

Chemistry Beyond the textbook

From Molecules to Real-World Applications



Harry Huang



黃德一

Harry
Huang
國立陽明交通大學
NATIONAL YANG MING CHIAO TUNG UNIVERSITY

■ Education

- B.S. in Chemistry: National Chiao Tung University (NCTU)
 - ✓ Project: Synthesis of Colorful Carbon Quantum Dots
- M.S. in Chemistry: National Yang Ming Chiao Tung University (NYCU)
 - ✓ Thesis: Contactless Surface-Assisted Ambient Ionization Mass Spectrometry

■ Publication

- ▶ Adv. Synth. Catal. 2024, 366, 101.
- ▶ FoodChemistry2023,426,136610.
- ▶ ACS Omega 2022, 7, 12, 10255–10261.
- ▶ Molecules 2021, 26(22), 6760.
- ▶ Analytica Chimica Acta 1113 (2020) 18-25.

■ Experience

2022 — ITRI: Material Mass Production

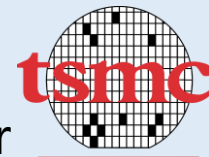
- Scale-up Production and shaping technique of MOF material
- Awards:
 - ✓ MEA Innovation Award Commendation

2024 — ITRI: Novel Adsorbent Development

- Development of the MOF synthesis, for multiple application.
- Awards:
 - ✓ ITRI startup Competition
 - ✓ ITRI Foresight Excellence Award

2025 — TSMC: SoIC Integration Engineer

- SoIC Advance Package(A14,N2P,N3P) Mass Production.
- Awards:
 - ✓ 2026 SoIC Rookie of the year
 - ✓ 2026 APTS honor award



What do people think of Chemistry

Breaking Bad



When Chemist found a Phenomenon couldn't be explained.



Freshman
Interested at chem experiment



A month later

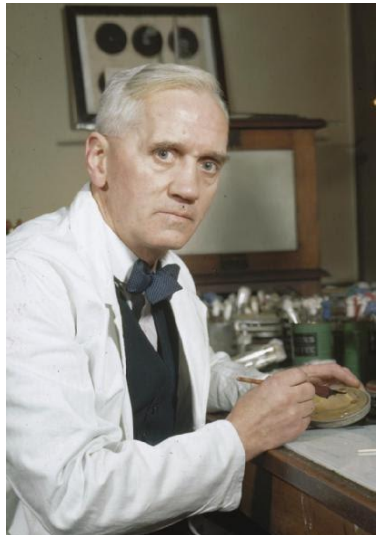


Chemistry v.s. Chemical Engineering

Long long time ago

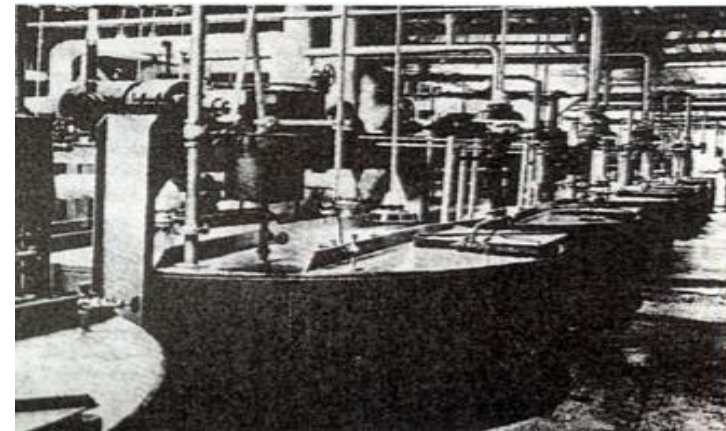
✓ The discovery of Penicillin

- 1928年Fleming found Penicillin
- 1940年Florey/Chain/Heatley confirm
- 1942年 production



✓ The Mass Production of Penicillin

- In 1944, some companies collaborated on the large-scale production of penicillin.
- Key engineering challenges included: aeration in fermentation tanks; gas-liquid-solid mixing; impeller and stirred-tank design.
- The penicillin program was considered one of the most important U.S. wartime industrial projects during World War II, second only to the **Manhattan Project**.
- By 1965, penicillin production had increased approximately **110,000-fold**, while its unit cost had fallen to about **1/1,000** of its original level.



Chemistry? Chemical Engineering?

Chemistry

- Chemistry programs emphasize fundamental chemical theories and principles, with the goal of developing future chemists.

From 0 to 1

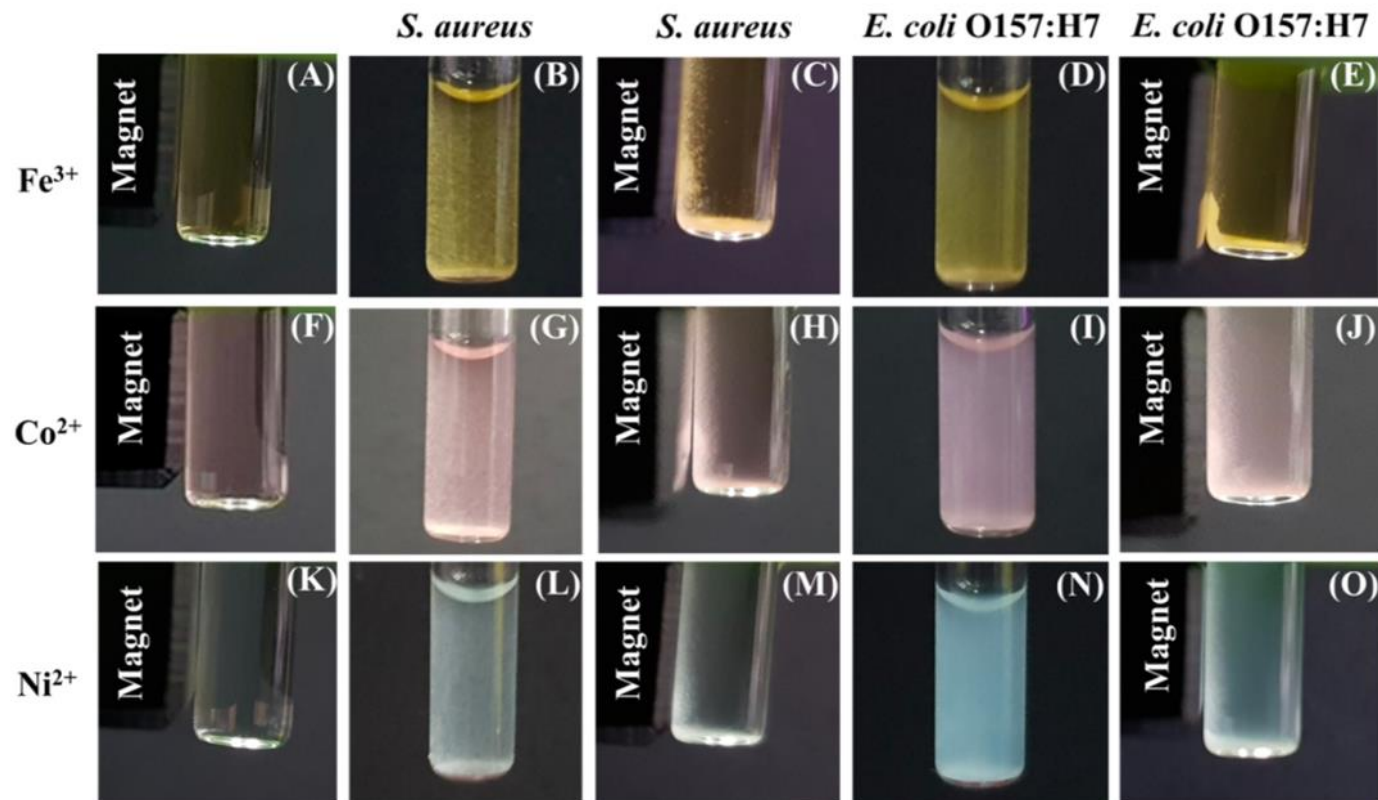
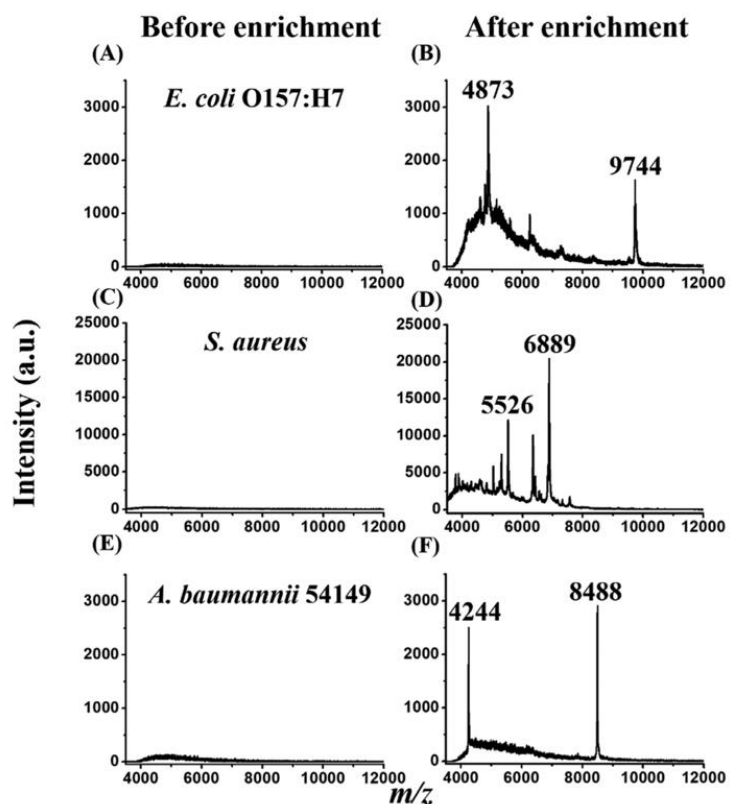
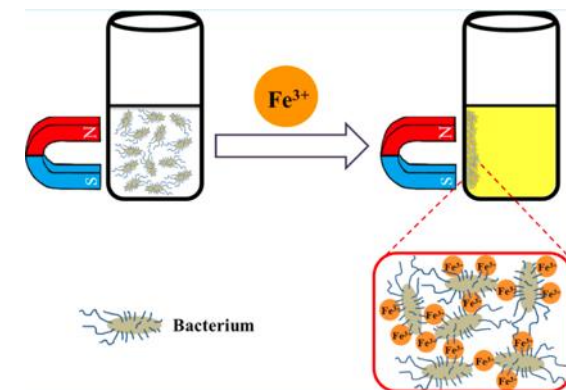
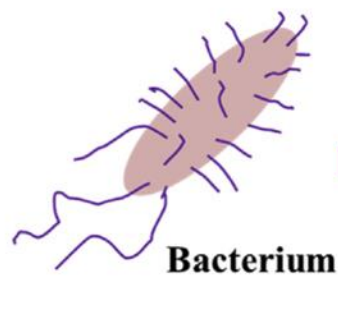
Chemical Engineering

- Applies chemical principles and process control to develop new products and processes.

From 1 to 100

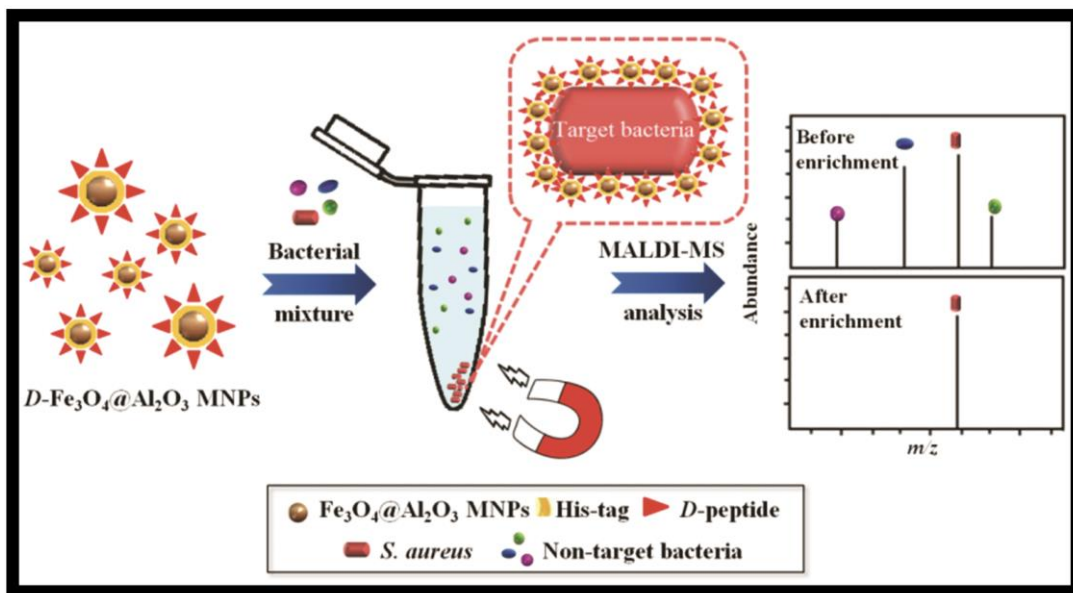
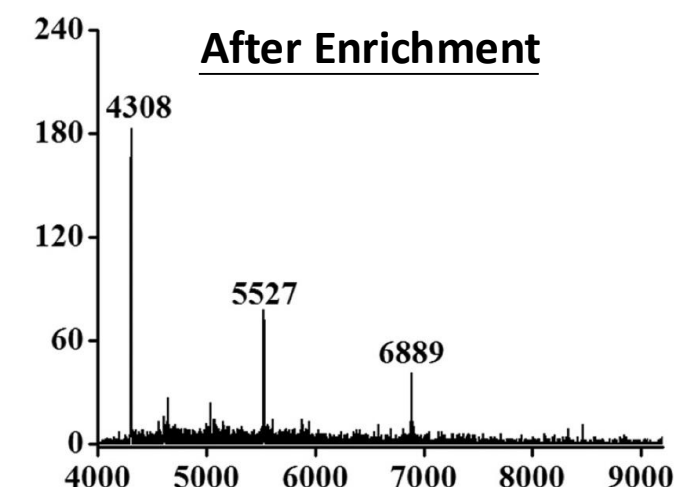
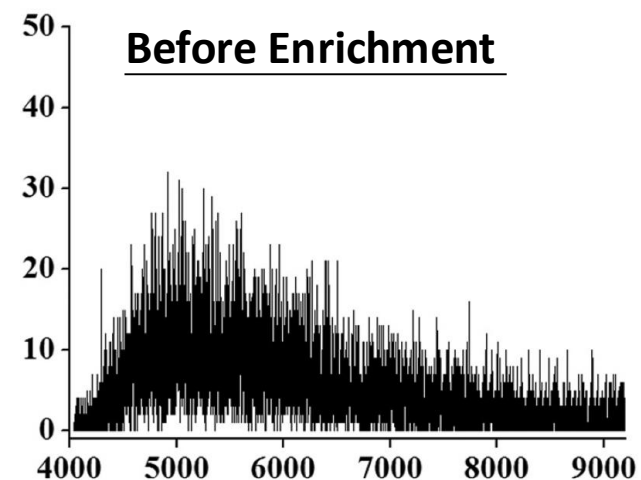
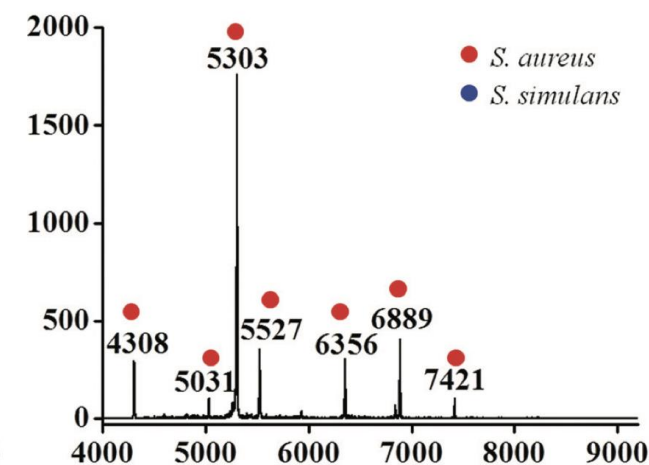
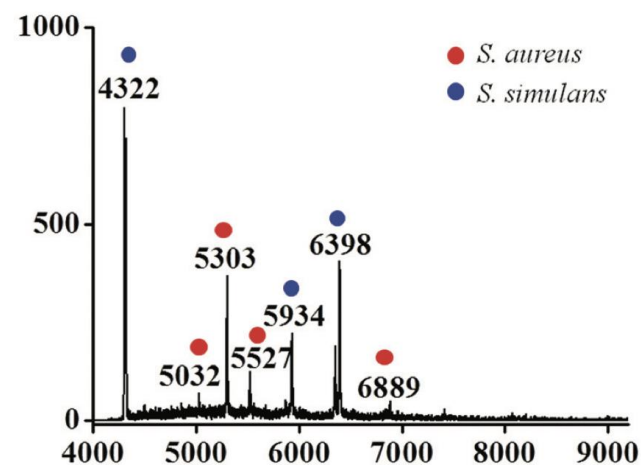
From Molecules to Materials: Nanotechnology

Using Magnetic Ions to Probe and Induce Magnetism of Pyrophosphates, Bacteria, and Mammalian Cells



Affinity capture using peptide-functionalized magnetic nanoparticles to target *Staphylococcus aureus*

Enriched from complex sample



Machine Learning X Analytical chemistry

► Analytical Chemistry X machine learning



Accuracy of the total:

Accuracy of Blue Mountain:

Accuracy of Brazil:

Accuracy of Guatemala:

Accuracy of Luwak:

Accuracy of Luwak 3:

trainable parameters: 28985

94.789% (18863/19900)

95.825% (3833/4000)

93.800% (3752/4000)

86.650% (3466/4000)

100.000% (3900/3900)

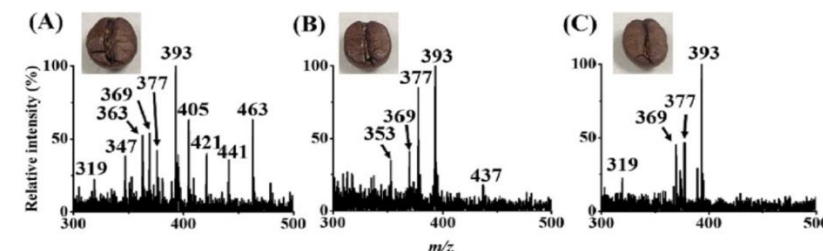
97.800% (3912/4000)

► Online news

【研究成果】質譜法結合機器學習 幫您挑選好咖啡豆

發表者 Yang-Kuang Chao | 825 觀看次數

撰稿 / 張鳳吟 (科學推展中心特約編輯)



在早餐或下午茶時光品嚐一杯咖啡，對許多人而言是日常生活中的小確幸，咖啡入口時感受到的風味和層次都讓人瞬間有了活力。咖啡豆的價格受到多方面的因素影響，包含味道、香氣、化學成分與處理過程等等，從最貴的麝香貓咖啡(kopi kuwak)到普通的豆子其價格可以差到千倍之多，也因此高價的麝香貓豆中魚目混珠摻雜一些廉價咖啡豆並不是件意外的事。由於咖啡的味道與香氣來自豆子的化學成分，豆子品質的分類也是依此為基礎，因此一些化學的分析方法如光譜法、色譜法、電化學法、質譜法等，已被應用在咖啡豆的特徵描述與分類。

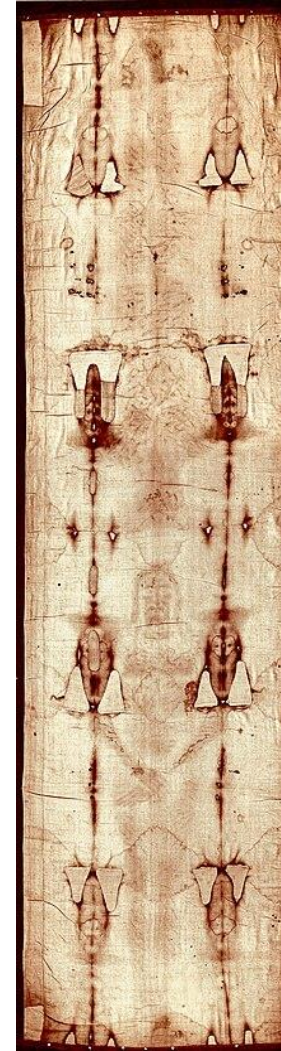
然而，大部分的方法需要先將豆子破壞來萃取成分，不僅耗時且耗人力。國立陽明交通大學應用化學系陳月枝教授與應用數學系林得勝副教授跨領域合作，結合質譜法與機器學習，提出一種能直接分析單一咖啡豆(不用事先破壞)的新方式，並利用機器學習從質譜快速且準確的辨識麝香貓豆與其它豆，有助於未來咖啡豆工廠與顧客的品管。此項結果發表於《食品化學》期刊[1]。

Some example of analytical chemistry

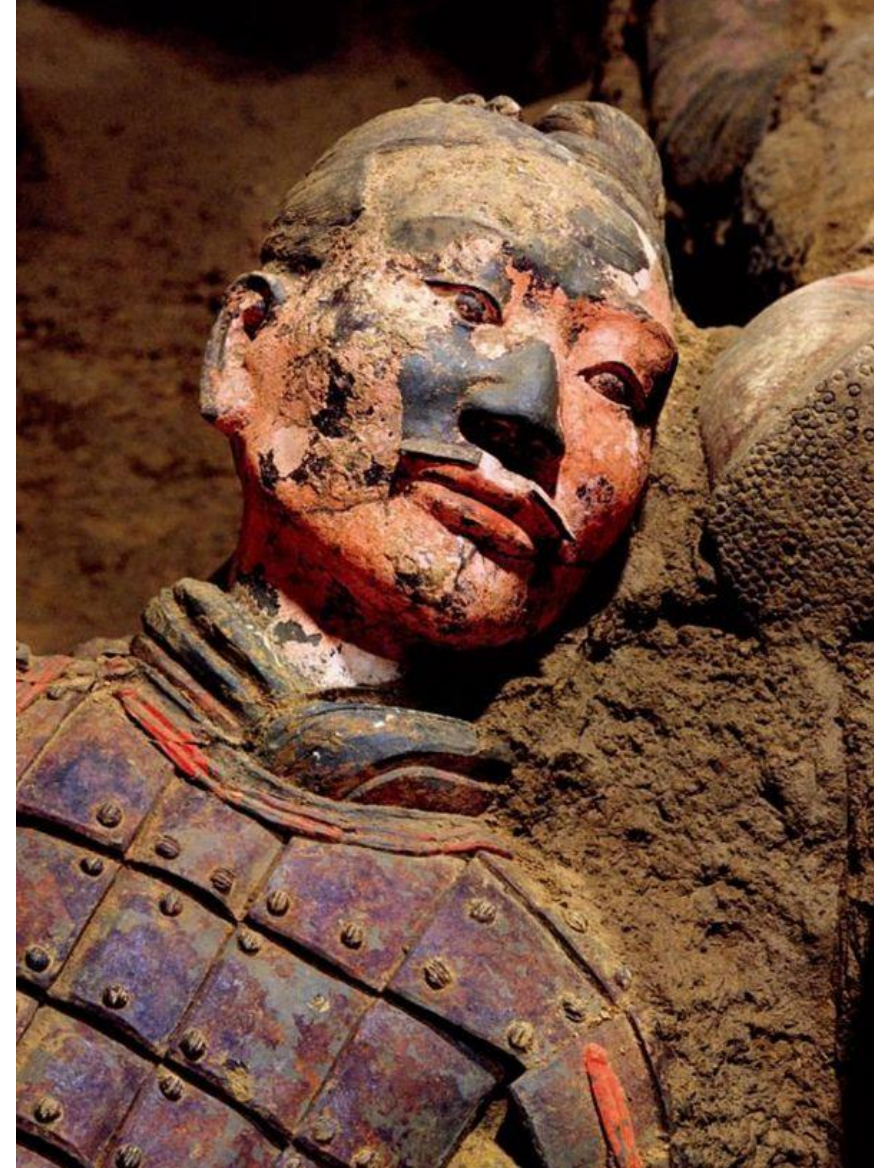
- Shroud of Turin
- Some analytical tech was used to determine the age of the shroud

► C-14

Pollen sample



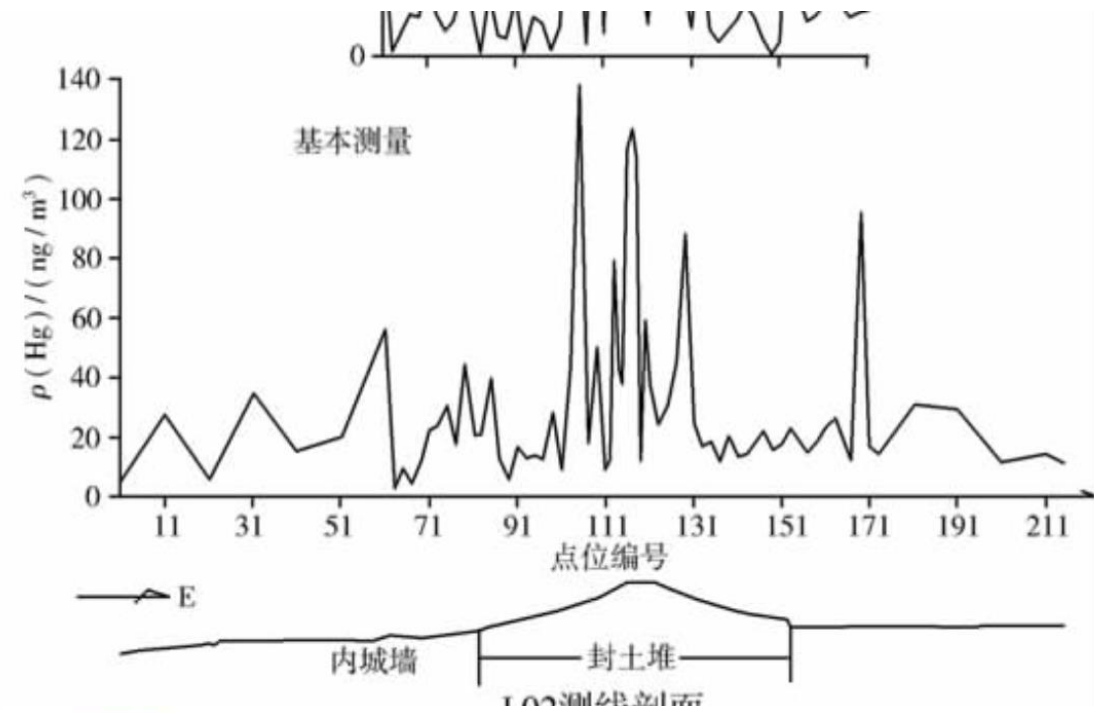
Study ancient culture by chemistry



Terracotta Army of Qin Dynasty, China (BC 200)



The study of the tomb



As recorded in the "Annals of Qin Shi Huang" (*Shiji*) and the "Biography of Prince Yuan of Chu" (*Hanshu*), its interior was packed with [replicas of] palaces, offices of the hundred officials, and rare utensils and extraordinary marvels. Artisans were commanded to manufacture mechanized crossbows and arrows, so that anyone who tunneled through and approached would be shot immediately. They used mercury to form the myriad rivers, the Yangtze, the Yellow River, and the great sea, with mechanisms causing them to flow and channel into one another. Above, the astronomical phenomena were fully depicted; below, the terrestrial geography was completely laid out. Candles were fashioned from the fat of the *renyu* (man-fish/dugong), calculated to remain unextinguished for a long duration.

The dead reason of Guangxu Emperor

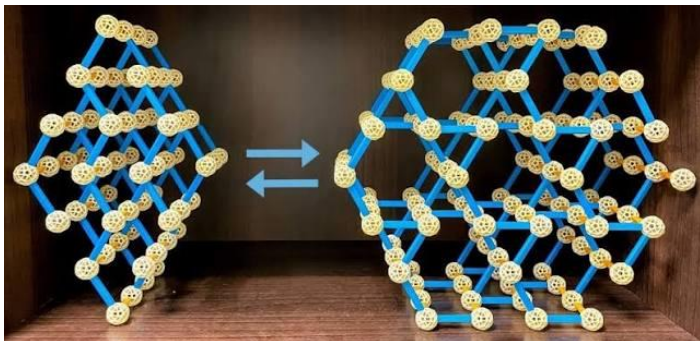
- Guangxu (1871–1908), the emperor of the Qing Dynasty.
- A key person behind the 100 Days' Reform, later placed under house arrest.
- He died one day before Empress Dowager Cixi.
- Forensic analysis found evidence of arsenenic poisoning.

Sample	As (ug/g)	Remark
Nowaday	0.14	
Same time	18.2	people
Same time	9.2	Royal family
Guangxu	2400	

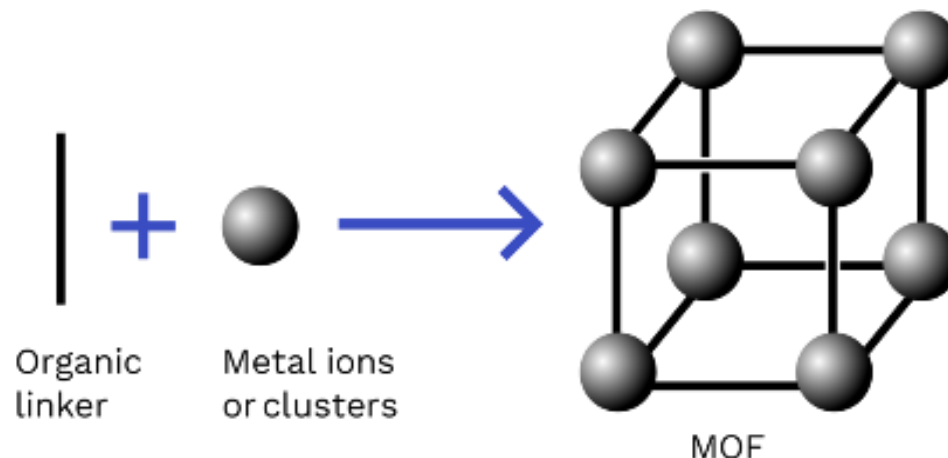


From Molecules to Materials: MOF

Metal Organic frameworks (MOFs)



numat

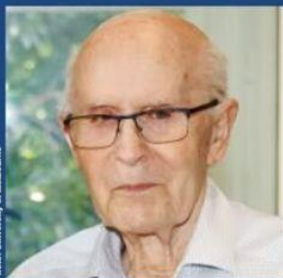


NOBELPRISET I KEMI 2025
THE NOBEL PRIZE IN CHEMISTRY 2025

KUNGL. VETENSKAPS-
AKADEMIEN
THE ROYAL SWEDISH ACADEMY OF SCIENCES



Susumu Kitagawa
Kyoto University
Japan



Richard Robson
University of Melbourne
Australia

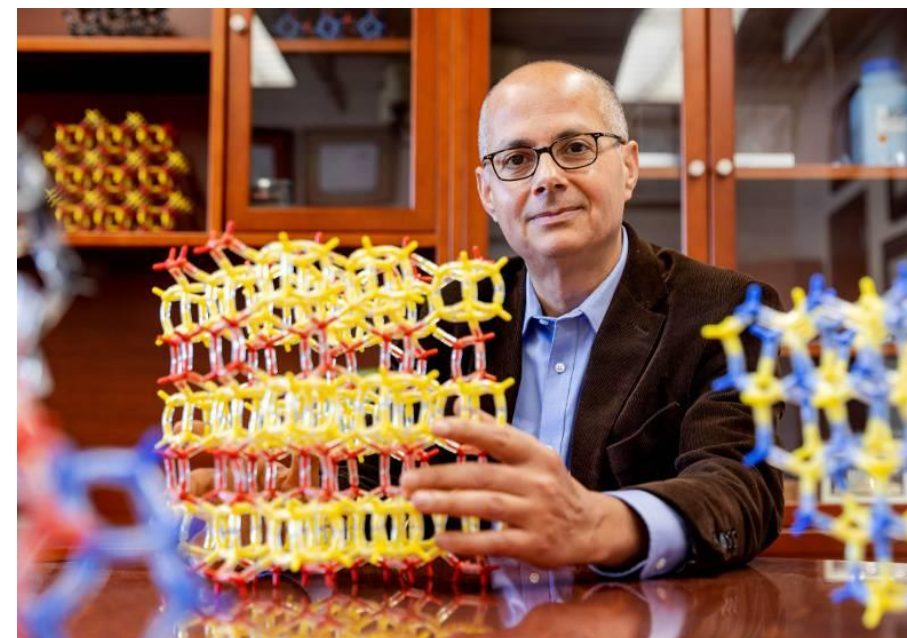


Omar M. Yaghi
University of California, Berkeley
USA

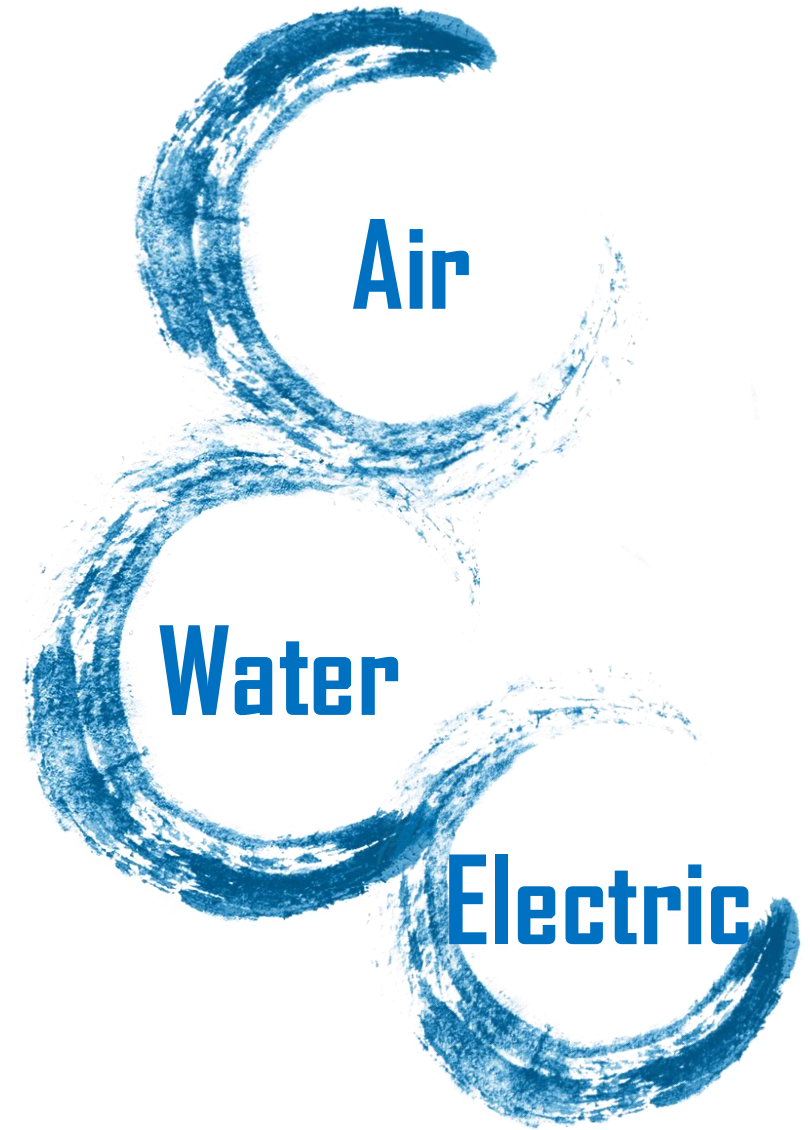
"för utveckling av metallorganiska ramverk"
"for the development of metal-organic frameworks"

#NobelPrize

THE NOBEL PRIZE

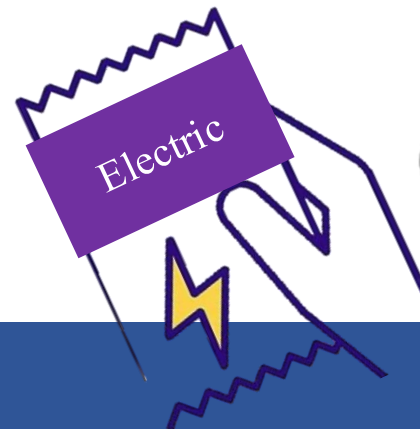


**Several System in Factory
maintain the yield and quality of
products**



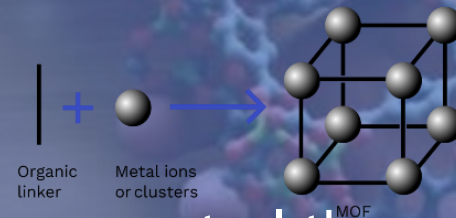


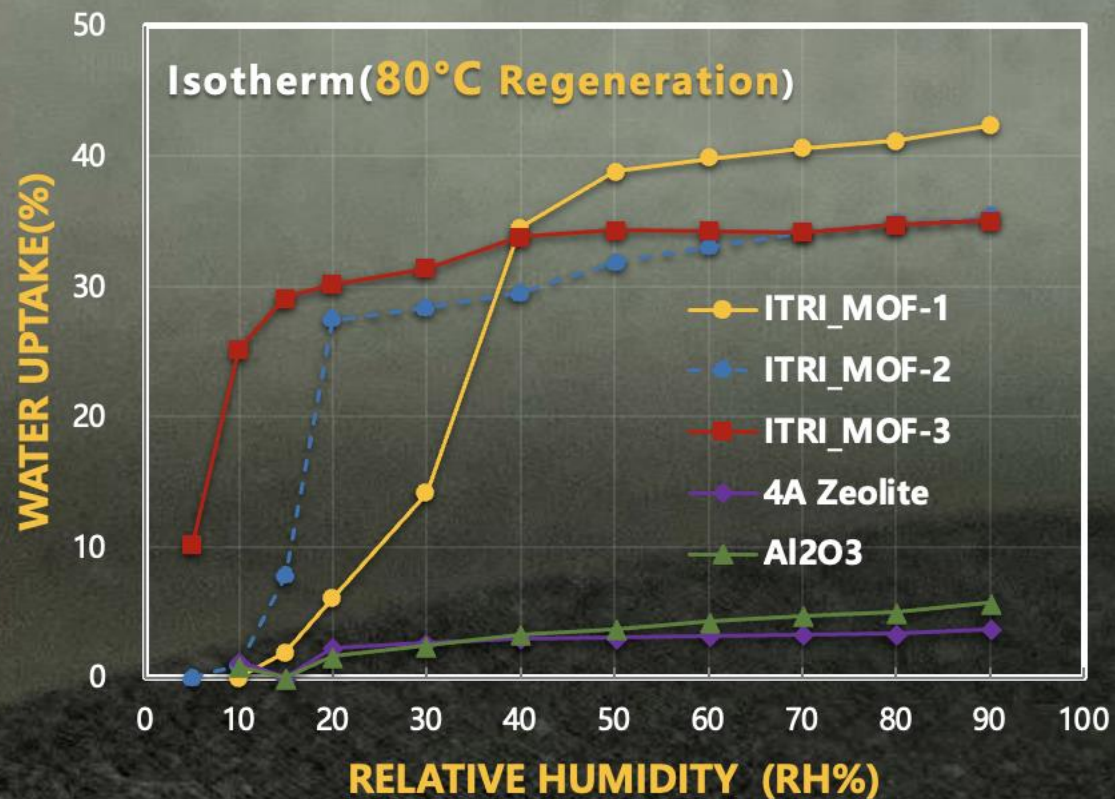
VOCs, toxic,
acid...



Use MOFs as Industrial material

surface area, pore size and shape control the molecular interaction.





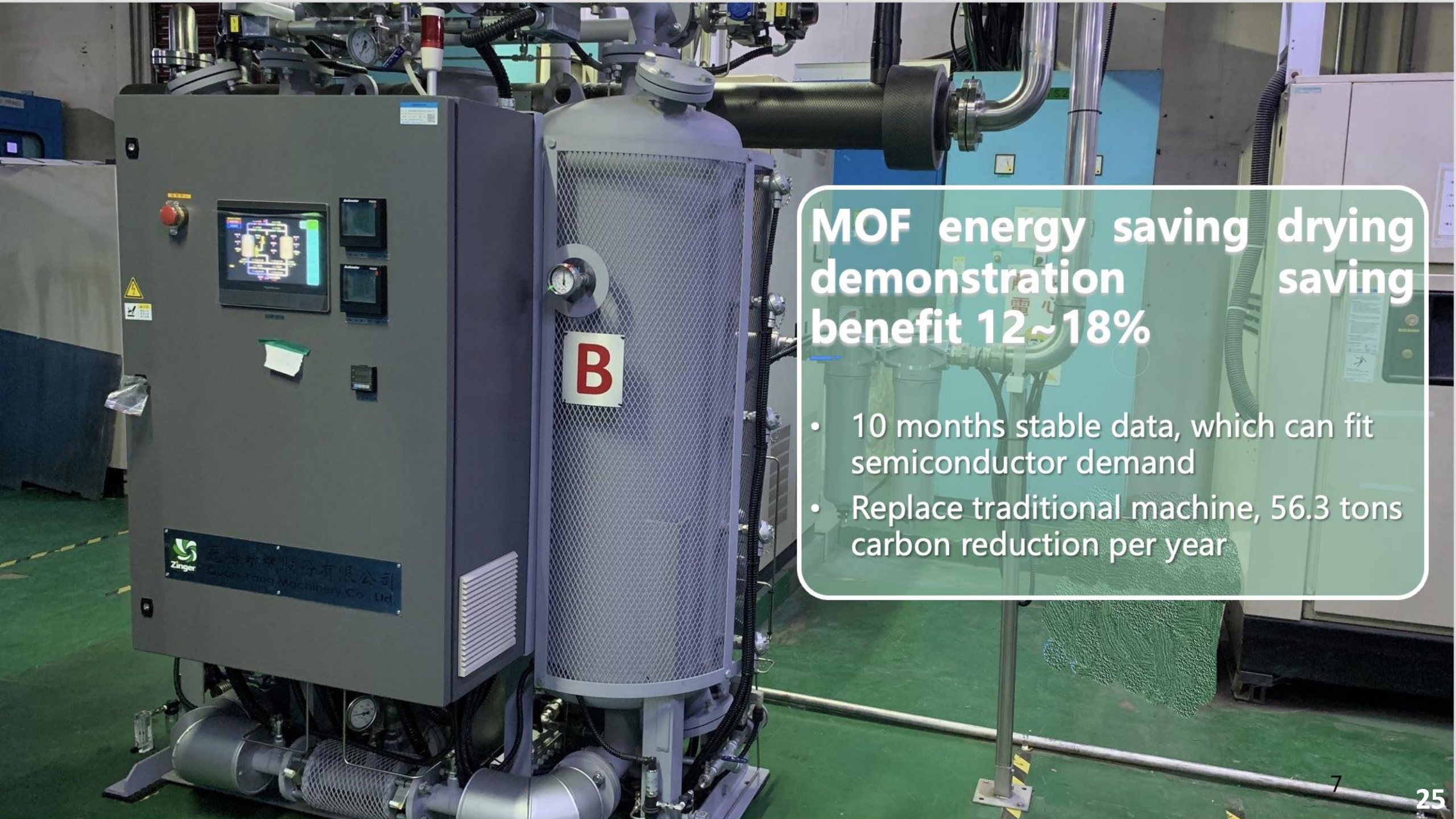
Price (NTD/kg)

100,000
10,000
1,000
100
10



Gram-scale Kilo-scale Ton-scale >100Ton-scale

Material	Al	zeolite	MOF
Area (m ² /g)	260 ~ 280	600 ~ 700	~ 1200
Temperature (°C)	120 ~ 160	160 ~ 260	60 ~ 80
absorb(kg/kg) (@25°C/30%RH)	0.05	0.07	>0.20

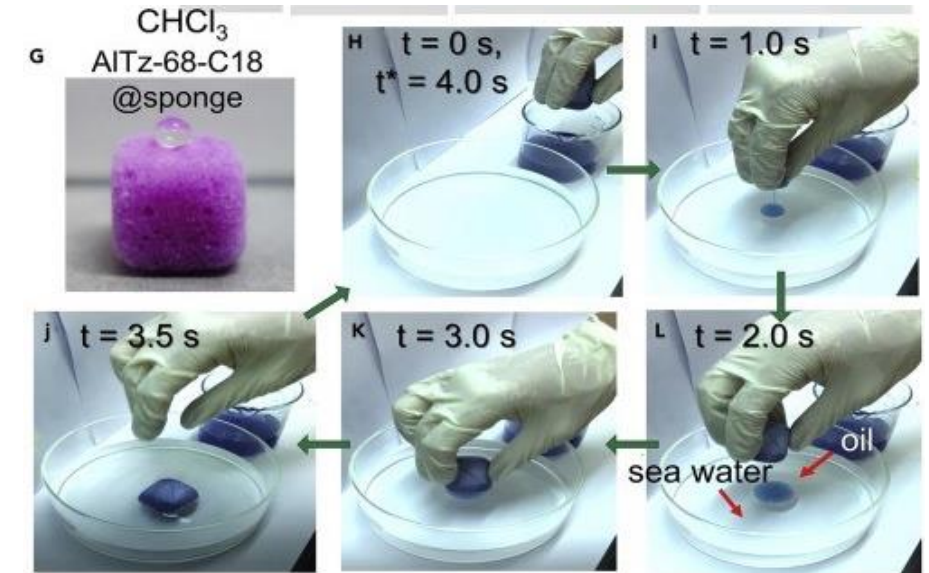
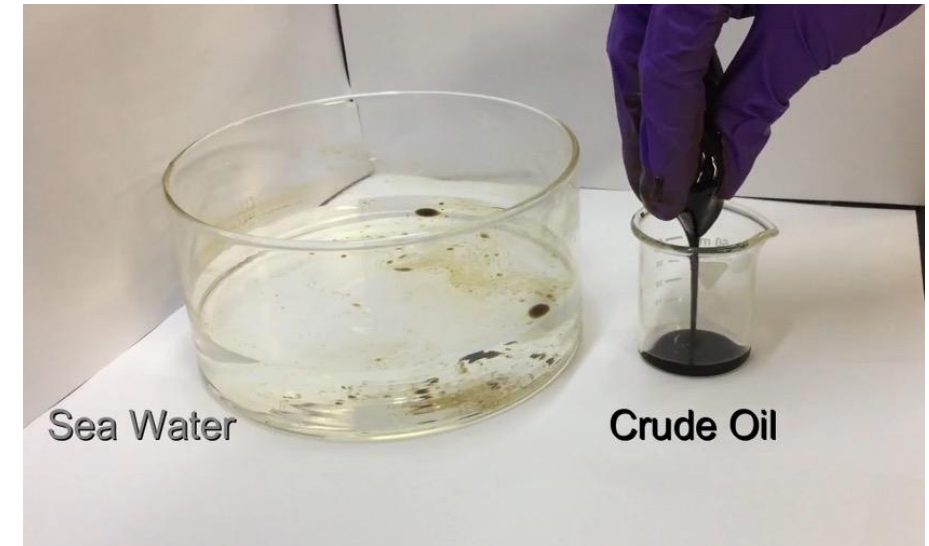
The image shows a large industrial machine, likely a MOF energy saving drying demonstration unit. It features a grey control cabinet on the left with a digital display showing a schematic diagram, several analog gauges, and a red emergency stop button. To the right of the cabinet is a tall, cylindrical vertical tank with a silver mesh exterior and a red 'B' label. The machine is connected to a complex network of pipes and hoses. The background shows a factory setting with other equipment and a green floor.

MOF energy saving drying demonstration benefit 12~18%

- 10 months stable data, which can fit semiconductor demand
- Replace traditional machine, 56.3 tons carbon reduction per year

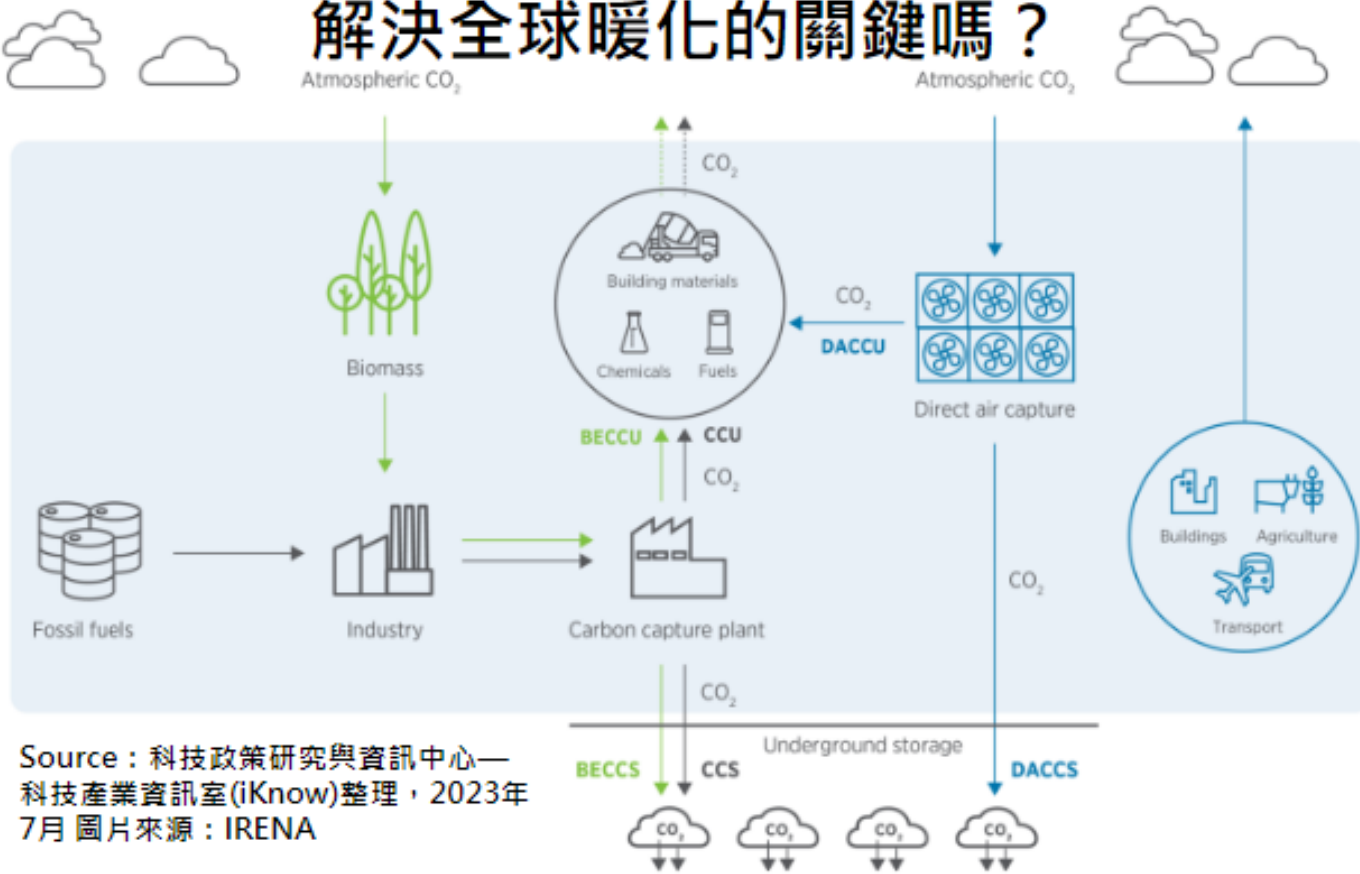
Zinger
Zinger Machinery Co., Ltd.

Utilize MOF to separate oil from sea water



Carbon Capture Storage and Direct air Capture

碳捕獲與封存(CCS)與直接空氣捕獲(DAC)：
解決全球暖化的關鍵嗎？



Source：科技政策研究與資訊中心—
科技產業資訊室(iKnow)整理，2023年
7月 圖片來源：IRENA

**\$100 MILLION PRIZE FOR
CARBON REMOVAL**

Elon Musks
XPRIZE



Some misunderstanding of chemistry

Something take away

- 1. Even in the Chemistry department, we always ask: “What can we do with this?”**
- 2. A strong foundation in basic science can open the door to many different career paths.**
- 3. In fact many science graduates go on to build careers in the semiconductor industry.**

Work Opportunity



Is Chemistry the suitable Major for You

Thank you

Backup

「化工系」在做的事



朋友以為我在做的事



家人以為我在做的事



社會以為我在做的事



老師要教我們做的事



我以為化工在做的事



但我大學真正做的事

常見鑑定黃金方法

- 密度測試
- 劃痕測試
- 火燒測試

純度	密度(g/ml)
24K純金	19.3
14K金	12.9~14.6
18K金	15.2~15.9
22K金	17.7~17.8

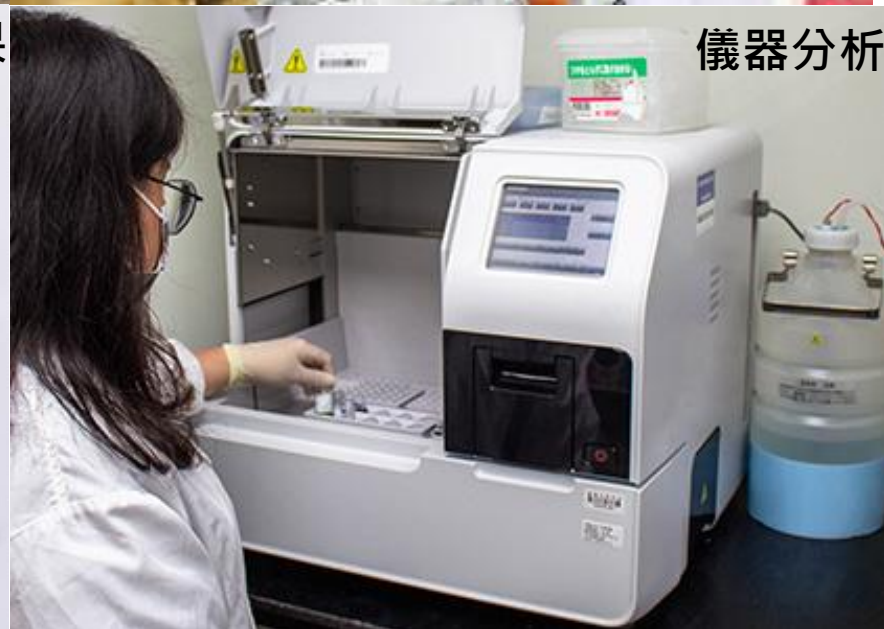
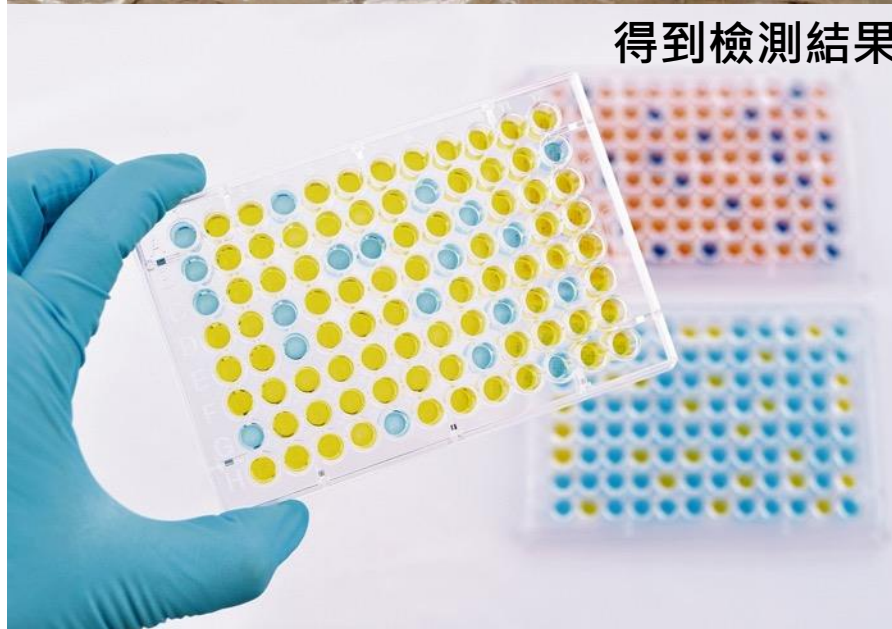


XRF (X-ray Fluorescence, X 射線螢光光譜)

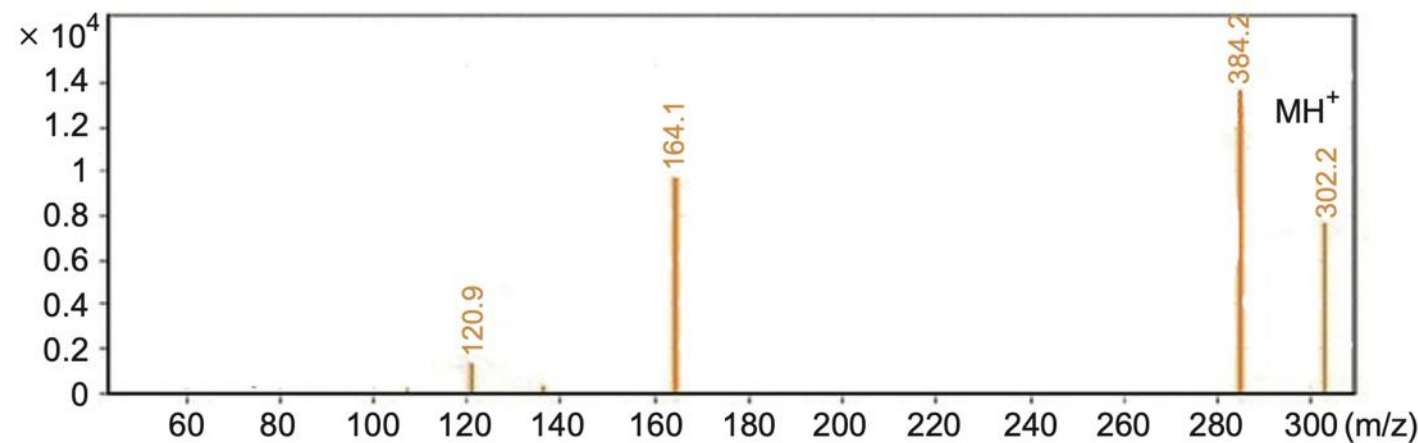
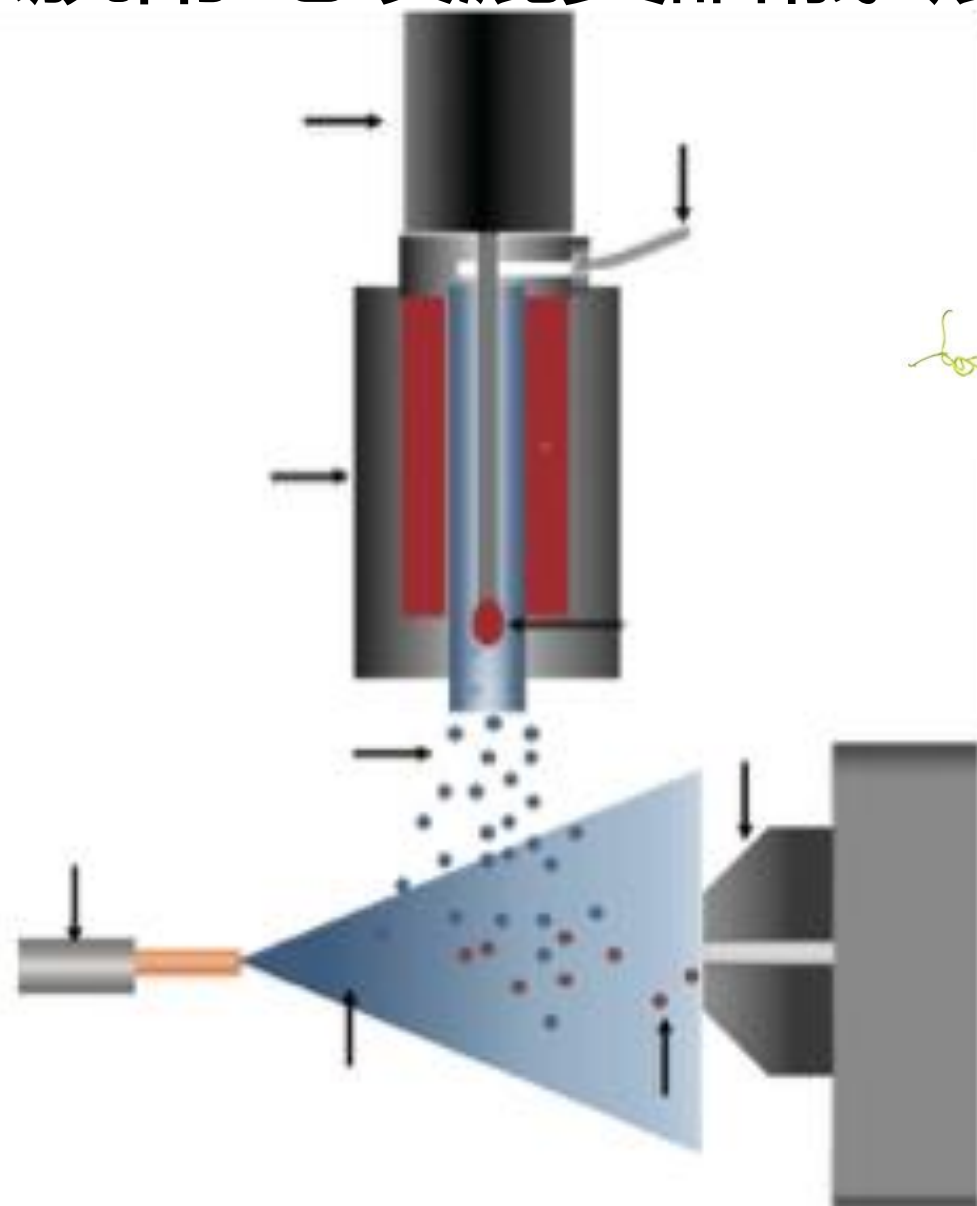
XRF 是一種無損分析技術，透過 X 射線照射樣品，引發元素特有的螢光輻射（特徵 X 射線），藉此辨識材料的元素組成，常用於黃金真假鑑定、金屬成分分析、珠寶鑑定、環境檢測等領域。



傳統食品檢測分析 (耗時2~6小時)



熱脫附電噴灑質譜儀-農藥檢測新方法



<https://www.youtube.com/watch?v=XMf-VgiQ6-o&t=569s>