore, the quartz based sensors are often inexpensive and easy to fabricate.

Piezoelectric quartz crystals coated with polymer, e.g. polystyrene and polyacrylonitrile, have been extensively studied. In this study, a simple microbalance based on a commercial quartz crystal and polyaniline adsorbent was developed. The characteristics of the polyaniline coated quartz crystal and its ability in detecting organic vapor in chemistry laboratory are presented.

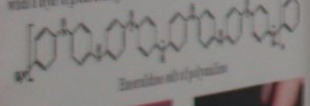
Experimental

1. Chemicals

All chemicals were obtained from Shimakyo's pure chemicals (Japan).

2. Fabrication of polyaniline coated quartz crystals

Piezoelectric crystals used were commercial AT-cut, plano-plano quartz crystals, each 0.22 cm with a basic frequency of 10 MHz and silver-plated metal electrodes on both sides (Tai Tien Electric Co., Ltd., Taiwan). The cost of each crystals is less than 0.5 US dollar each. The crystals were coated with polyaniline via electrochemical means. Before coating, the metal case of the quartz crystal was removed by using a hammer (Fig. 1). Coating solution of aniline was prepared in 2 M HCl solution. Coating was conducted in a home-made polycyclic electrolysis cell as shown in Fig.2. The volume of the cell was less than 1 ml. The voltage was set at 0.8 volt during electrolysis and the reaction was stopped when a layer of green coating was observed.



Emeraldine salt of polyaniline

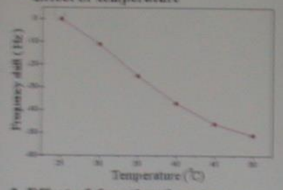
Fig. 1 Quartz crystals
(1) Before removing the metal case
(2) After removing the metal case
(3) After coating with polyaniline

3. Setup of the gas sensor

Results and Discussion

1. Piezoelectric system

Effect of temperature



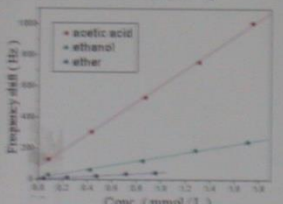
Stability of the system

- With clean air, the variation was found to be 2 Hz in a period of ten minutes at 30°C.
- Using n-butanol as the test solvent, the within-day and between-day reproducibility were found to be 2.6 % and 3.4 % respectively.

Fig. 4 Various temperatures on frequency shift

- Frequency was found to be very sensitive to temperature.

2. Effect of functional group



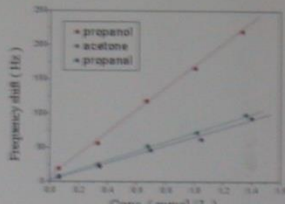


Fig. 5 Various organic solvents on frequency shift

- Frequency shift is proportional to the polarities of the functional groups.
- Coulombic interaction and hydrogen bonding between polyaniline and the test molecules were the major reasons for the greater frequency shifts.

3. Effect of chain length

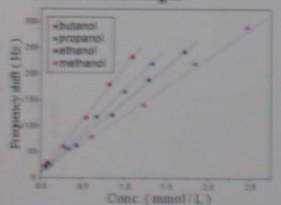


Fig. 6 Alcohols of different chain length on frequency shift

- Greater frequency shifts were observed for alcohols of higher molecular weight.
- Larger frequency shifts are most likely due to the greater mass per adsorbed molecule.

4. Effect of steric hindrance

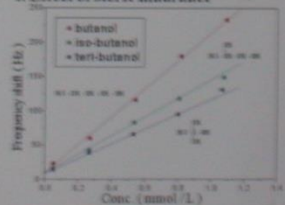


Fig. 7 Butanol isomers on frequency shifts

- Linear molecule exhibited a greater frequency shift than branched molecule.
- The horizontal adsorption of linear molecule provided more efficient adsorption and thus greater frequency shift.

5. Effect of π electrons

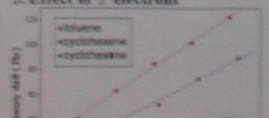


Fig. 8 Organic solvents with different π electrons on frequency shifts

- π - π interaction appeared to enhance the adsorption of alkenes and aromatic molecules.

作品名稱：吸〝氣〞大法-QCM 對有機氣體之吸附與偵測

2. Fabrication of polyaniline coated quartz crystals

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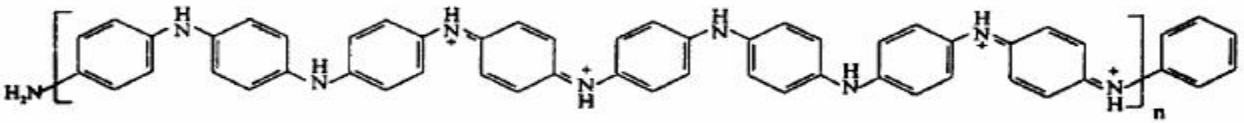
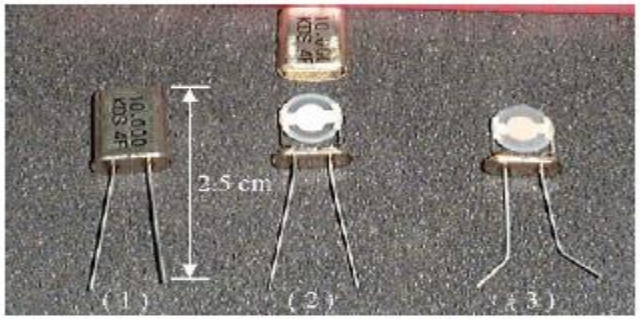


Emeraldine salt of polyaniline



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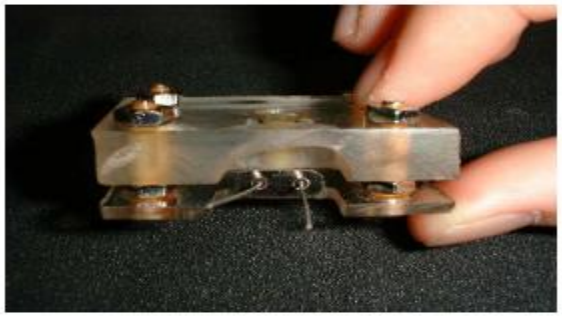
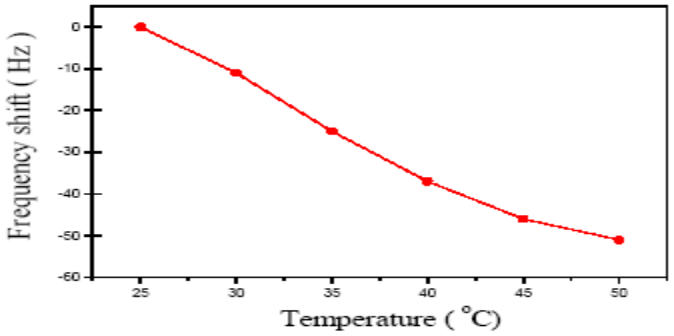


Fig. 2 A homemade polyacrylic electrolysis cell

Results and Discussion

1. Piezoelectric system

Effect of temperature



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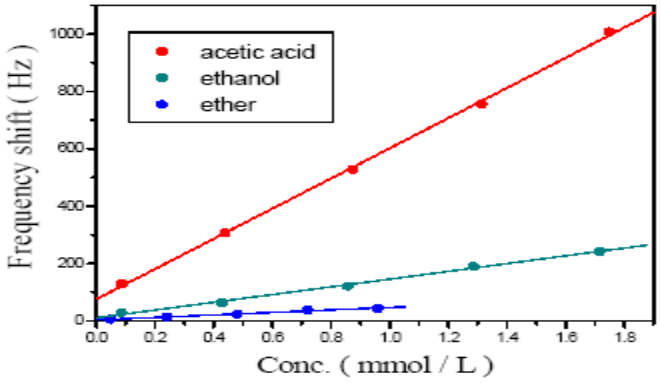

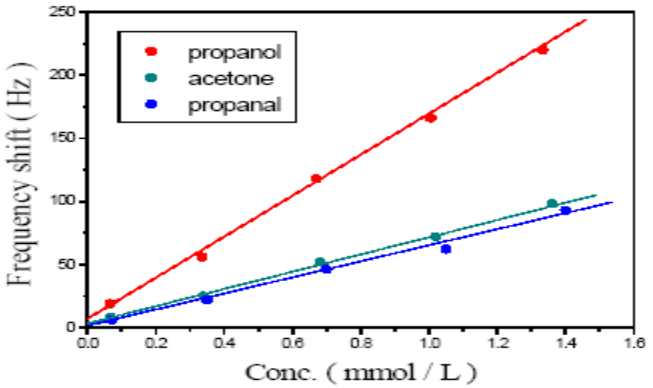

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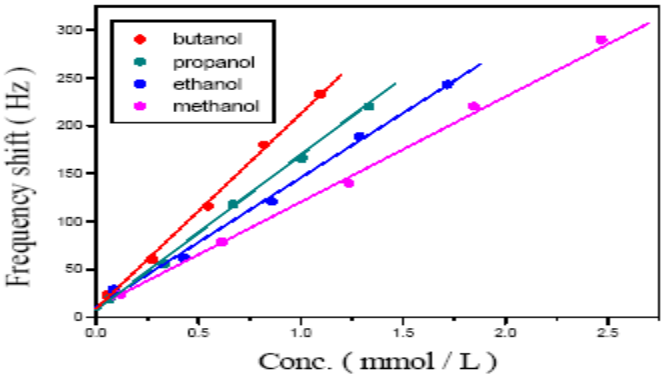

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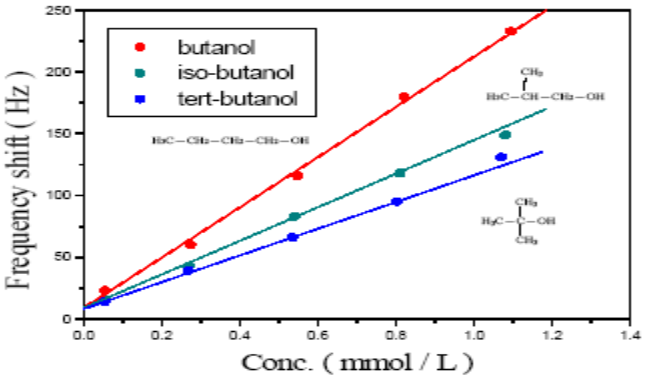

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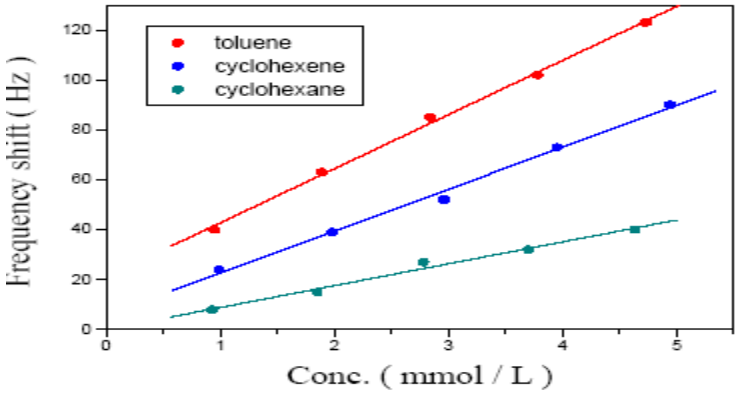


Fig. 8 Organic solvents with different π electrons on frequency shifts

- **π - π interaction appeared to enhance the adsorption of alkene and aromatic**

Conclusions

- A simple and inexpensive quartz crystal microbalance was developed for the detection of organic vapors.
- Acidic and polar compounds were more easily adsorbed onto the surface of the microbalance.
- Coulombic interaction and hydrogen bonding were the most important factors in the adsorption process.
- Smaller frequency shifts of nonpolar compounds were more likely due to the dipole-induced dipole interaction.
- Factors such as the size of molecule, steric hindrance and π electron also affect the adsorption of organic molecules.
- The gas sensor was found to be useful in the detection of organic vapor.

6. Relative response of fourteen organic solvents

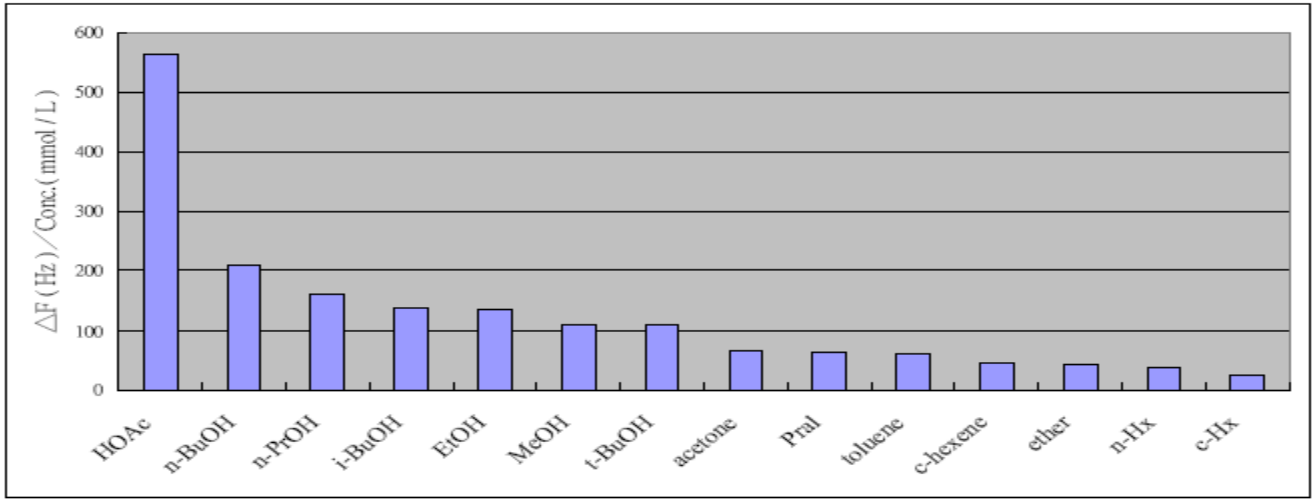


Fig. 9 Frequency shifts of fourteen organic solvents

- **Among the compounds studied, acetic acid showed the greatest frequency shifts followed by alcohol, ketone, aldehyde, aromatic compound, alkene and alkanes.**

7. Detection of organic vapors in the chemistry laboratory of our school

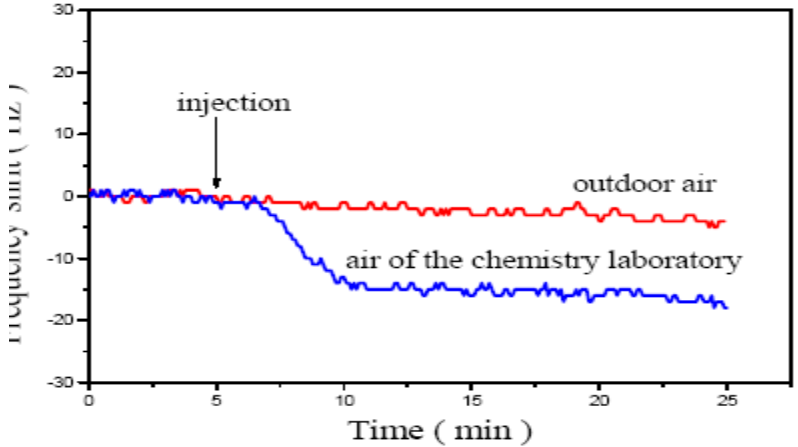


Fig. 10 Frequency shift due to the ethanol vapor in the chemistry laboratory

- **Concentration of ethanol vapor was about 0.055 mmol/L.**

Intel ISEF 名人堂

蔡辰葳

瓦斯熱水爐一氧化碳觸媒轉化器之研究

Optimizing a catalyst fo

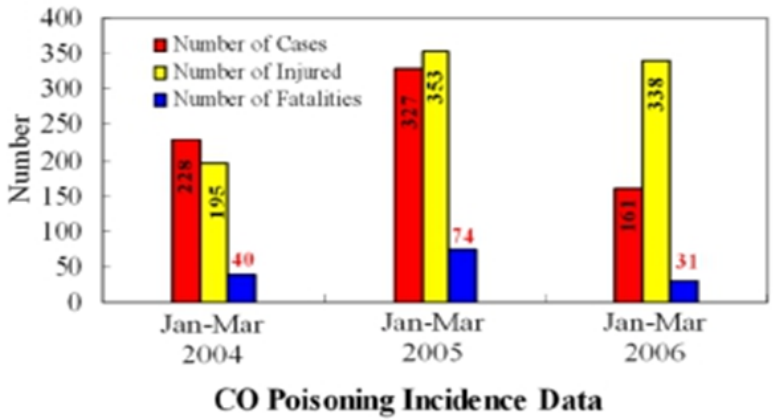
得獎年度：2006年　　科別：化學科

大會化學科最傑出獎 | 大會化學科一等獎

參展時就讀學校：國立高雄師範大學附屬高級中學

Motivation

In Taiwan, gas water heater (GWH) is the most popular heater for taking a hot water shower; however, the horrible news often hits the headlines in newspapers that many careless users of GWH die from inhaling too much carbon monoxide (CO). In this study, a catalyst was designed and generated; the efficiency of the catalyst in terms of reducing the amount of CO from GWH was evaluated.



From: Taiwan National Fire Agency, Ministry of the Interior

Gas water heater

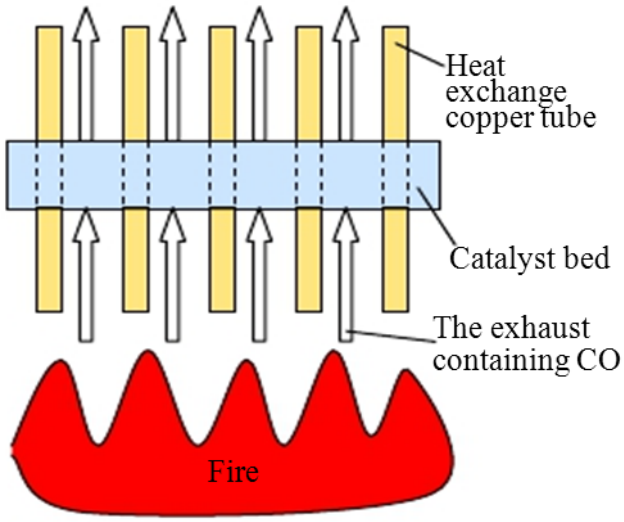
Analysis of the problem

The composition of the exhaust

It was found that at high power output condition often used in winter time where the concentration of CO can reach as high as 10,860 ppm, but that of $O_2$is as low as only 6.2 %.

Strategy—installation a catalytic converter in GWH

A catalytic converter was proposed to place around the heat exchange area. When the GWH is switched on, the high-temperature exhaust will heat the catalyst bed up to the working-temperature, and then convert CO into CO_2 effectively.



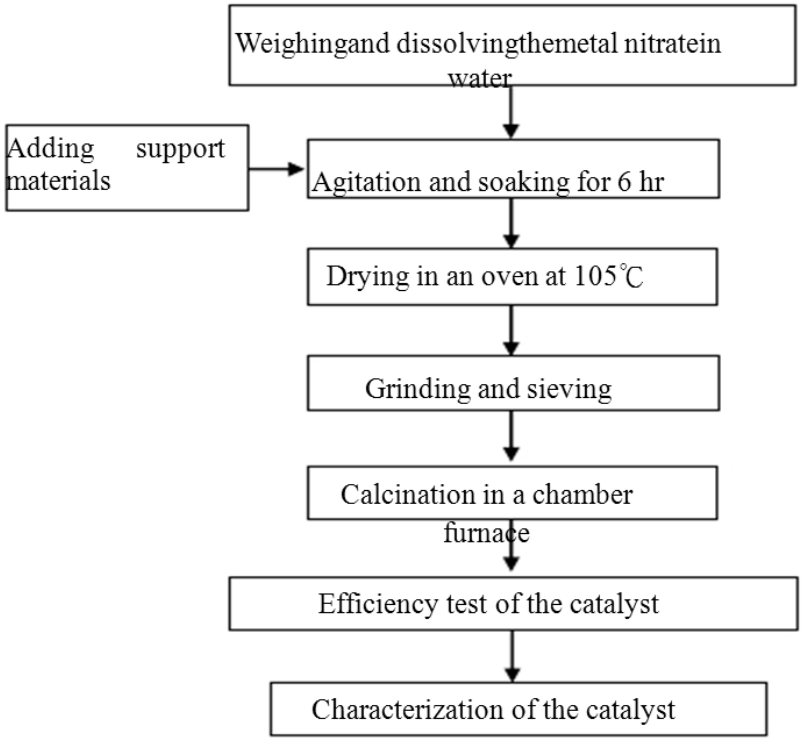
Experimental

Methods

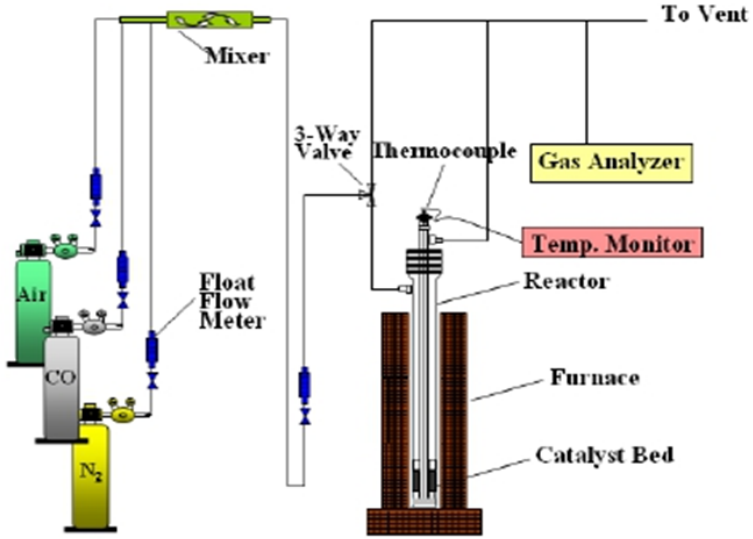
A one-factor-at-a-time experimental plan was performed to search for a suitable catalyst. Four different active metals (cobalt, copper, iron, and nickel), four different supports (silicon oxide, aluminum oxide, titanium oxide, and kaolin), metal to supports ratio (loads 5% to 20%), and calcination temperatures (200 to 500℃) were studied in order to develop a catalyst for the conversion of CO.

Procedures

Catalyst preparation



The schematic diagram of the apparatus for the catalytic reactions



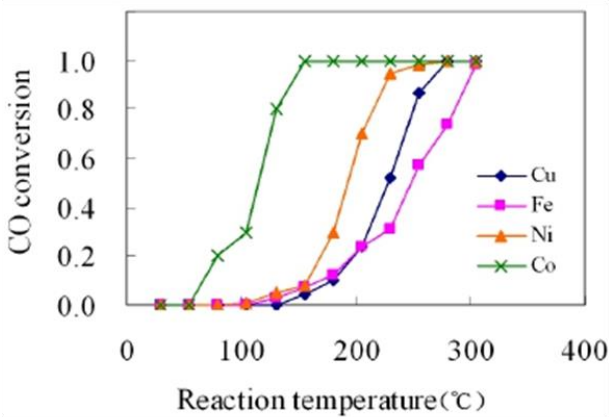
The reactants were the standard gas of CO diluted with nitrogen and air to reach the required concentration. The oxygen concentration was kept at 6% in all tests.

Results and Discussion

Composition of the suitable catalyst

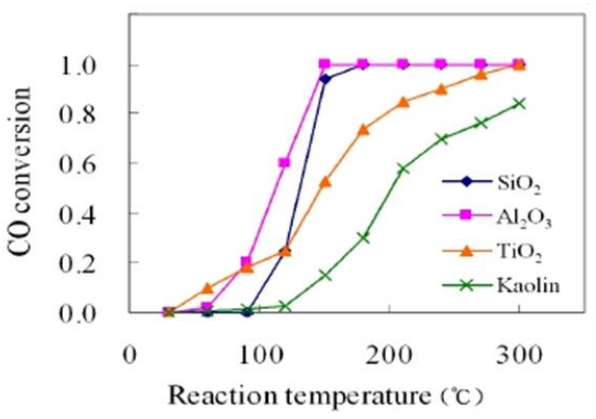
Selection of active metal and the support

Active Metal



Cobalt nitrate showed the highest CO conversion efficiency at all temperature test.

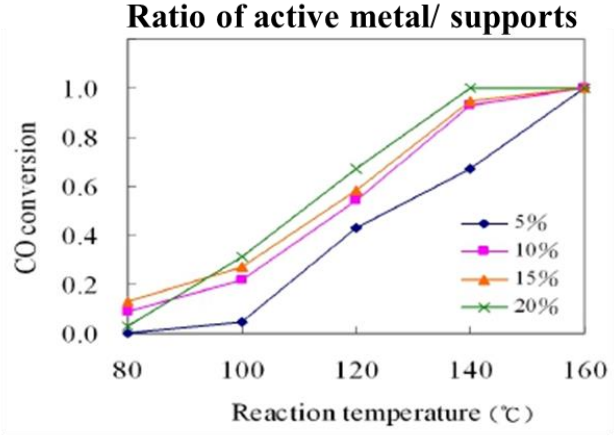
Support



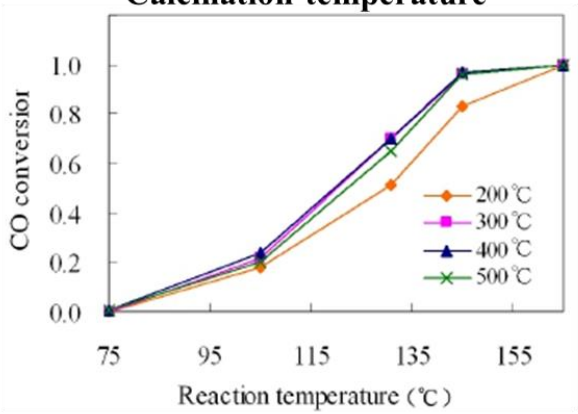
Aluminum oxide showed the highest CO conversion efficiency at all temperature test.

Ratio of active metal/support and the calcination temperature

Ratio of active metal/ supports



Calcination temperature



Summary

1) Co was the most effective active metal

2)Aluminum oxide was the best support

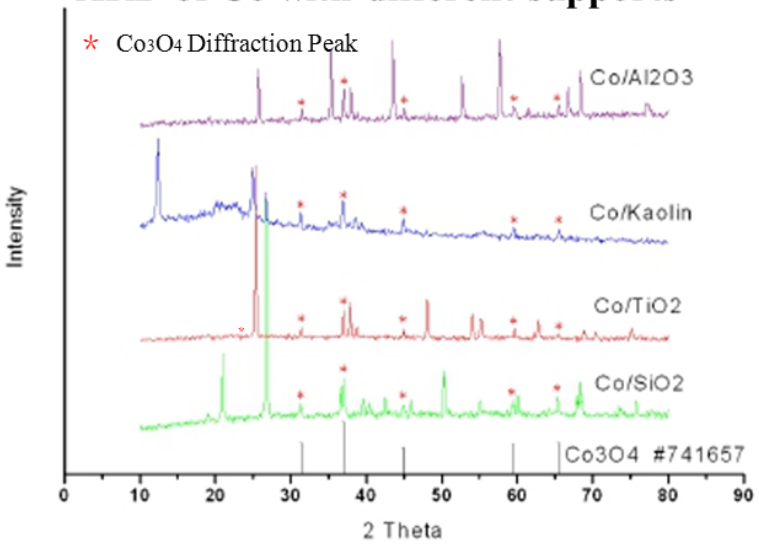
3) Co toAl_2O_3 ratio at 10% was reasonable good

4) The best calcination temperature was 300℃

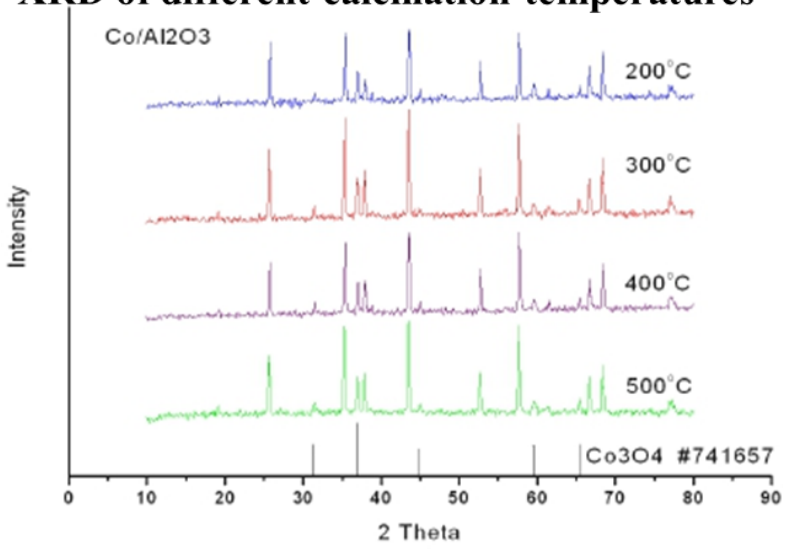
Identification of the catalyst

X-ray Diffraction Spectroscopy (XRD)

XRD of Co with different supports



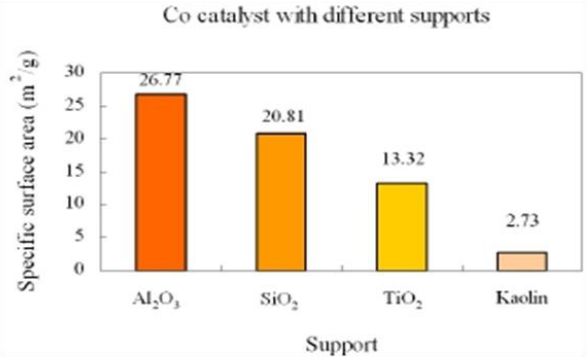
XRD of different calcination temperatures

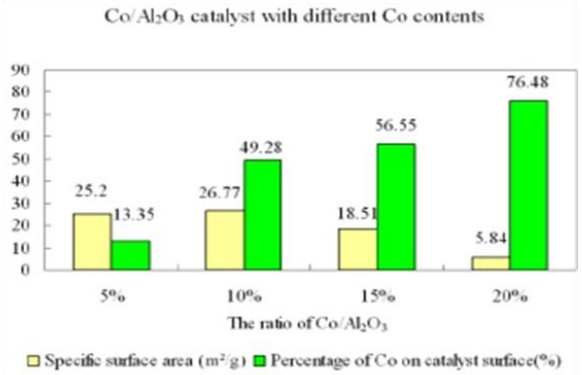


1. The active metal was found to be Co_3O_4.
2. The types of support and the calcination temperature did not influence the crystallization type of Co_3O_4.

BET-specific surface area and Scanning Electron Microcopy (SEM)

BET-specific surface area

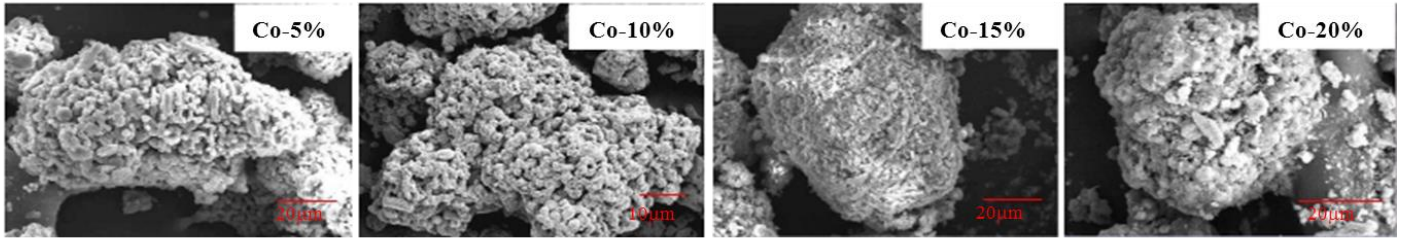




The aluminum oxide has the highest surface area, which is consistent, the fact that it was found to be the best support.

The specific surface area with higher cobalt decreased. High Co/specific area were observed 15 and 20% Co content which suggest that the holes might be aggregated with the particle of Co_3O_4.

The SEM of Co/Al_2O_3catalyst



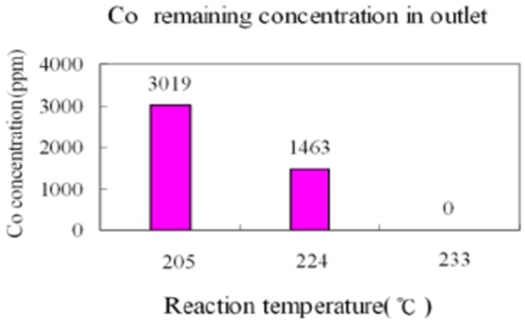
Based on specific area and SEM data, 5% and 10% Co have porous holes for gas to pass through, whereas holes of 15% and 20% were clogged with particle of Co_3O_4.

Catalyst practicability

Conversion efficiency

Space Velocity (min^{-1})	Inlet CO (ppm)	Inlet O_2 (%)	Reaction Temperature (℃)	Outlet CO (ppm)
500	3,500	6	206	0
1,000	3,500	6	224	0
1,000	15,000	6	233	0

Space velocity（min^{-1}）＝Reactant flow（L/min）÷ catalyst volume (L)



Inlet CO: 15,000ppm O_2: 6%

Catalyst volume

Suppose that the fuel burns at 0.045 Nm^3/min (under high power output), the reaction temperature is 233℃ (506.15K), and the O_2 concentration in exhaust is 6%; the volume of catalyst bed was calculated to be about 1.3 L, which is practical to be installed in a family-size gas water heater.

Conclusions

1) The catalyst of Co/Al_2O_3 with the Co content of 10%, calcined at 300℃ displays the highest catalytic performance.
2) The Co metal is existed as Co_3O_4; calcination temperature and types of support did not influence the crystallization type of Co.
3) Co_3O_4 has the highest surface area. The catalyst aggregates at higher Co content.
4) The optimized catalyst is able to completely eliminate CO at a concentration as high as 15,000 ppm at a space velocity of 1,000 min^{-1} at all below 233℃.

References

1. G. C. Bond (1986) "Heterogeneous Catalysis: Principles and Applications", 2nd Edition.
2. J. Zhang (1996) "Heterogeneous Reaction Catalyst: Characteristic & Application", 1st Edition.
3. J. B. McCammom, L. E. McKenzie & M. Heinzman (1996) "Carbon Monoxide Poisoning Related to the Indoor Use of Propane-Fueled Forklifts in Calarado Workplaces" *Applied Occupational and Environmental Hygiene*, volume 11. Issue 3, P.192-198.

化學科 (Chemistry)
Intel ISEF 大會獎 – 化學科第四名 (Forth Award)，獎金 500 美元
作品：可重複使用之新型固體酸在藥物合成與生質能的催化應用
沈玉宣，女，臺北市立第一女子高級中學　　2014

化學科 (Chemistry)
第四名，獎金500美元
作品：氧化亞銅奈米複合材料於非酵素型葡萄糖感測器之應用
王琳嘉，女，17歲，台北市立第一女子高級中學
林依萱，女，16歲，台北市立第一女子高級中學　　2015

化學科（Chemistry）
大會獎第三名（Grand Awards – Third Award），獎金 1,000 美元
作品：吸收紫外光之透明有機薄膜太陽能電池
林承霈，女，16 歲，台北市立第一女子高級中學

Introduction

Nowadays, the commercially available solar cells are made of material that absorbs the visible light and are often not transparent. Ultra-violet (UV)-sensitive organic solar cells (OSCs) can be colorless and transparent to human eyes. This kind of OSC has potential to mount on our house glasses and able to generate renewable energy for our daily lives.

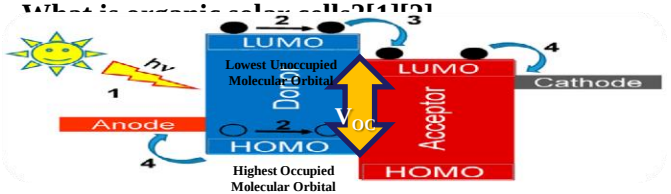


Fig.1 Device working principle.

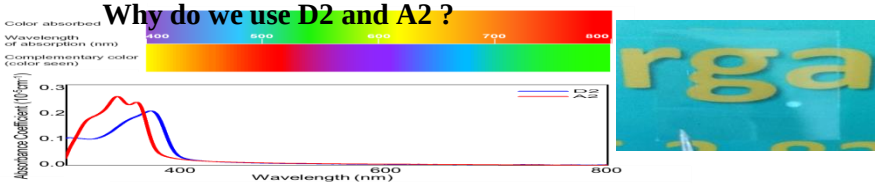


Fig.2 Color absorbed and color seen and the mixed film of D2 and A2.

Objectives and Approaches

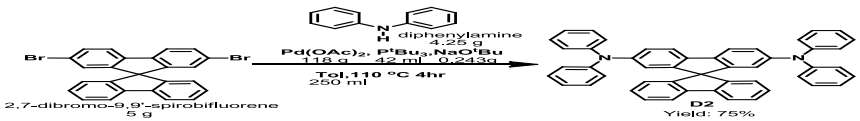
To develop UV-Light sensitive transparent organic solar cells.

- Synthesize UV-sensitive materials, donor material D2 and acceptor material A2[3].

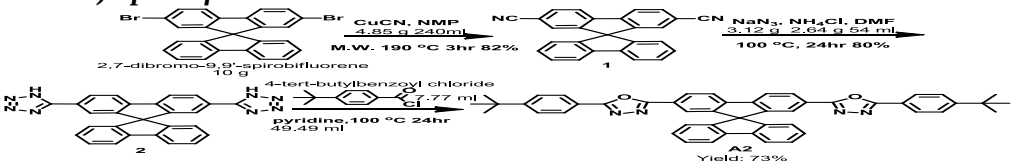
Methods

1. Synthesis of D2 and A2

1) Spirobifluorene-based D2



2) Spirobifluorene-based A2



NMR and Mass Spectrometry were used to determine their chemical structures and molecule weights.

2. Device Fabrication

Thermal Evaporator was used to fabricate the OSC devices (Fig.3).

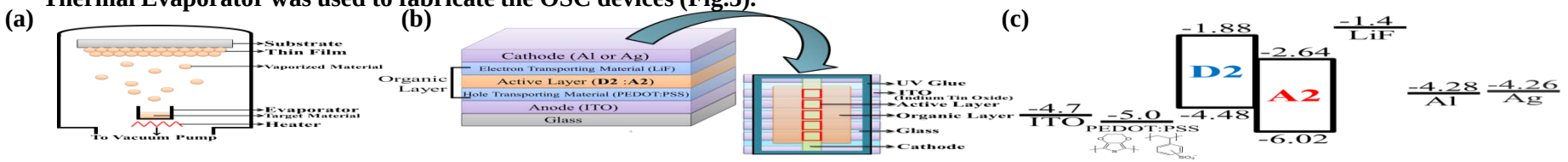
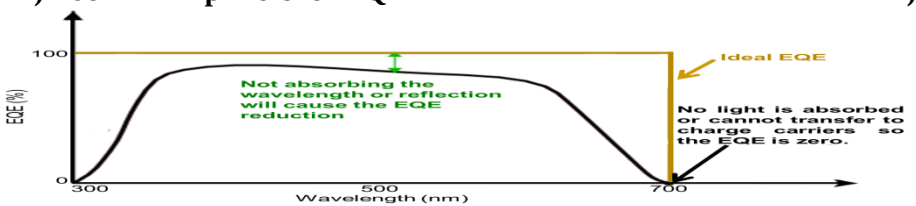


Fig.3 (a) Thermal Evaporator, (b) Structure and top view of each device, (c) Energy band diagram of devices.

3. Measuring External Quantum Efficiency and Power Conversion Efficiency[4]

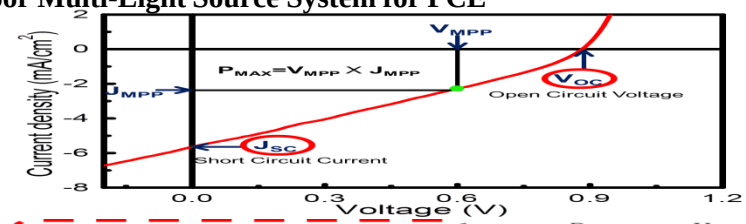
1) Lock-In Amplifiers for EQE



$$EQE = \frac{\text{The number of carriers}}{\text{The number of photons}}$$

Fig.4 EQE spectrum.

2) Indoor Multi-Light Source System for PCE



$$PCE = \frac{P_{out}}{P_{in}} = \frac{V_{OC} \times J_{SC} \times FF}{P_{in}} \qquad FF = \frac{P_{MAX}}{V_{OC} \times J_{SC}} = \frac{V_{MPP} \times J_{MPP}}{V_{OC} \times J_{SC}}$$

FF: Fill Factor

Fig.5 Light current-voltage characteristics measurement.

Results and Discussion

1. Photophysical Properties of D2 and A2

Absorption spectra of D2 and A2 were analyzed in solution, and transmittance spectra were recorded for D2, A2, and D2:A2 (1:1) mixed film.

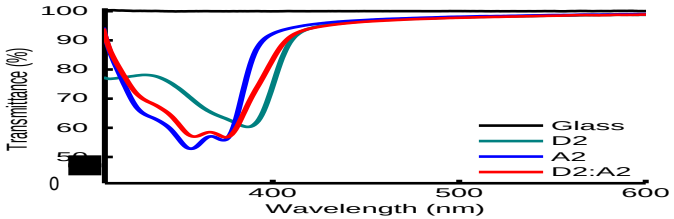


Fig.6 Transmittance spectra (film).

	λ_{max} in CH_2Cl_2 (nm)	ε_{max} in CH_2Cl_2 ($M^{-1}cm^{-1}$)
D2	381	68000
A2	352	95000

1) Both D2 and A2 absorb UV-light with high extinction coefficient.
2) The absorption of D2:A2 (1:1) mixed film is only the combination of the pure D2 and A2 films.
3) These films show high transmittance in the visible light region with an average of

2. UV-Sensitive OSCs with Aluminum Cathode

The devices with Al cathode were fabricated for the purpose of knowing whether D2 and A2 can serve as the donor and acceptor, respectively, in organic solar cells.

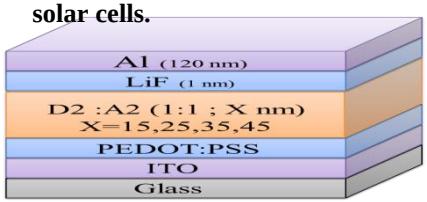


Fig.7 OSC with Al cathode.

Fig.8 Photo of the device.

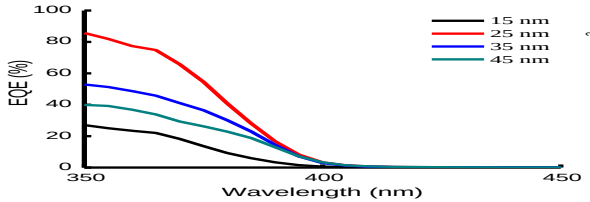


Fig.9 EQE spectrum with different thickness.

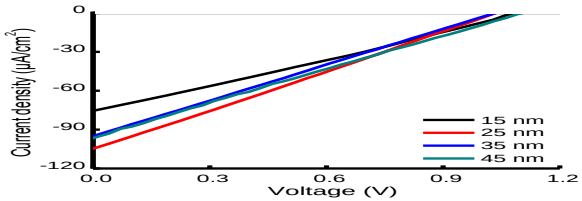


Fig.10 Light current-voltage characteristics.

Incident Power Density: 170 μW/cm² (i.e. living room, classroom conditions)

Thickness (nm)	V_{OC} (V)	J_{SC} (μA cm^{-2})	FF (%)	PCE (%)	Vmax (V)	Pmax (μW)	EQE at 350 nm (%)
15	1.10	75.5	26.3	12.9	0.06	1.00	27.1
25	1.03	105.0	24.5	15.6	0.46	1.06	85.7
35	1.03	95.0	25.1	14.5	0.55	1.22	52.9
45	1.10	96.4	24.5	15.3	0.58	1.04	39.9

Table 1 D2 and A2 device's data.

1) D2 and A2 can serve as the donor and acceptor materials in OSC active layer.
2) The best performance was given by device with 25 nm active layer, whose PCE is 15.6% (Table 1) and EQE up to 85.7% (Fig. 10).
3) The organic layer is transparent, but not Al cathode.

3. UV-Sensitive OSCs with Transparent Cathode

The Al cathode was changed to Ag for higher transmittance.

Fig.15 Transparent device (left) and glass (right).

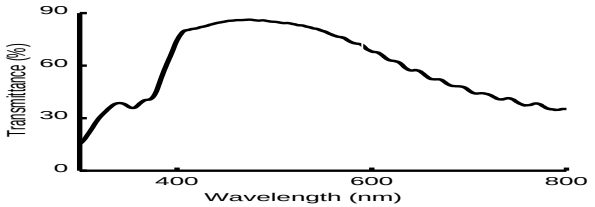


Fig.16 Transmittance spectrum of device.

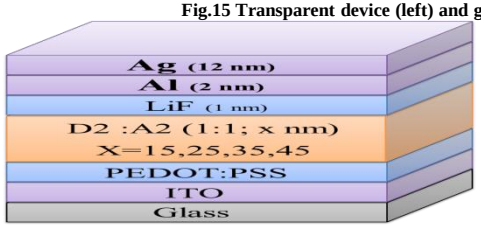


Fig.11 OSC of the device.

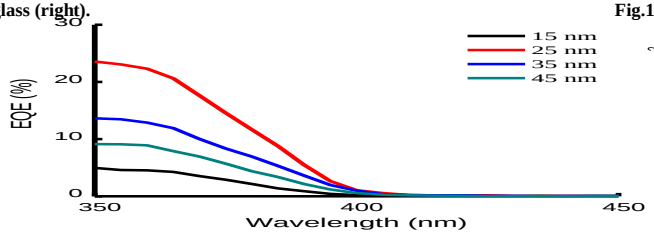


Fig.14 EQE spectrum with different thickness.

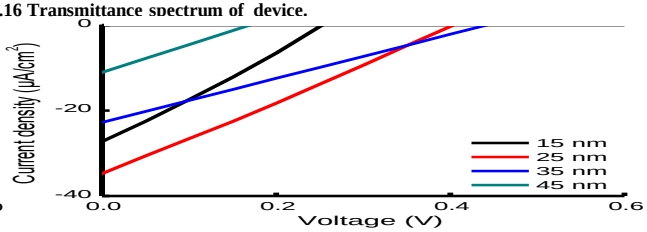


Fig.13 Light current-voltage characteristics.

Incident Power Density: 170 μW/cm^2 (i.e. living room, classroom conditions)

Thickness	V_{OC} (V)	J_{SC} (μA cm^{-2})	FF (%)	PCE (%)	Vmax (V)	Pmax (μW)	EQE at 350 nm (%)
15 nm	0.30	36.1	27.3	1.8	0.15	0.11	5.0
25 nm	0.40	43.3	26.1	2.7	0.20	0.18	23.6
35 nm	0.49	28.8	25.0	2.0	0.24	0.14	13.6
45 nm	0.17	18.7	24.6	0.5	0.10	0.03	9.1

Table 2 Transparent device's data.

1) The device with Ag cathode showed higher transmittance than the device with Aluminum cathode.
2) The best PCE was 2.7% with 25 nm thickness and EQE is 23.6% (Table 2).

4. UV-Sensitive OSCs under Different Irradiation

The OSC device was measured under different intensity of UV-light for knowing its performance in different conditions.

Intensity (μW/cm^2)	V_{OC} (V)	J_{SC} (μA cm^{-2})	FF (%)	PCE (%)	Vmax (V)	Pmax (μW)
170	0.45	156.0	26.16	11.0	0.23	0.75
120	0.47	121.0	25.39	12.0	0.23	0.58
80	0.39	97.3	25.18	12.1	0.19	0.38
40	0.29	68.4	25.16	12.5	0.14	0.20

Table 3 Data of the devices under different irradiation.

1) The device showed higher PCE under the lower intensity of UV-light.
2) The J_{SC} was raised when increasing the incident intensity of light.

Self-Powered UV Detector

These materials are visually transparent, UV absorbing, and energy generating, so the D2 and A2 OSC can also form the self-powered UV detector, and this provide the information of UV-light intensity. This real time information may alert people to take necessary measurements for protecting their bodies from harmful UV exposure. For example, coating the materials on the eye-glasses to become carried-on UV detector which can protect eyes from UV exposure.

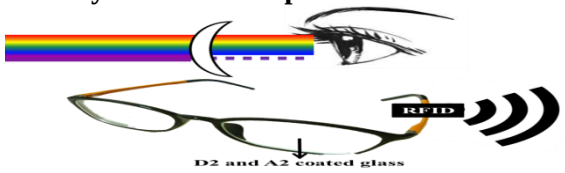


Fig.17 Conception of UV-sensitive detector.

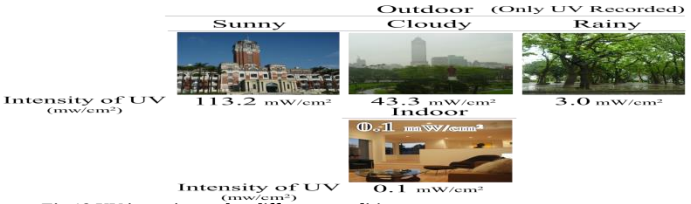


Fig.18 UV intensity under different conditions.

Conclusions

1. D2 and A2 can serve as donor and acceptor for UV-sensitive OSCs because of suitable energy levels alignment [Fig.3(c)].
2. D2, A2, and D2:A2 mixed film showed high transmittance in visible region (Fig. 6).
3. Semi-transparent OSCs were developed with a thin Ag electrode and can achieve a PCE of 2.7% (Table 2) under weak light condition.
4. The UV-sensitive daul-function device can serve as not only the transparent OSC but also the self-powered UV detector because of its photocurrent generation functions.

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2. P. Kumaresan, S. Vegiraju, Y. Ezhumalai, S.-L. Yau, C. Kim, W.-H. Lee , M.-C. Chen, *Polymers* **2014**, *6*, 2645-2669.
3. H.-W. Lin, S.-Y. Ku, H.-C. Su, C.-W. Huang, Y.-T. Lin, K.-T. Wong, C.-C. Wu, *Adv. Mater*. **2005**, *17*,2489-2493.
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Tips for Effective Posters

Make the
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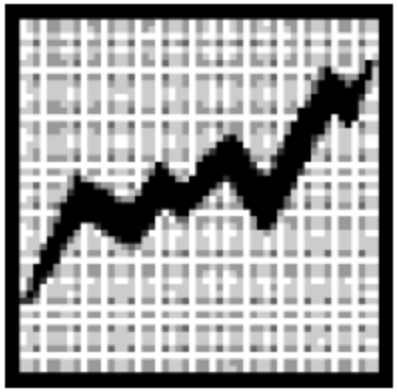
to educated
laypeople

Effective posters share the following traits:

- Viewer-friendly style with large (not small) typeface & informative subheadings
- Use pictures, drawing and cartoons to present the majority of the information
- Small offerings of information vs. long paragraphs of text (bullets not sentences)
- Logical and orderly progression of presentation of information
- Summary statement(s) of key aspects
- Easily understood language without jargon or undefined acronyms

Tips for Effective Posters



Minimize Text -

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(Hint: A poster is not a research paper.)

壁報≠研究報告

條理清晰

重點明確

簡要易懂

作者不在場的情形下仍能明確的傳達主要訴求及所獲得的成果。

數量分立器	DataStudio 數據擷取軟體		
白金棒	造鈷家(12000-14000hz) (TESUNG)	電壓轉換器(PEGO)	鹼性鋅錳乾電池(電流錶)
磁棒	若基鐵 CoB_2O_4 (氧化物研究所)	甲基藍 $C_{16}H_{18}ClN_3S$ (氧化物研究所)	
pH計	磁氧化鐵 $FeFe(CN)_6$ Ferak Laborat Gmbh	過硫氧二銨 $(NH_4)_2S_2O_8$ (中強公司有限公司)	
		過硫氧二鉀 $K_2S_2O_8$ (中強公司有限公司)	

磁鐵	1	2	3	4	5	6	7	8	9	0
電壓差(V)	0.026	0.038	0.051	0.031	0.039	0.045	-0.021	0.046	0.005	0.00

	1	2	3
電壓差	-0.001	-0.004	0.001

	1	2	平均
電壓差	0.043	0.053	0.048

	第一次	第二次	第三次
電位差(V)	0.079	0.089	0.109	0.125
	0.33	0.055	0.076	0.101
	0.080	0.100	0.140	0.067

	1	2	3
ΔV	0.148	0.108	0.142	0.158	0.210

	1	2	3
ΔV	0.148	0.180	0.195

	1	2	3
電壓差	0.148	0.180	0.195

	1	2	3
電壓差	0.148	0.180	0.195

	溶液15分鐘	溶液	細菌15分鐘
電壓(V)	0.272	0.252	0.240
	0.247	0.237	0.229
	0.240	0.231	0.213

	溶液15分鐘	溶液	細菌15分鐘
電壓(V)	0.272	0.252	0.240
	0.247	0.237	0.229
	0.240	0.231	0.213

金屬離溶液(A)	氧化劑(B)	水晶體(C)
20mL 鐵離溶液 +0.5mL 鐵離溶液	20mL 鐵離溶液+0.5mL 1M 的 KCl 鐵離溶液	20mL 鐵離溶液+0.5mL 0.5M 水晶體鐵離溶液

	金屬離溶液(A)	氧化劑(B)	水晶體(C)
電壓差	第一次	0.042	0.105	0.250
	第二次	0.067	0.214	0.217
	第三次	0.076	0.092	0.228
	平均	0.062	0.104	0.231

pH值	pH=4.0	pH=7.4		pH=4.0	pH=7.4
電壓	△V(V)	△V(V)		△V(V)	△V(V)
	-0.038	+0.061		+0.028	+0.181
白金	-0.044	+0.084	磁棒	+0.020	+0.145
	-0.043	+0.059		+0.037	+0.143
平均	-0.042	+0.068	平均	+0.028	+0.156

1. DARRELL DEBRING GENERAL CHEMISTRY third edition, Wayne State University, A-9～A-14

結合幾丁聚醣及聚麩胺酸對重金屬離子吸附之研究

－研發全新吸附暨檢測之循環系統

研究動機

研究目的

實驗器材

實驗流程

實驗原理與方法

研究結果

結論

Introduction

It is known that the diamagnetic and zero-resistance nature of superconductors can greatly reduce the amount of energy lost. In 2008, iron-based superconductors were discovered and helped lead to a theory of non-BCS-theory superconductivity. Iron-Selenium was found to be a new toxicity-free superconductor, which has a simple crystal structure. Recent publications[2] indicate that turning superconductors into nanoscale particles may enhance their superconducting critical temperature (Tc). Therefore, in our project, we found three effective chemical routes to synthesize FeSe into nanocrystals and found that the tetragonal FeSe1-x shows a Tc (40 K) that is higher than that of their bulk form (7 K) [1] .

Objectives

1. To find an effective method for synthesizing FeSe nanocrystals with higher Tc
2. To study the physical and superconducting properties of FeSe nanocrystals

Experimental

Flow Chart

Improvement of chemical synthesis: 1. **HDOL**-TOP hot injection → modification → 2. **EG**-TOP hot injection → modification → 3. **HDA**-TOP hot injection

Physical analysis : •X-ray diffraction (XRD) •Scanning electron microscope (SEM) •Transmission electron Microscope (TEM) •Magnetization (M) •Magnetic susceptibility (χ) → Data analysis

1. HDOL-TOP hot injection method (a) with Fe^{3+} (b) with Fe^{2+}

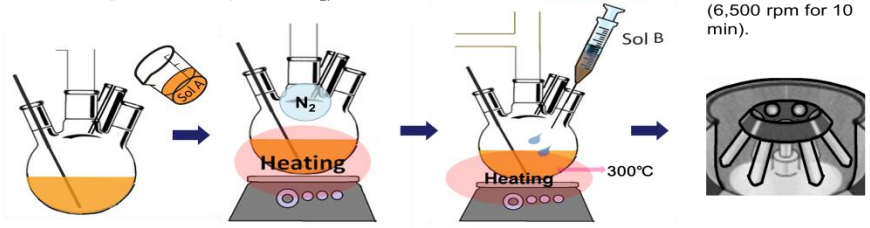
Solution A: 1 gram of Hexadecanediol (HDOL), and 8 ml of benzyl ether
Experiment (a) 1 mmol of Iron(III) acetylacetonate, Experiment (b) 1mmol of $Fe(CH_3COO)_2$
Solution B: 2 mmol of Se powder and 2 ml of TOP and 5 mmol of TOPO

1. **Solution A** were added into a three-neck boiling flask.

2. We heated it up to 300 °C in a closed system of N_2.

3. After the solution in step 3 reached 300 °C, we added in **solution B**.

4. The products were centrifuged after reaction (6,500 rpm for 10 min).



(2) EG-TOP hot injection method

Solution A: 5 ml EG (ethylene glycol) and 1 mmol of $FeCl_2 \cdot 4H_2O$
Solution B: 0.5 mmol of Se powder and 2 ml of TOP
Reaction temperature: 200 °C
Reaction time: 2 hours

(3) HDA-TOP hot injection method

Solution A: 14 mmol of HDA (1-hexadecylamine) and 4 mmol of $Fe(CO)_5$
Solution B: 4 mmol of Se and 16 mmol of TOPO and 3 ml of TOP
Reaction temperature: 250 °C
Reaction time: 1 hour

Introduction

Iron-Selenium has been found to be a new toxicity-free superconductor, that has a simple crystal structure. Recent publications[2] indicate that turning superconductors into nanoscale particles may enhance their superconducting critical temperature Tc . We found three effective chemical routes to synthesize FeSe into nanocrystals and study their superconducting properties. There are several phases and crystal structures in the Fe-Se series. Among them, the tetragonal $FeSe_{1-x}$ shows a Tc that is higher than that of their bulk form at 7 K [1].

Objectives

1. To find an effective method for synthesizing FeSe nanocrystals
2. To study the physical and superconducting properties of FeSe nanocrystals

Materials and Methods

Flow Chart

1. HDOL-TOP hot injection
2. EG-TOP hot injection
3. HDA-TOP hot injection

→ •X-ray diffraction (XRD) •Scanning electron microscope (SEM) •Magnetization (M) •Magnetic susceptibility (χ) → Data analysis

(1) HDOL-TOP hot injection method

Through pilot study, we discovered that the use of strongly acidic or strongly basic solutions producing no optimal FeSe nanocrystals, since it is difficult to prevent oxidation. We then employed TOPO-TOP (trioctylphosphine oxide/ trioctylphosphine) to dissolve selenium and heated FeSe in an oily environment to produce FeSe.

Steps:
1. **Solution A**: 1 mmol of Iron(III) acetylacetonate $[Fe(acac)_3]$ and 2 ml of benzyl ether
2. **Solution B**: 2 mmol of Se powder and 2 ml of TOP, were added in a 5 ml of TOPO solution.
3. One gram of Hexadecanediol (HDOL), 8 ml of benzyl ether and **solution A** were added into a three-neck boiling flask. Then, we slowly heated it up (~5 °C / min) to 300 °C in a closed system of N_2 .
4. After the solution in step 3 reached 300 °C, we added in **solution B** and maintained the heat for 5 minutes.
5. The products were centrifuged after reaction (6,500 rpm for 10 min).

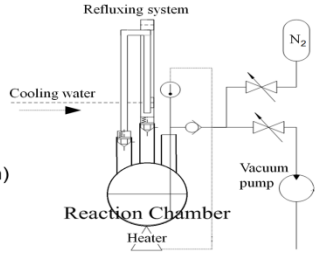


Fig. 1 Experimental device

(2) EG-TOP hot injection method

Steps[3] **:**
1. **Solution A**: 1 mmol of $FeCl_2 \cdot 4H_2O$ and 5 ml EG (ethylene glycol) were mixed at 100 °C.
2. **Solution B**: 0.5 mmol of Se powder and 2 ml of TOP were mixed at 120 °C.
3. **Solution A** was added into a three-neck boiling flask and slowly heated to 200 °C in a closed system of N_2 .
4. After the solution in step 3 reached 200 °C, we added in **solution B** and maintained the heat at 200 °C for 2 hours.
5. The products were centrifuged after reaction (6,500 rpm for 10 min).

(3) HDA-TOP hot injection method

Steps[4] **:**
1. **Solution A**: 14 mmol of HDA (1-hexadecylamine) and 16 mmol of TOPO were heated up to 160 °C.
2. **Solution B**: 3 ml of TOP, 4 mmol of Se and 4 mmol of $Fe(CO)_5$
3. The well-mixed **solution A** and **solution B** were added into a three-neck boiling flask and heated to 250 °C slowly, and then maintained the heat for 1 hour.
4. When the solution cooled down to 80 °C, we poured it into hexane/ethanol.
5. The products were centrifuged after reaction (6,500 rpm for 10 min).

The Development of a Simple Microbalance for Detecting Volatile Organic Compounds in Chemistry Laboratory

Ting-Nien Lin and Ting-Chun Liu
National Taoyuan Senior High School, Taiwan

Introduction

Organic solvents such as methanol, acetone, etc., are often used in high school chemistry laboratory. These solvents can be easily absorbed by human body through breathing and/or skin contact, and thus may cause serious adverse impacts on students' health.

Piezoelectric crystals such as quartz are known to be sensitive to pressure on their surface. The vibrational frequency of an oscillating piezoelectric crystal decreases as adsorption of a foreign substance onto its surface. As shown in Sauerbrey's equation $\Delta f = -2.3 \times 10^6 f_0^2 (\Delta M/A)$, the variation of vibrational frequency is related to the mass of adsorption materials. This relationship and the theoretical resolution detection limit of oscillating quartz crystals make them ideal choices as gas sensors. Furthermore, the quartz based sensors are often inexpensive and easy to fabricate.

Piezoelectric quartz crystals coated with polymer, e.g. polystyrene and polyacrylonitrile, have been extensively studied. In this study, a simple microbalance based on a commercial quartz crystal and polyaniline adsorbent was developed. The characteristics of the polyaniline coated quartz crystal and its ability in detecting organic vapor in chemistry laboratory are presented.

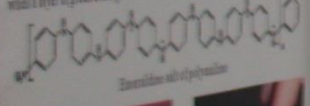
Experimental

1. Chemicals

All chemicals were obtained from Shimakyo's pure chemicals (Japan).

2. Fabrication of polyaniline coated quartz crystals

Piezoelectric crystals used were commercial AT-cut, plano-plano quartz crystals, each 0.22 cm with a basic frequency of 10 MHz and silver-plated metal electrodes on both sides (Tai Tien Electric Co., Ltd., Taiwan). The cost of each crystals is less than 0.5 US dollar each. The crystals were coated with polyaniline via electrochemical means. Before coating, the metal case of the quartz crystal was removed by using a hammer (Fig. 1). Coating solution of aniline was prepared in 2 M HCl solution. Coating was conducted in a home-made polycyclic electrolysis cell as shown in Fig.2. The volume of the cell was less than 1 ml. The voltage was set at 0.8 volt during electrolysis and the reaction was stopped when a layer of green coating was observed.



Emeraldine salt of polyaniline

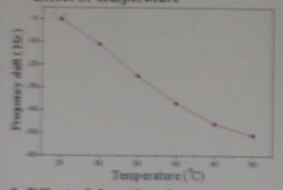
Fig. 1 Quartz crystals
(1) Before removing the metal case
(2) After removing the metal case
(3) After coating with polyaniline

3. Setup of the gas sensor

Results and Discussion

1. Piezoelectric system

Effect of temperature



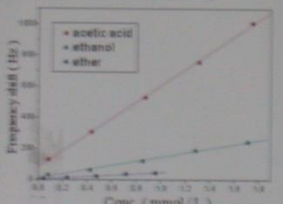
Stability of the system

- With clean air, the variation was found to be 2 Hz in a period of ten minutes at 30°C.
- Using n-butanol as the test solvent, the within-day and between-day reproducibility were found to be 2.6 % and 3.4 % respectively.

Fig. 4 Various temperatures on frequency shift

- Frequency was found to be very sensitive to temperature.

2. Effect of functional group



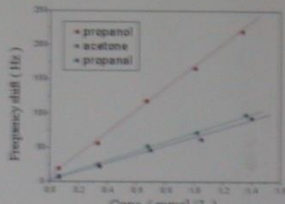


Fig. 5 Various organic solvents on frequency shift

- Frequency shift is proportional to the polarities of the functional groups.
- Coulombic interaction and hydrogen bonding between polyaniline and the test molecules were the major reasons for the greater frequency shifts.

3. Effect of chain length

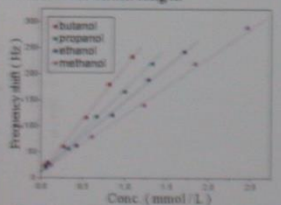


Fig. 6 Alcohols of different chain length on frequency shift

- Greater frequency shifts were observed for alcohols of higher molecular weight.
- Larger frequency shifts are most likely due to the greater mass per adsorbed molecule.

4. Effect of steric hindrance

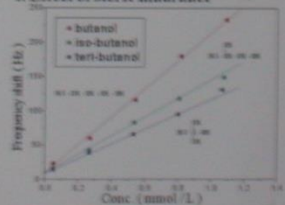


Fig. 7 Butanol isomers on frequency shifts

- Linear molecule exhibited a greater frequency shift than branched molecule.
- The horizontal adsorption of linear molecule provided more efficient adsorption and thus greater frequency shift.

5. Effect of π electrons

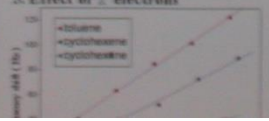


Fig. 8 Organic solvents with different π electrons on frequency shifts

- π - π interaction appeared to enhance the adsorption of alkenes and aromatic molecules.