出國報告（出國類別：開會）

赴日本大阪參加第二屆氫能暨能源科技研討會(HEET2019)出國報告

服務機關： 核能研究所
姓名職稱： 沈錦昌 副研究員
派赴國家/地區：日本/大阪
出國期間： 108 年 12 月 11 日~108 年 12 月 14 日
報告日期： 109 年 1 月 14 日

摘要

本次國際會議於日本大阪召開主題為「國際氫能與能源技術研討會HEET2019」，職赴日本大阪參加國際氫能與能源技術研討會 HEET2019 發表論文，並收集綠能、新能源、材料化學等先進技術進展與國際專家學者交流學習討論，以提供系統技術整合之規畫參考。

氫能研發方面，美國 West Virginia University Prof. JOHN (JIANLI) HU 研發，以甲烷分解產氫，利用美國便宜且豐富之甲烷作為原料，研究在固定床反應器中，以 SiO_2 載體上的單金屬和雙金屬 3d 過渡金屬(Ni、Fe、Co)用於甲烷分解為 H_2 和具價值的奈米碳管(CNT)。

氫能利用主要會以如何減低其 PEM 燃料電池成本提高可靠度並延長壽命，此關係其未來應用進展。中央大學曾教授使用脈衝雷射沉積法，可均勻將重要貴金屬白金分散於轉化反應層，除能大幅降低成本也能提高可靠度與延長壽命，未來能源效率提升還需仰賴材料科學與電腦模擬科技進展，因此我國需持續關注資源於基礎材料科學研究與電腦科技研究。

甲烷分解產氫研發，除了產生氫能又能生產奈米碳管此技術值得注意。對於未來氫能發展與衍生價值產品會有衝擊，此奈米碳管如何做好分離與回收技術進展值得關注。

目次

圖目錄

一、目　的

(一) 參加日本大阪召開之國際氫能與能源技術研討會 HEET2019 主要目的:

1.收集綠能、新能源、材料化學等先進技術進展與國際專家學者交流學習討論，以提供系統技術整合之規畫參考。

2.將研究成果發表『The study of STH pilot system by photocatalyst and CO_2 thermal reduction by CeO/NiO/MCM catalyst』論文發表於國際氫能與能源技術研討會 HEET2019，同時收集綠能、新能源、材料化學等技術進展，並與國際專家交流研討，以提升本所之研發能量。

3. 未來再生能源科技運用有賴技術持續進步，其中觸媒材料技術與電腦半導體科技之進展將扮演重要角色，因此需要持續關注國際科技開發之突破與進展。

二、過　程

(二) 公差行程與過程:

1. 期程自 108 年 12 月 11 日至 12 月 14 日合計 4 天，12 月 11 日(三)早上 7 點出發前往機場，搭華航飛機飛往日本大阪，抵達大阪旅館時約為 PM 2:30，之後再搭捷運前往會場註冊簽到繳交研討會相關費用。
2. 過程-公差行程

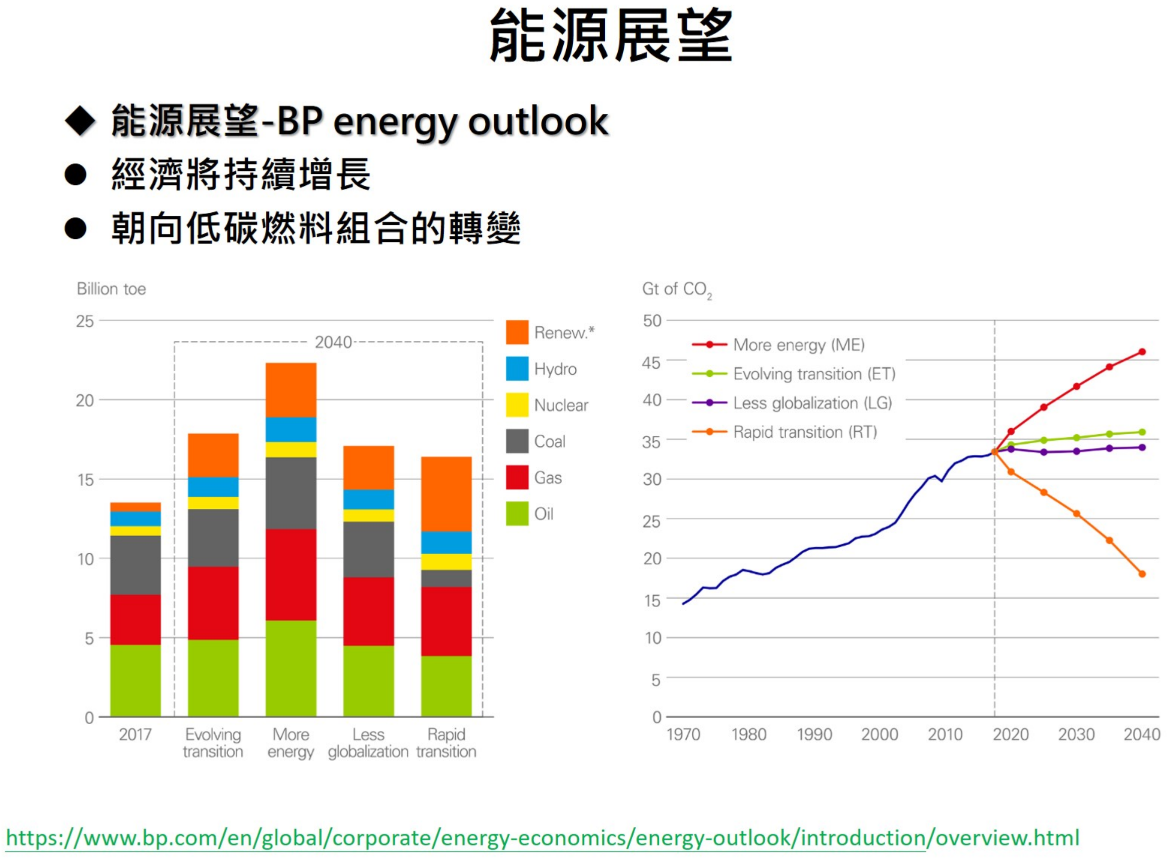
日期	行程內容	公差地點
108/12/11(三)	去程、研討會註冊簽到	桃園-日本大阪
108/12/12(四)	參與第二屆氫能暨能源科技研討會 (2019 The 2nd International Symposium on Hydrogen Energy and Energy Technologies) 發表論文	日本大阪
108/12/13(五)	參與第二屆氫能暨能源科技研討會 (2019 The 2nd International Symposium on Hydrogen Energy and Energy Technologies) 發表論文	日本大阪
108/12/14(六)	回程	大阪-桃園

三、心　得

(三) 能源議題部分:

3.1 能源趨勢

關於能源趨勢如圖 3-1 能源展望趨勢所示[1]，未來經濟將持續增長，能源將朝向低碳燃料組合的轉變，再生能源會增加，天然氣使用也會增加。



能源展望

◆ 能源展望-BP energy outlook

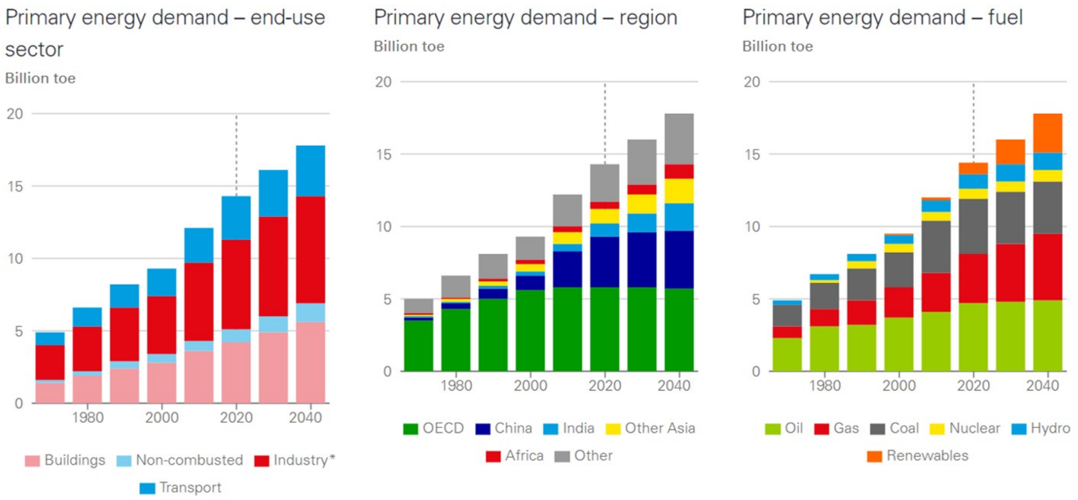
● 經濟將持續增長

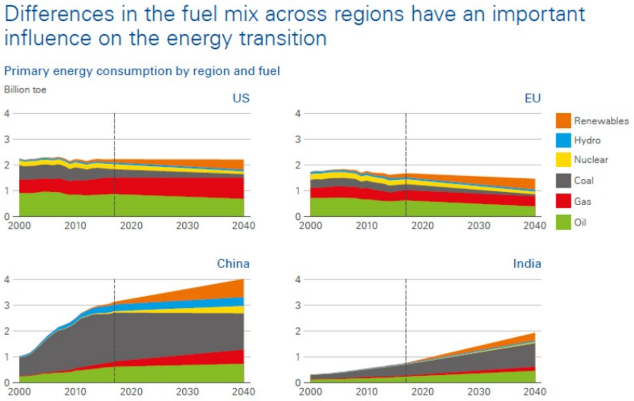
● 朝向低碳燃料組合的轉變

https://www.bp.com/en/global/corporate/energy-economics/energy-outlook/introduction/overview.html

圖 3-1 能源展望趨勢 BP energy outlook 1-1[1]

未來能源需求持續增長主要地區為中國、印度、非洲區域國家，如圖 3-2 所示[2]，歐洲與亞洲已開發國家則維持緩緩增長之趨勢。我國用電維持增長但應為緩緩增長之趨勢，但如果未來電動車銷售增長快速，則用電會有較大增長需求。





未來能源需求持續增長
主要增加地區為

- ➢ 中國
- ➢ 印度
- ➢ 非洲區域

圖 3-2 能源展望趨勢 BP energy outlook 1-2[1]

世界能源配比變化預估

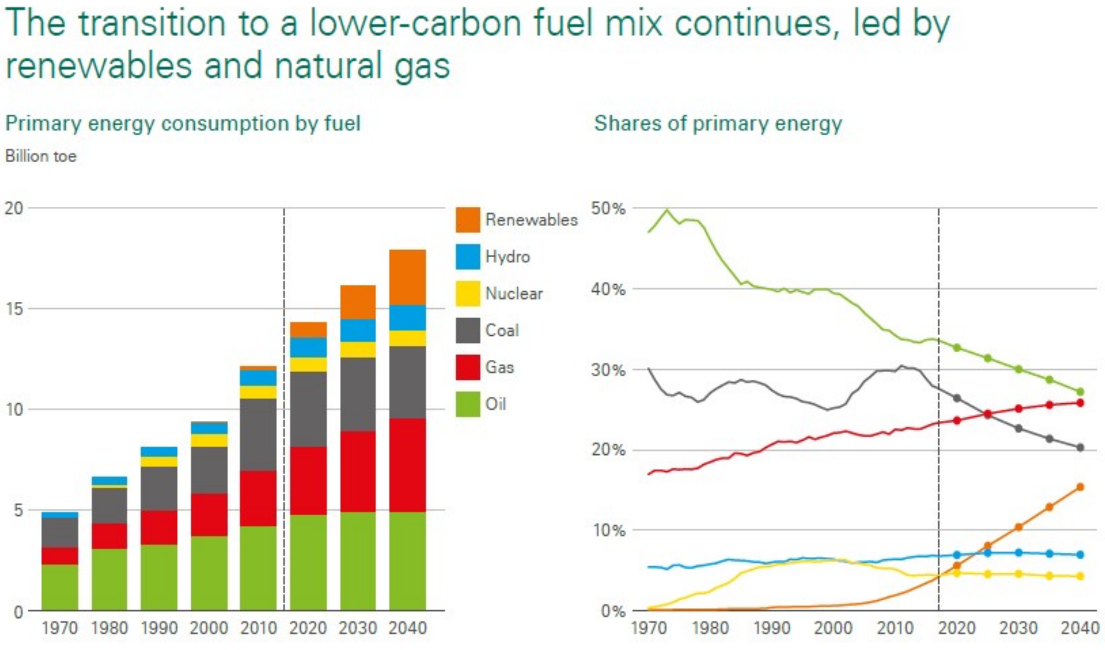


圖 3-3 能源展望趨勢 BP energy outlook-世界能源配比變化預估[2]

再生能源會增加(橘色)，天然氣使用也會增加(紅色)，煤炭使用配比會下降(灰黑色)，如圖 3-3 中右邊能源配比變化所示，其再生能源、天然氣增加，煤炭與燃油減少。

再生能源分析部分，呈現以增加太陽能與風能為主，我國在太陽能與風能在再生能源中持續增長趨勢與世界一致，在圖 3-4 再生能源展望中，可以看到地熱能源與生質能源則維持速率穩定增長。

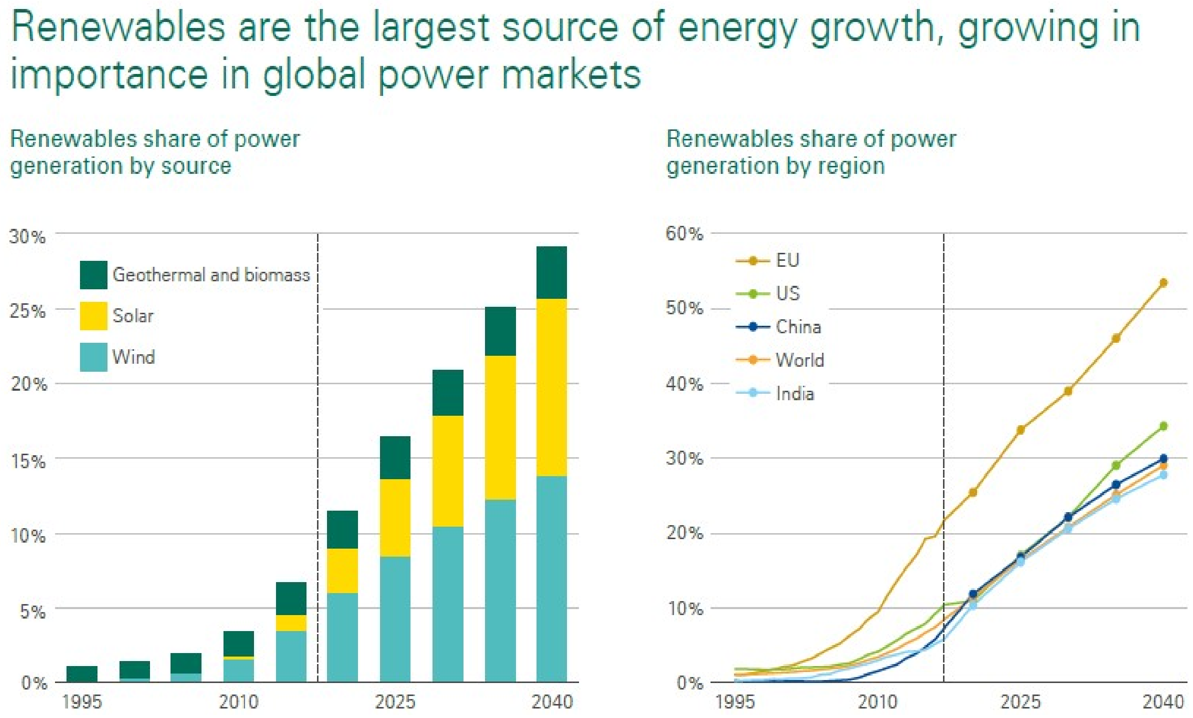


圖 3-4 再生能源展望[2]

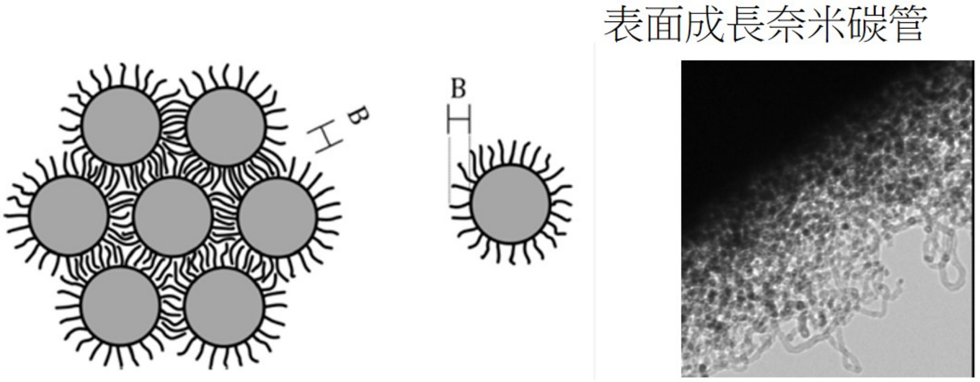
總體來說，未來經濟將持續增長，能源將朝向低碳燃料組合的轉變，再生能源會增加，天然氣使用也會增加。而地熱能源與生質能源則維持速率穩定增長。

3.2 產氫與智慧節能膜研究開發

West Virginia University(西維吉尼亞大學) Prof. John (Jianli) Hu, 有別於蒸氣重組產氫，採用乾法產氫，透過以 SiO_2 載體上的單金屬和雙金屬 3d 過渡金屬觸媒(Ni、Fe、Co)用於甲烷催化分解為 H_2 和具價值的奈米碳管(CNT) ，此法不產生 CO_2，透過雙金屬觸媒將甲烷催化分解為 H_2 和奈米碳管(CNT)[3]，因此胡教授發表題目「Methane decomposition to tip and base grown carbon nanotubes and CO_2 free H_2 over mono and bimetallic 3d transition metal catalysts」，研究在

固定床反應器中，以 SiO_2 載體上的單金屬和雙金屬 3d 過渡金屬(Ni、Fe、Co)用於甲烷分解為 H_2 和具價值的奈米碳管(CNT)。在其工作中合成具有不同摩爾比的單/雙金屬 Ni、Fe 和 Co 催化劑。研究在相同的反應條件下測試了催化劑的甲烷分解及其性能對 CNT 的特徵的影響。發現合成的雙金屬催化劑具有更高的活性和穩定性，高於單金屬催化劑。在雙金屬催化劑中，鎳含量較高的那些(9Ni-1Fe/SiO_2 和 9Ni-1Co/SiO_2)顯示出更高的甲烷轉化率。該團隊使用各種分析技術研究新鮮和廢催化劑以及形成的 CNT 之特性:透過 XRD 和 TPR 分析證實雙金屬催化劑中的合金形成;使用 XRD 和拉曼分析計算在各種催化劑上形成的 CNT 化程度和結晶度，並將其與催化劑性能相關聯;使用 TEM 分析研究了所形成的 CNT 的結構形態(魚骨形或平行壁型)和生長機理(尖端或基礎生長) ；TGA 分析證實在 Ni，Fe 和 Co 基催化劑上甲烷分解過程中不存在無定形碳的形成。該團隊還進行一些初步研究，以在 Fe/SiO_2 催化劑上選擇合成 CNT，其生長的 CNT 效果更好且對於催化劑之再生也更容易。

此奈米碳管可以生長在碳纖維或薄膜表面，所成長之薄膜表面具有改質之特性[4]，圖 3-5 為生長在碳纖維或薄膜表面的奈米碳管[5, 6]，可以據此方法產製智慧節能膜，尋求不同功能如疏水性，因具導電特性可進一步以電壓電流調控表面特性，其甲烷分解為可產 H_2 和具價值的奈米碳管(CNT)，使其價值增加具應用潛能。圖 3-6 為鎳鐵觸媒催化甲烷分解轉化率之結果，圖 3-7 為鎳鈷觸媒催化甲烷分解轉化率之結果，圖 3-8 為鐵鈷觸媒催化甲烷分解轉化率之結果，其中圖 3-6 之鎳鐵觸媒催化甲烷分解轉化率可達 60%，圖 3-9 與 3-10 單金屬和雙金屬鎳鐵、鎳鈷、鐵鈷催化劑上奈米碳管的拉曼光譜。在 T = 650°C 下，甲烷分解後如圖 3-11 所示，在催化劑上其碳絲的生長圖形，明顯可由 TEM 觀察出奈米碳管之成長產物。



Continuous CVD carbon nanotube-grafted-carbon fiber with potential difference (300 V)

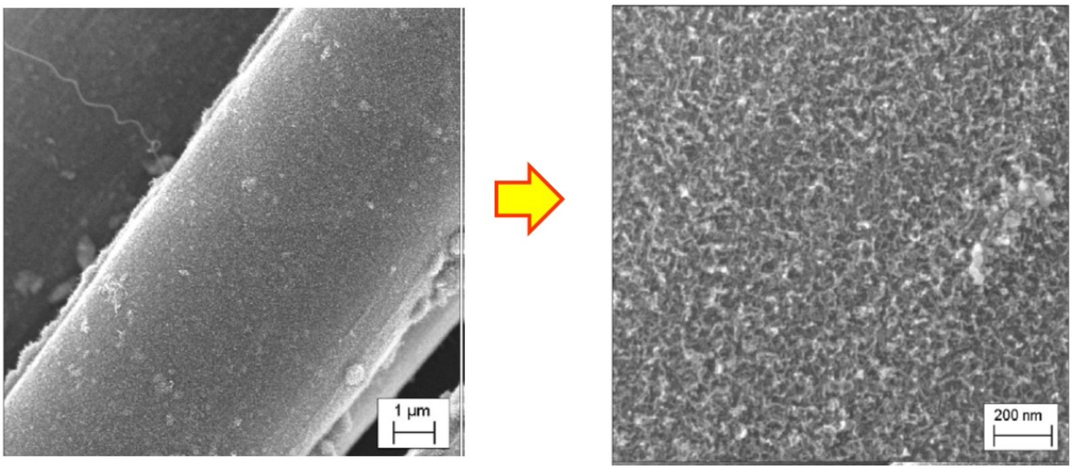
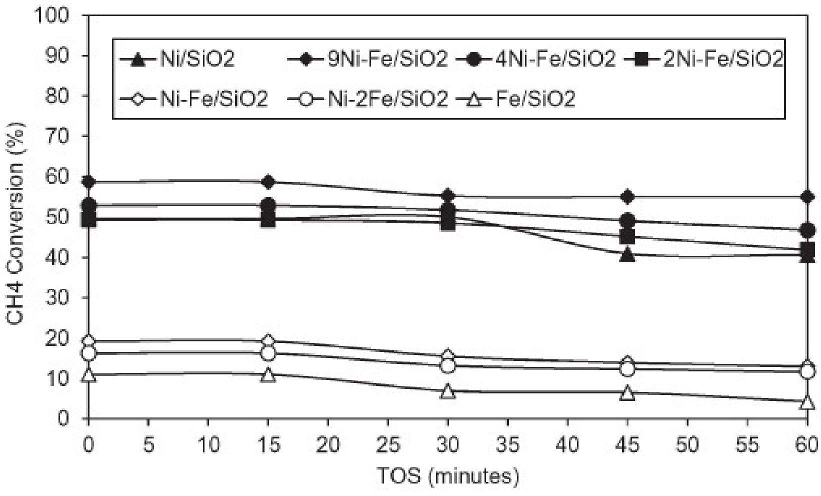
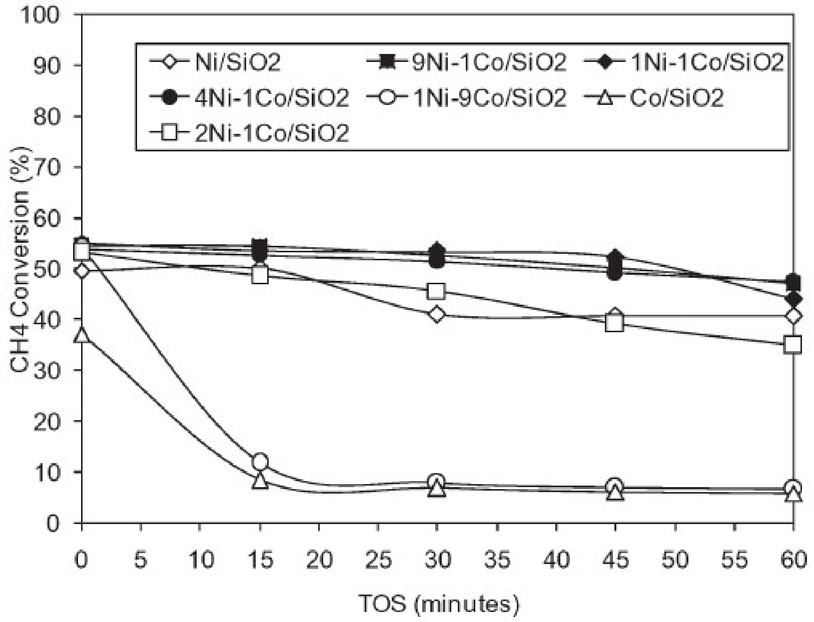


圖 3-5 生長在碳纖維或薄膜表面的奈米碳管



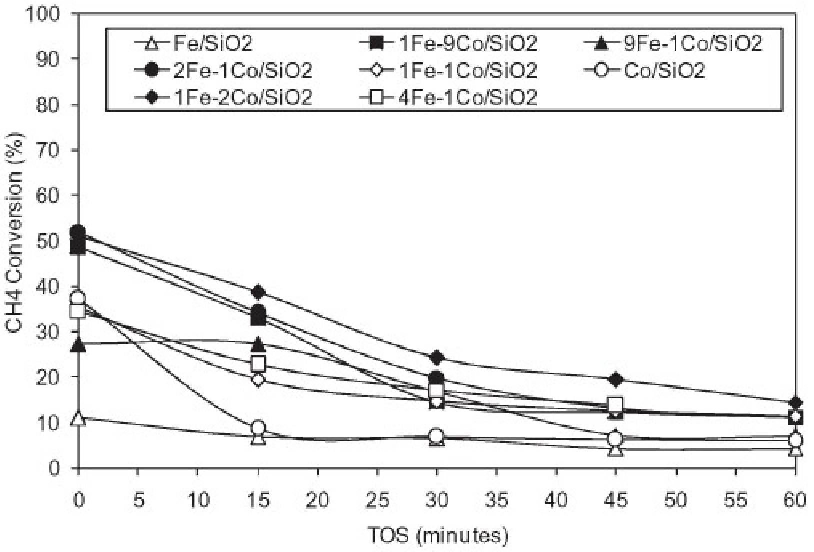
Methane decomposition over Ni–Fe/SiO_2 catalysts with various mole ratios at T = 650 °C, TOS = 0-60 minutes, GHSV = 42 000 h^{-1}

圖 3-6 鎳鐵觸媒催化甲烷分解轉化率之結果



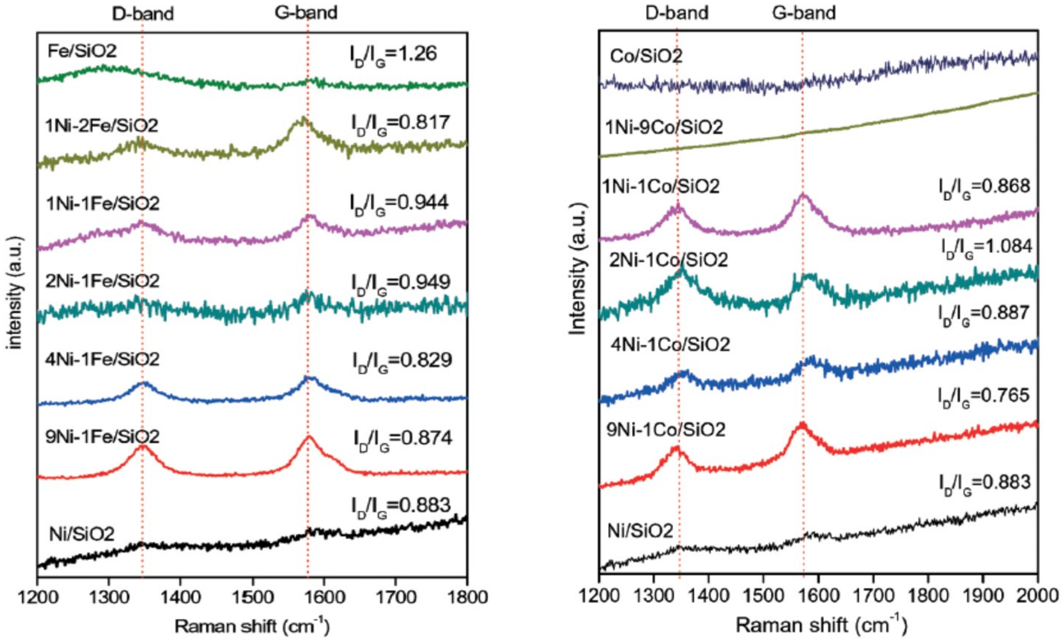
Methane decomposition over Ni–Co/SiO_2 catalysts with various mole ratios at T = 650 °C, TOS = 0–60 minutes, GHSV = 42 000 h^{-1}.

圖 3-7 鎳鈷觸媒催化甲烷分解轉化率之結果



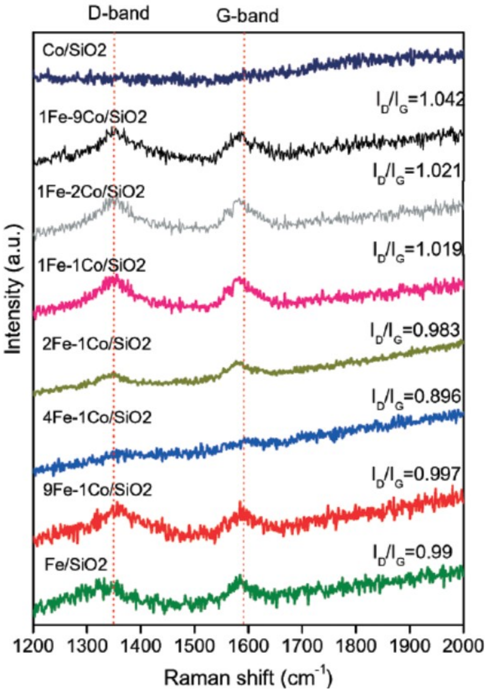
Methane decomposition over Fe–Co/SiO_2 catalysts with various mole ratios at T = 650 °C, TOS = 0–60 minutes, GHSV = 42 000 h^{-1}.

圖 3-8 鐵鈷觸媒催化甲烷分解轉化率之結果



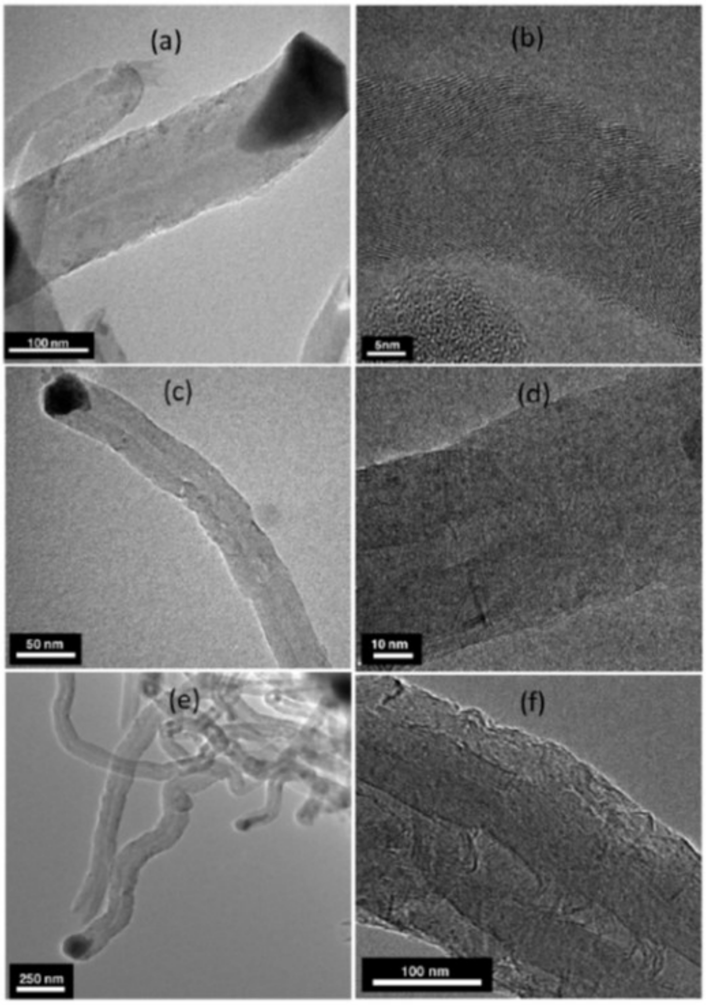
Raman spectra of CNTs over mono- and bimetallic Ni–Fe catalysts, Ni–Co catalysts.

圖 3-9 單金屬和雙金屬鎳鐵、鎳鈷催化劑上奈米碳管的拉曼光譜



Raman spectra of CNTs over mono- and bimetallic Fe–Co catalysts

圖 3-10 單金屬和雙金屬鐵鈷催化劑上奈米碳管的拉曼光譜

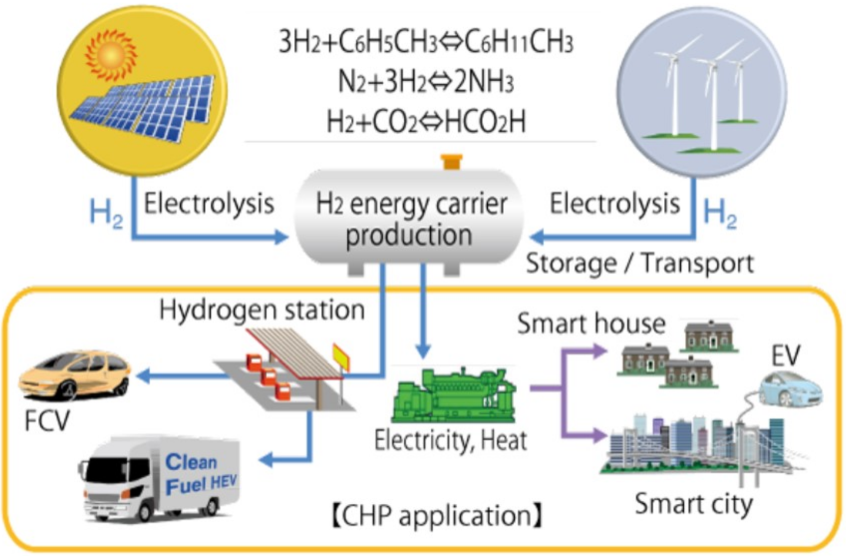


Growth of carbon filaments over (a and b) 9Ni–1Fe/SiO_2, (c and d) 9Ni–1Co/SiO_2, and (e and f) 1Fe–2Co/SiO_2 catalysts after methane decomposition at T = 650 °C, TOS = 60 minutes, GHSV = 42 000 h^{-1}.

圖 3-11 在 T = 650°C 下，甲烷分解後 (a 和 b) 9Ni-1Fe/SiO_2 (c 和 d) 9Ni-1Co/SiO_2 和 (e 和 f) 1Fe-2Co/SiO_2 催化劑上碳絲的生長 TOS= 60 分鐘，GHSV = 42 000 h-1。

3.3 氨作為 PEM 燃料電池的氫載体

日本 AIST 的 *Rahat* Javaid 研究人員發表 Catalytic synthesis of CO_2 free ammonia as a hydrogen and energy carrier。*Rahat* Javaid 服務於福島之 Hydrogen Energy Carrier Team, Renewable Energy Research Center, Fukushima Renewable Energy Institute, AIST[7]。Hydrogen Energy Carrier Team of AIST 主要有 3 種標的物，$C_6H_{11}CH_3$、NH_3、HCO_2H 等 Hydrogen Energy Carrier 選擇標的。



Production and utilization of hydrogen from renewable energy

圖 3-12 AIST 規劃氫能應用情境圖

日本 AIST 研發氫能技術進展，如圖 3-12 AIST 規劃氫能應用情境圖所示，圖 3-13 為 AIST 開發以氨為燃料之渦輪發電機，氨燃燒發電後還需經過 De-NOx 催化劑反應床，使排放之 NOx 小於 25ppm。

4.Development of internal combustion engine firing ammonia【Fig. 3】

This team is collaborating with Tohoku University on technology research for the direct combustion of ammonia. Work has been done on a micro gas turbine (rated power: 50 kW), and 41.8 kW power generation was successfully achieved by burning methane-ammonia gas or 100% ammonia. These are world-leading research results. In terms of nitrogen oxide (NOx) emission, the gas turbine fueled with ammonia emits less than 25 ppm of NOx by using NOx removal equipment. This emission level meets the standard of the Ministry for the Environment of Japan.

*This research and development is being conducted under the Cross-Ministerial Strategic Innovation Promotion Program (SIP) "Energy Carrier" of the Cabinet Office (management corporation: JST).

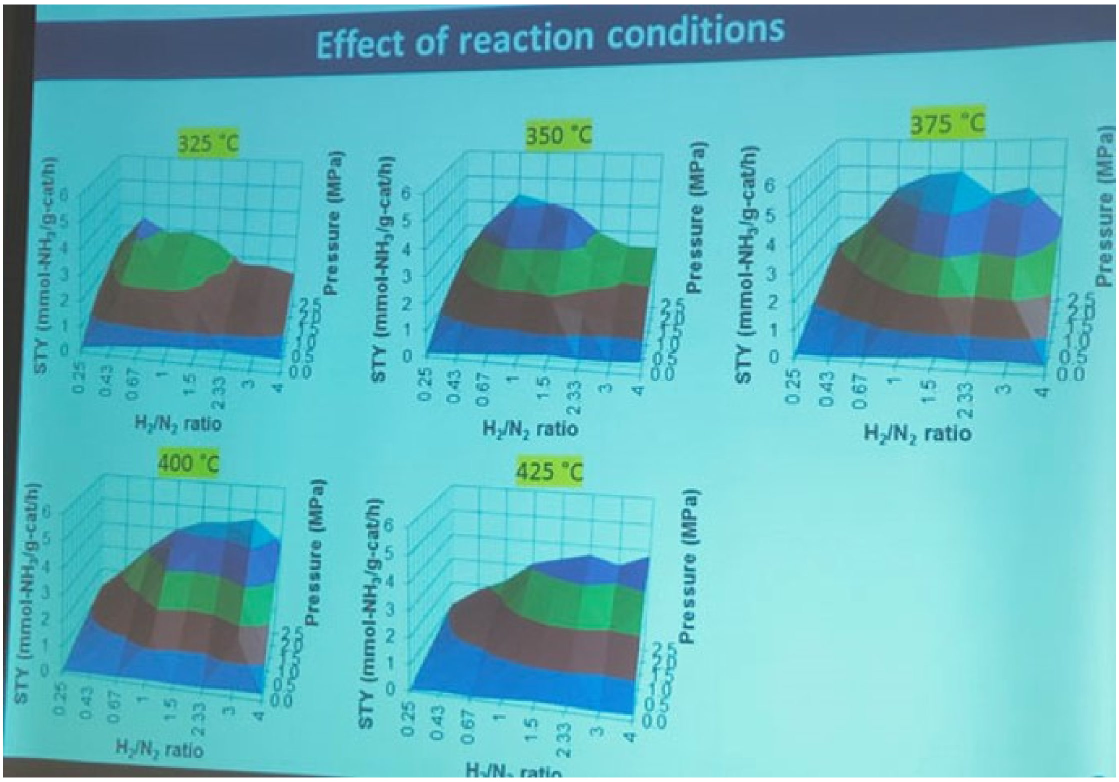
【Fig. 3】Ammonia gas turbine

圖 3-13 AIST 開發以氨為燃料之渦輪發電機

日本 AIST 的 Rahat Javaid 介紹以催化劑合成氨，氨是潛在的氫和能量載體[8, 9]，具有很高的氫氣比。作為能量載體，氨被認為是具能量密集的零碳排燃料。在工業上，氨是通過哈伯-博世(Haber-Bosch) 法使用鐵基催化劑合成，此合成過程的重大缺點包括需要高溫(425-600°C)和壓力(20-30 Mpa)條件與溫室氣體的排放。因此 AIST 希望研究開發綠色科技方法合成氨，透過使用再生能源或水電解所產生的氫氣，透過催化劑以氫氣和氮氣為反應物合成氨。

該研究以浸漬法先合成 Ru/CeO$_2$ 催化劑。再以氫氣和氮氣為反應物，測定 Ru/CeO$_2$ 催化劑合成氨的活性與研究反應條件的影響。在低於 400℃條件下，通過降低 H$_2$ / N$_2$

比可獲得更高的氨合成速率，此方法有別於哈伯-博世法合成氨，此法所合成之氨不需要高壓，也可以在低於 400℃條件下合成氨，也沒有溫室氣體的排放，為具潛力之程序方法。



Effect of reaction conditions

圖 3-14 Ru/CeO$_2$ 催化劑合成氨之變數影響

圖 3-14 呈現 Ru/CeO$_2$ 催化劑合成氨之在不同 H_2／N_2 比例與壓力變數條件下對合成氨產率之影響，結果呈現低於 400℃條件下可以順利有效率的合成氨。

3.4 反應觸媒技術與研發

氫能利用需要一般以 Proton exchange membrane (PEM) fuel cells 燃料電池為主，此 PEM 燃料電池之電極的功能和要求，須具有活化表面位置可以提供反應作用氣體(燃料和氧氣)電離或去電離反應，同時提供燃料和氧化劑的途徑，反應電子傳導與熱傳導，圖 3-15 呈現 Proton exchange membrane (PEM) fuel cells 結構圖。

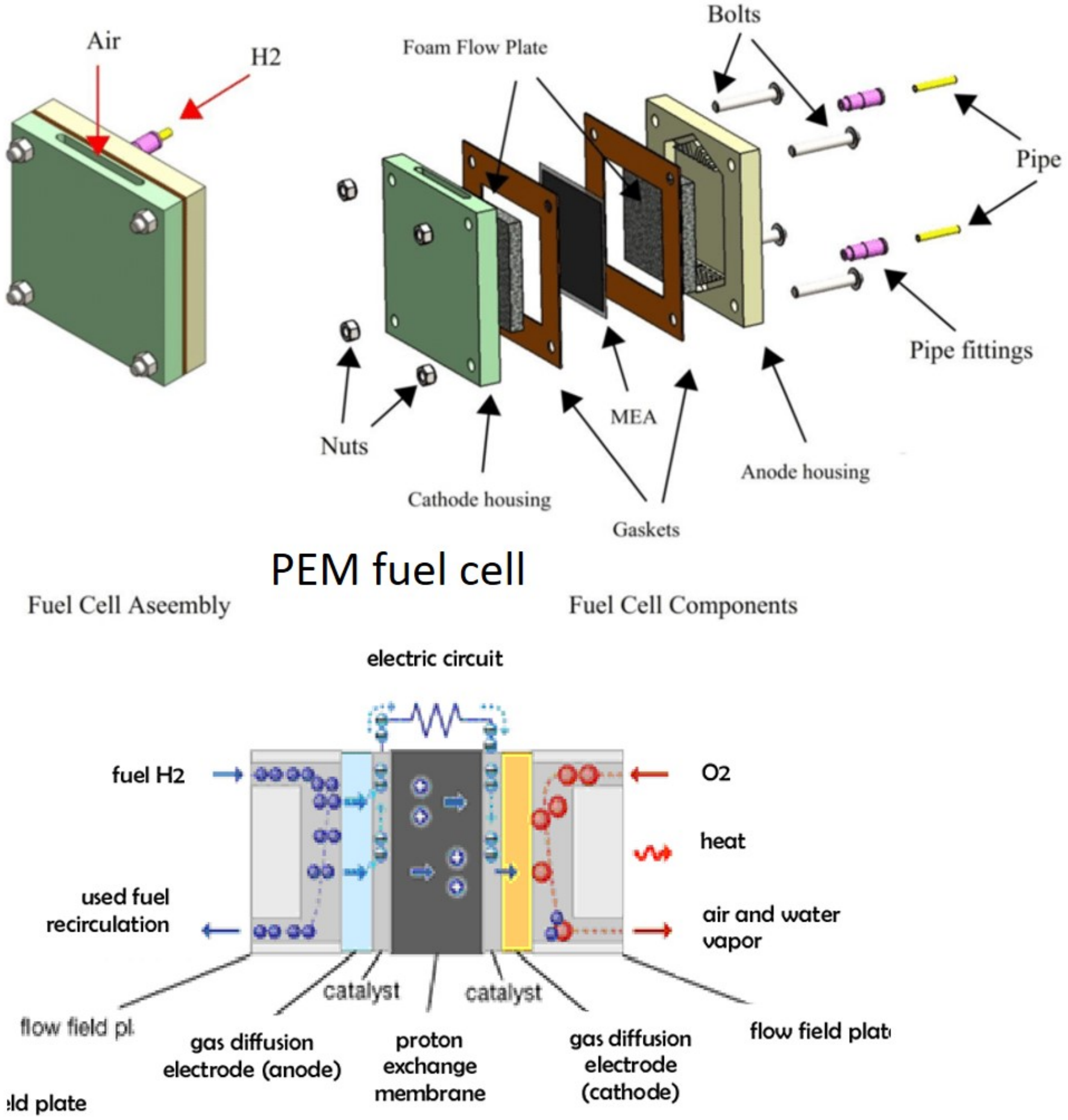
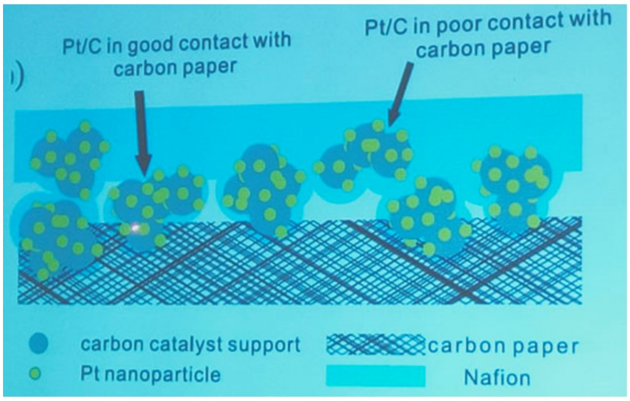
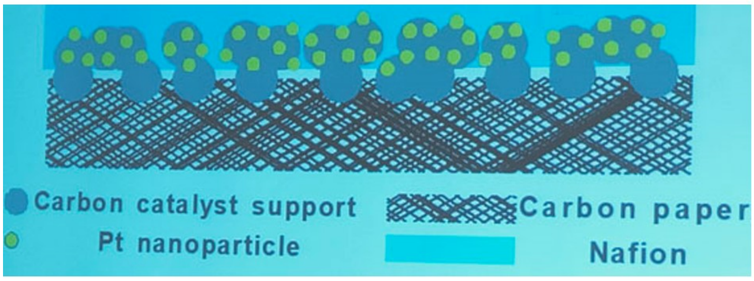


圖 3-15 Proton exchange membrane (PEM) fuel cells 結構圖

Problems of conventional ink coating process

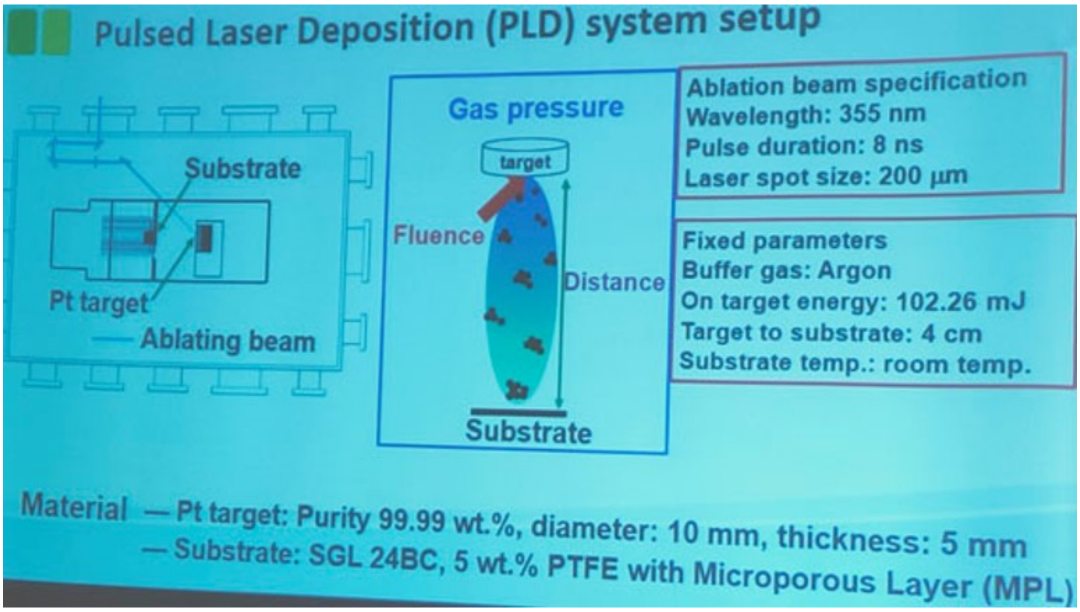


Part of catalysts are not in good contact with carbon paper, resulting in low catalyst utilization.



Ideal catalyst distribution in the catalyst layer

圖 3-16 傳統 ink coating 缺點與理想觸媒分布圖



Pulsed Laser Deposition (PLD) system setup

Ablation beam specification
Wavelength: 355 nm
Pulse duration: 8 ns
Laser spot size: 200 μm

Fixed parameters
Buffer gas: Argon
On target energy: 102.26 mJ
Target to substrate: 4 cm
Substrate temp.: room temp.

Material — Pt target: Purity 99.99 wt.%, diameter: 10 mm, thickness: 5 mm
— Substrate: SGL 24BC, 5 wt.% PTFE with Microporous Layer (MPL)

圖 3-17 脈衝雷射沉積法系統條件與操作示意圖

中央大學曾重仁教授發表 High performance low Pt catalysts for proton exchange membrane fuel cells，曾教授以脈衝雷射沉積(PLD)法之製程，應用於材料觸媒薄膜製程改良應用[10, 11]，從圖 3-16 中，經由傳統 ink coating 缺點與理想觸媒分布圖，以脈衝雷射沉積法改善反應，減少 PEM 電極白金之金屬使用，以降低 PEM 燃料電池整體成本價格。使用如圖 3-17 脈衝雷射沉積法系統條件，結果與商用 Pt/C 催化劑相比，使用 PLD 可使 Pt 負載降低 5 倍，其耐久性得到改善。使用脈衝雷射沉積法配合微加工在氣體擴散層上製造週期性溝槽以提高 PEMFC 的最大功率密度的方法。可降低白金之催化劑，相較於商業性產品，只需其 20%白金使用量，因而可以降低成本，同時因其具高功率密度可降低電池尺寸和重量。

3.5 廢棄物產氫

生質能應用開發對減少污染改善環境具潛力。以印尼與馬來西亞為例，其考量以 palm oil 產業發展 biofuel 並將廢料轉變為燃料，包括燃料丸或轉換生質能等。透過廢棄物分解處理產製氫能，例如劣質煤、廢橡膠、廚餘、油污泥等以「煤炭氫化」技術產生的「富氫氣體」作為燃料進行發電，不僅可以解決廢棄物問題，發電過程也能大幅減少空氣污染。固體廢棄物種類繁多，儘管經過資源回收轉化為可用產品，但廢棄物數量仍在增加。廢棄物回收和轉化對於污染減輕有幫助。例如印尼與馬來西亞為生產 palm oil 產業發展 biofuel 會有許多榨油後之廢料，如何有效利用將廢料轉變為燃料值得關注。

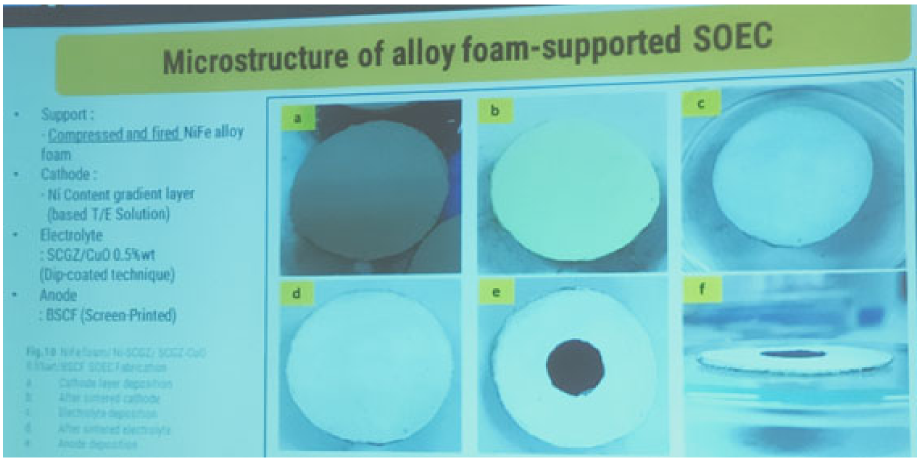
國內對於生質能源發展也逐漸有進展，臺灣生質能技術發展協會[12]於 2019 年 12 月 6 日在台中國立中興大學森林學系，舉辦「國際生質能源發展現況與展望研討會」，探討固體廢棄物資源應用。

圖 3-18 廢棄物機械生物處理能資源化示意圖[12]

3.6 SOEC 產氫

R. Visvanichkul 團隊發表 Fabrication and performance of alloy foam-supported solid oxide electrolysis cell (SOEC) for hydrogen production 論文。該文認為氫能為清潔、可持續的能源是很有前途的能源載體，其需求將持續增長。通過固體氧化物電解槽(SOEC)進行的蒸汽電解可以產生高純度的氫氣。SOEC 開發的挑戰是如何提高電池的性能和耐用性。使用合金作為載體來製造薄電池可以提供較低的電阻和氧化速率，並有助於增強電池的機械性能。

此項研究中製造金屬泡沫支撐的 SOEC:以鎳鐵(Ni-Fe)合金泡沫(孔隙率：5-130 ppi)應用於電池支架；製作由 $Ni\text{-}Sc_{0.1}Ce_{0.005}Gd_{0.005}Zr_{0.89}$(SCGZ)陰極，SCGZ 電解質和 $Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_{3-\delta}$(BSCF)陽極組成的單薄電池；將電極粉末與添加劑混合，形成濕法化學塗料漿料；陰極的多層被製造成在載體和電解質之間具有熱膨脹係數(TEC)的梯度，以克服熱處理過程中的熱膨脹係數梯度影響；在塗覆陰極和電解質後，將半電池在合適的溫度和加熱速率下共燒結，以避免形成缺陷並提供足夠的緻密化電解質；陽極通過絲網印刷沉積；分別通過流變儀，掃描電子顯微鏡(SEM)和通用測試機(UTM)特徵漿液的流變特性、形態和機械性能。 SOEC 的電化學性能量測以 H_2O/H_2 進料條件下，在 600˚C 至 900˚C 的受控溫度下測量分析。


Microstructure of alloy foam-supported SOEC

- Support :
  - Compressed and fired NiFe alloy foam
- Cathode :
  - Ni Content gradient layer (based T/E Solution)
- Electrolyte
  : SCGZ/CuO 0.5%wt
  (Dip-coated technique)
- Anode
  : BSCF (Screen-Printed)

Fig.19 NiFe foam/ Ni-SCGZ/ SCGZ-CuO 0.5%wt/BSCF SOEC Fabrication
a Cathode layer deposition
b After sintered cathode
c Electrolyte deposition
d After sintered electrolyte
e Anode deposition

圖 3-19 金屬泡沫支撐的 SOEC

3.7 論文發表以催化劑之聚光型產氫系統產氫及 CO_2 熱還原研究

本所團隊以白金修飾之奈米鈦管光催化劑之聚光型產氫系統研究和以 CeO/NiO/MCM 熱催化 CO_2 還原法，在大會中發表題目為『The study of STH pilot system by photocatalyst and CO_2 thermal reduction by NiO/CeO、NiO /MCM catalyst』論文，以海報展出並配合作者現場解說，呈現白金修飾之奈米鈦管之光觸媒產氫技術。

本團隊合成各種修飾 Pt 奈米鈦管，並研究修飾 Pt 奈米鈦管催化劑的特徵。通過光催化產製氫氣試驗，對於 Pt / TiO_2 奈米鈦管上光催化分解水產氫進行測試。在 56.1 mW/cm^2 日光照射條件下的聚光型產氫系統，其達到 STH 效率達到 2.1%，系統產氫速率可達到每小時 2.5 公升。

對於 CO_2 的熱還原，本團隊使用通過浸漬法合成的 CeO/NiO/MCM 催化劑。CeO/NiO/MCM 催化劑在 400℃條件下進行 CO_2 熱催化還原，其分析結果為 CH_4 生成回收率為 96%。所製備的樣品經過 X 射線繞射，X 射線光電子能譜，氮吸附-解吸等溫線，UV-VIS 反射光譜和 SEM-EDS 進行分析。

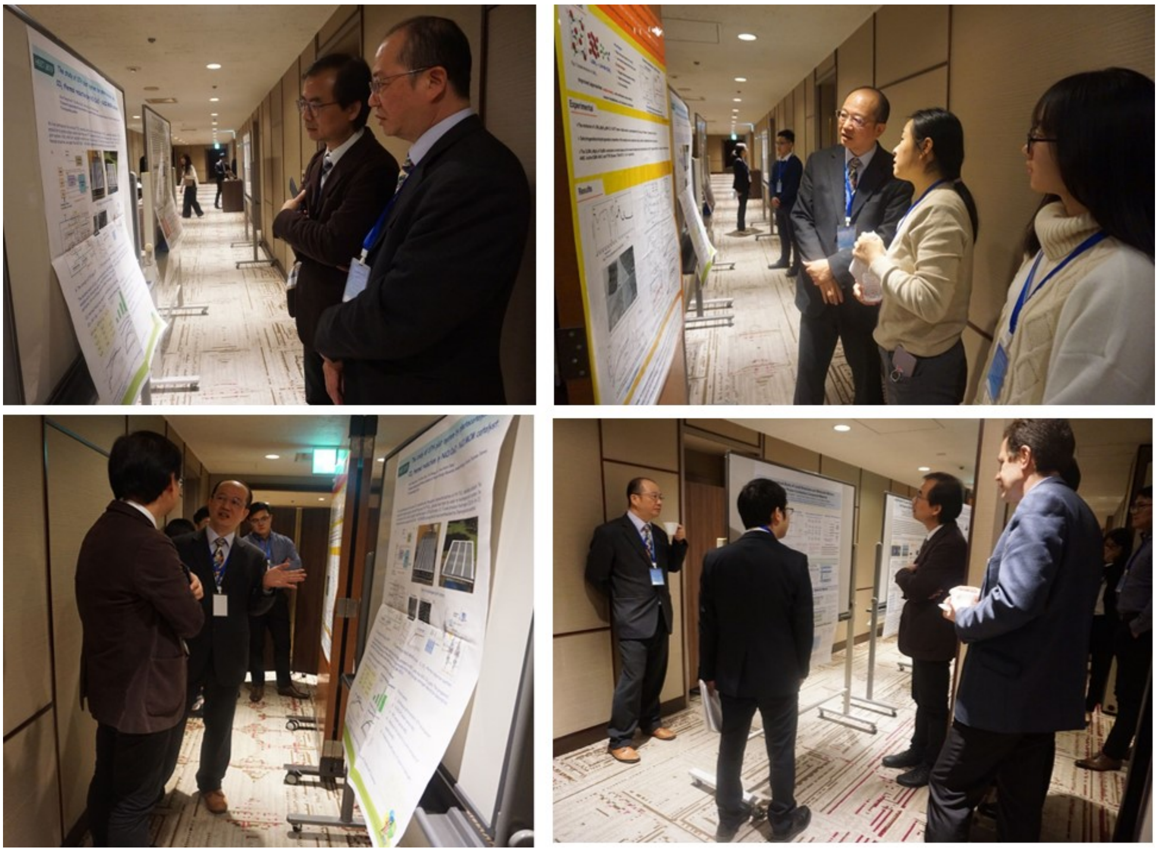


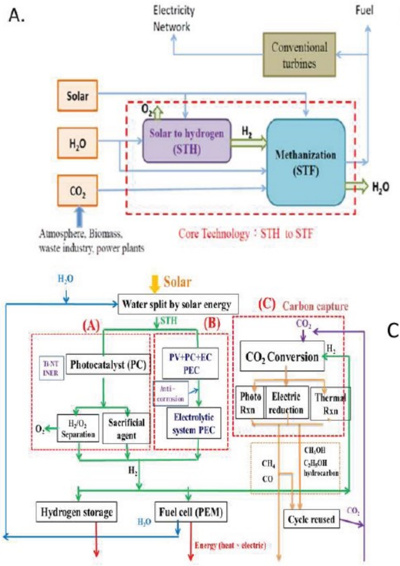
圖 3-20 論文發表應用光觸媒於聚光型產氫系統研究及 CO_2 熱觸媒還原研究

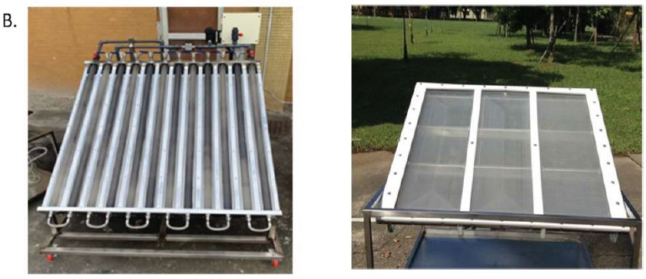
HEET 2019

The study of STH pilot system by photocatalyst and CO_2 thermal reduction by NiO/CeO、NiO/MCM catalyst.

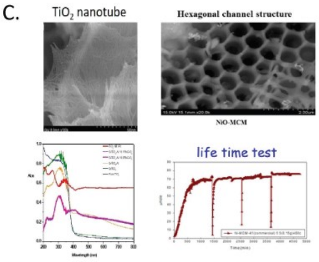
Chin-Chang Shen[1]*, *Yu-Zhen Zeng*[1], *Yu-Chang Liu*[1], *Jen-Chieh Chung*[1]
[1]**Chemical Engineering Division, Institute of Nuclear Energy Research, Atomic Energy Council, Taoyuan, Taiwan**
***Corresponding author.**

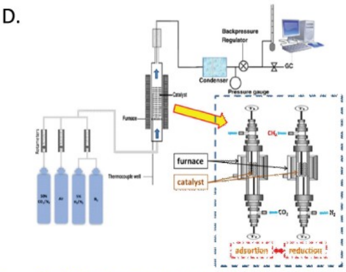
We had synthesized the various TiO_2 nanotube and study the characterization of Pt/TiO_2 nanotube catalyst. The production by photocatalytic water splitting over Pt/TiO_2 nanotube had test by solar to hydrogen pilot system. The pilot system in 56.1 mW/cm^2 sunlight condition reach STH efficiency 2.1 % and produce hydrogen 2.5L/hr. For CO_2 thermal reduction, we used the NiO/CeO 、NiO/MCM catalyst which had synthesized by Impregnation method.





B. solar to hydrogen pilot system





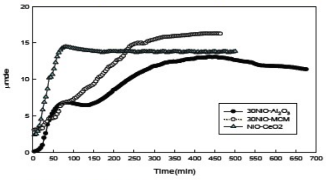
A. The concept of STH and STF C. TiO_2 nanotube and NiO/MCM catalyst D. CO_2 thermal reduction system.

The analysis result of CO_2 thermal reduction by NiO/MCM catalyst in 400 ℃ with the 96% CH_4 yield. The prepared samples were characterized by X-ray diffraction, X-ray photoelectron spectroscopy, nitrogen adsorption-desorption isotherms, UV-vis diffuse reflectance spectroscopy, and SEM-EDS.

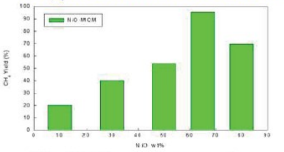
CO_2 thermal reduction results of conversion CO_2 to methane

$CO_2 + 8H^+ + 8e^- \rightarrow CH_4 + 2H_2O$

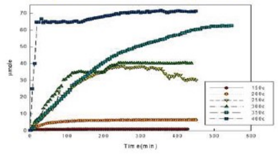
30% NiO	BET(m^2/g)	CH_4 (%)
P25	50.2	-
Al_2O_3	241	16.61%
CeO_2	132	20.24%
MCM	1006	39.92%



CH_4 yield at different NiO contents



CH_4 yield at variance temperature



Future works:

1. Continuous photocatalytic STH development.
2. PV+EC+PC model system R&D.
3. PEC model system R&D.
4. Enhanced the durability by Anticorrosion of materials R&D.
5. Promoted the efficiency of solar to hydrogen.

Acknowledgements
This work was supported by grants from the Taiwan Ministry of Science and Technology (MOST 108-08800301).

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圖 3-21 論文海報內容

四、建 議 事 項

(一) 再生能源將持續發展，因此電網中能源配比之衝擊需事先規劃與準備：再生能源中風電與太陽能併網佔比將持續增加，未來對電網控制與衝擊會加劇變化，需事先規劃因應與準備減低衝擊。

(二) 智慧電網系統對電網控制助益很大，本所微型電網系統對再生能源聯網極具潛力：現在太陽能、風能、生質能等再生能源持續增長，如何以智慧電網系統與微型電網好好控制並整合再生能源電力，使電網能穩定保持好的可靠度。

(三) 生質能應用開發對減少污染改善環境具潛力:以印尼與馬來西亞為例考量 palm oil 產業發展 biofuel 並將廢料轉變為燃料，包括燃料丸或轉換生質能等。

(四) 鼓勵本所研究人員參加研討會:研究人員透過參加研討會與資訊交流能有思想衝擊，有助於增長研究進步。建議本所鼓勵研究人員參加研討會進行分享交流，藉以增進研究進步與研發成效。

(五) 甲烷產氫研發，除了產生氫能又能生產奈米碳管值得注意:對於未來氫能發展與衍生價值產品會有衝擊，而奈米碳管如何做好分離與回收值得注意。

五、附　錄

(一)參考文獻

1. Bp, Energy Outlook https://www.bp.com/en/global/corporate/energy-economics/energy-outlook/introduction/overview.html. **2020**.
2. Bp, BP Energy Outlook 2019 edition https://www.bp.com/content/dam/bp/business-sites/en/global/corporate/pdfs/energy-economics/energy-outlook/bp-energy-outlook-2019.pdf.
3. Kutteri A. D.; W. I. W.; Samanta A.; Li L.; Hu J., Methane decomposition to tip and base grown carbon nanotubes and COx-free H2 over mono- and bimetallic 3d transition metal catalysts. *Catalysis Science & Technology* **2018,** *8* (3), 858-869.
4. Kim, B. S.; Ju, W. K.; Lee, M. W.; Lee, C.; Lee, S. G.; Beom-Hoan, O., Simple fabrication of antireflective silicon subwavelength structure with self-cleaning properties. *Journal of nanoscience and nanotechnology* **2013,** *13* (5), 3622-6.
5. Anthony, D. B.; Sui., X. M.;Kellersztein, I.;De Luca, H. G.;White, E. R.;Wagner, H.D.; Greenhalgh, E. S.;Bismarck, A.;Shaffer, M. S. P.,, Continuous carbon nanotube synthesis on charged carbon fibers. *Composites Part A: Applied Science and Manufacturing* **2018,** *112*, 525-538.
6. Lavagna, L. M., D.;Pantano, M. F.;Bosia, F.;Pugno, N. M.;Pavese, M., Grafting carbon nanotubes onto carbon fibres doubles their effective strength and the toughness of the composite. *Composites Science and Technology* **2018,** *166*, 140-149.
7. AIST, AIST NH_3 synthesis method. *https://www.aist.go.jp/*.
8. DOE, Potential Roles of Ammonia in a Hydrogen Economy. *https://www.energy.gov/sites/prod/files/2015/01/f19/fcto_nh3_h2_storage_white_paper_2006.pdf* **Feb 2006**
9. Kojima Y.; Adachi T., Ammonia As a Hydrogen Carrier for PEM Fuel Cells. *https://nh3fuelassociation.org/2018/12/09/ammonia-as-a-hydrogen-carrier-for-pem-fuel-cells/* **2018,** *Hiroshima University*.
10. Dutta, D.; Ganda, A. N. F.; Chih, J. K.; Huang, C. C.; Tseng, C. J.; Su, C. Y., Revisiting graphene-polymer nanocomposite for enhancing anticorrosion performance: a new insight into interface chemistry and diffusion model. *Nanoscale* **2018,** *10* (26), 12612-12624.
11. Huang T. W.; Tseng. C. J., Production of Improved Stability and High Performance Pt-Nanoparticle Catalyst using Pulsed Laser for PEMFC Application. *master degree thesis* **2016**.
12. 台灣生質能協會, 台灣生質能技術發展協會. *https://www.twbiomass.org.tw/*.

附件 HEET 2019 OSAKA CONFERENCE CONFERENCE SCHEDULE

HEET 2019 OSAKA CONFERENCE

CONFERENCE SCHEDULE

2019 The 2nd International Symposium on Hydrogen Energy and Energy Technologies

HEET 2019
December 12-13, 2019 |Osaka, Japan

Osaka, Japan

December 12-13, 2019

http://www.heet-18.org/

HEET 2019 OSAKA CONFERENCE

Simple Version of the Schedule

December 12th a.m. Registration (09:00 AM--11:00 AM)

December 12th p.m. Keynote Speech (13:00 PM--14:30 PM)
Coffee Break (14:30 PM -14:25 PM)
Oral Presentation (14: 25 AM-16:50 PM)

December 13th a.m.
Keynote Speech (09:00 AM--09:30 AM)
Oral Presentation (09: 30 AM-10:20 PM)
Photos & Coffee Break (10:20 AM--10:45 AM)
Oral Presentation (10: 45 AM-12:00 PM)

December 13th p.m. Lunch (12:00 PM-13:20 PM)
Oral presentation (13:20 PM -14:35 PM)
Coffee Break (14:35 PM -15:00 PM)
Poster presentation (15:00 PM -18:00 PM)

Committees

Technical Program Committees

Prof.Dr. Kenshi Itaoka,Kyushu University, Japan
Prof.Dr. S.A. Grigoriev,National Research University "Moscow Power Engineering Institute", Russia
Prof.Dr. GUO Yun ,University of Science and Technology of China, China
Prof.Dr. Bashir Ahmmad Arima,Yamagata University, Japan
Prof. Dr. Narottam Das, University of Southern Queensland, Australia
Prof. Dr. Corrado Lo Storto,University of Naples Federico II, Italy
Prof.Dr. Rui Chibante,School of Engineering of Polytechnic Institute of Porto, Portugal
Prof.Dr. Balasubramanian Viswanathan,Indian Institute of Technology Madras, India
Prof.Dr. Salvador Aceves,Lawrence Livermore National Laboratory, USA
Prof.Dr. Gheorghe-Daniel Andreescu,Politehnica University of Timisoara, Romania
Prof.Dr. Paolo Beccarelli,University of Nottingham, England
Prof.Dr. Samo Kralj,University of Maribor, Slovenia
Prof.Dr. Yangkyun Kim,Korea Institute of Civil Engineering and Building Technology, Korea
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Prof. Hua Meng,Zhejiang University, China
Dr. Ihaddaene RazikaMed Boudiaf M'sila University, M'sila Algeria
Dr. Yasin POLAT,Nevşehir Hacı Bektaş Veli University, Turkey
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Dr. Ranjit Sundaramurthi,The Ohio State University, Columbus, OH, US
Dr. Alfonso Chinnici,University of Adelaide, Australia
Dr. Balaji Trimbak Khogare,Raje Ramrao Mahavidyalaya, India
Dr. Pang－Chieh Sui,Wuhan University of Technology，China
Dr. Nicolae Vaszilcsin,Politehnica University of Timisoara，Romania
Dr. Umair Yaqub Qazi, University of Hafr Al Batin, Saudi Arabia
Dr. Veronica Bermudez, QEERI- Qatar Environment & Energy Research Institute, Qatar
Prof.Gioele Di Marcoberardino, Università degli Studi di Brescia, Italy
Dr. Amandeep Singh Oberoi, Thapar University, India
Dr. Michel Noussan, Politecnico di Torino, Italy
Dr. Francesco Neirotti, Politecnico di Torino, Italy

Venue

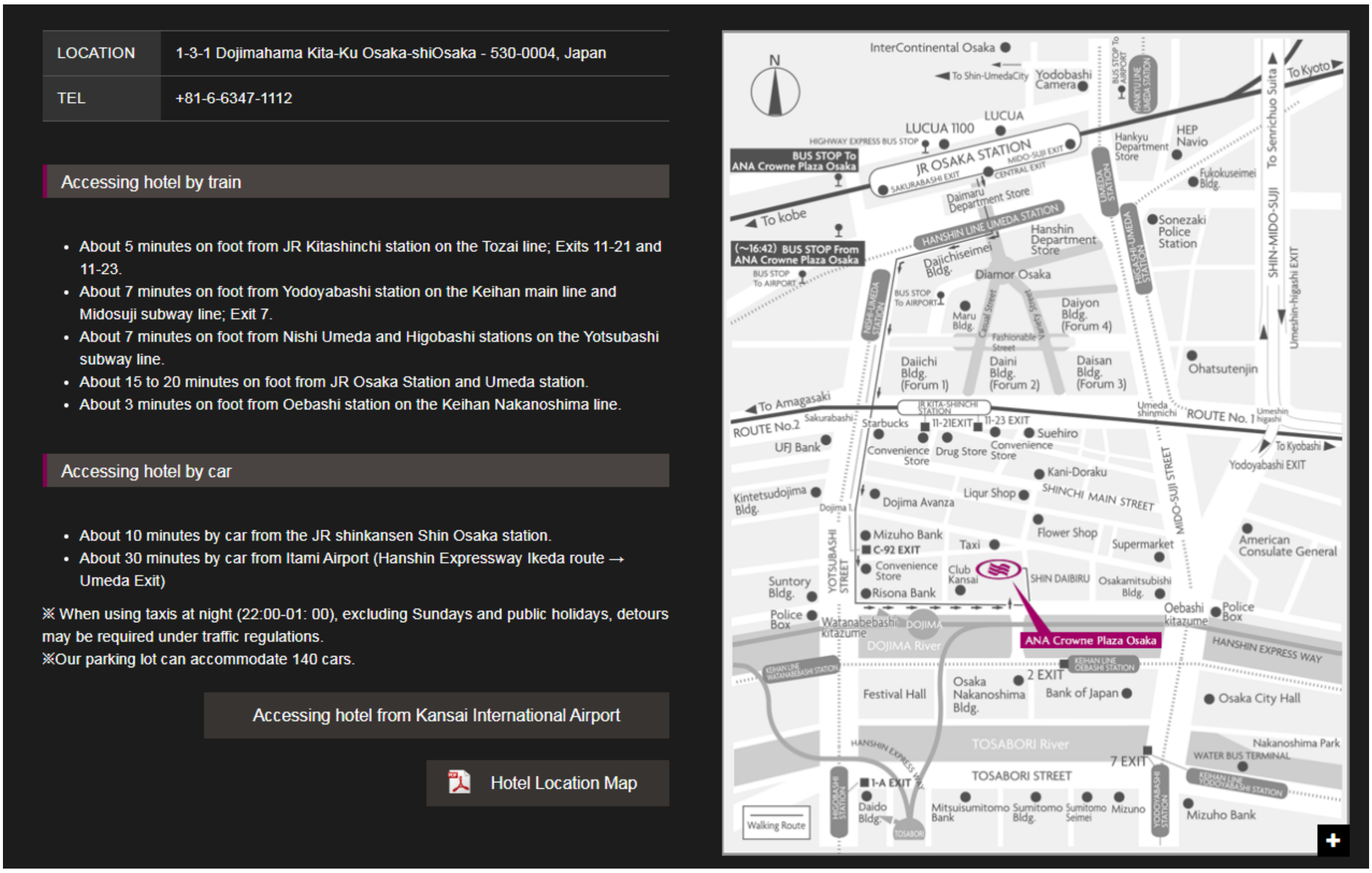
Conference venue: ANA CROWNE PLAZA OSAKA, Japan.
Address: 1-３-１ Dojimahama, Kita Ward, Osaka, Osaka Prefecture 530-0004, Japan

TEL : +81-6-6347-1112
Fax : +81-6-6348-9208

Web: https://www.anacrowneplaza-osaka.jp/

HEET 2019 OSAKA CONFERENCE

Location



LOCATION	1-3-1 Dojimahama Kita-Ku Osaka-shiOsaka - 530-0004, Japan
TEL	+81-6-6347-1112

Accessing hotel by train

- About 5 minutes on foot from JR Kitashinchi station on the Tozai line; Exits 11-21 and 11-23.
- About 7 minutes on foot from Yodoyabashi station on the Keihan main line and Midosuji subway line; Exit 7.
- About 7 minutes on foot from Nishi Umeda and Higobashi stations on the Yotsubashi subway line.
- About 15 to 20 minutes on foot from JR Osaka Station and Umeda station.
- About 3 minutes on foot from Oebashi station on the Keihan Nakanoshima line.

Accessing hotel by car

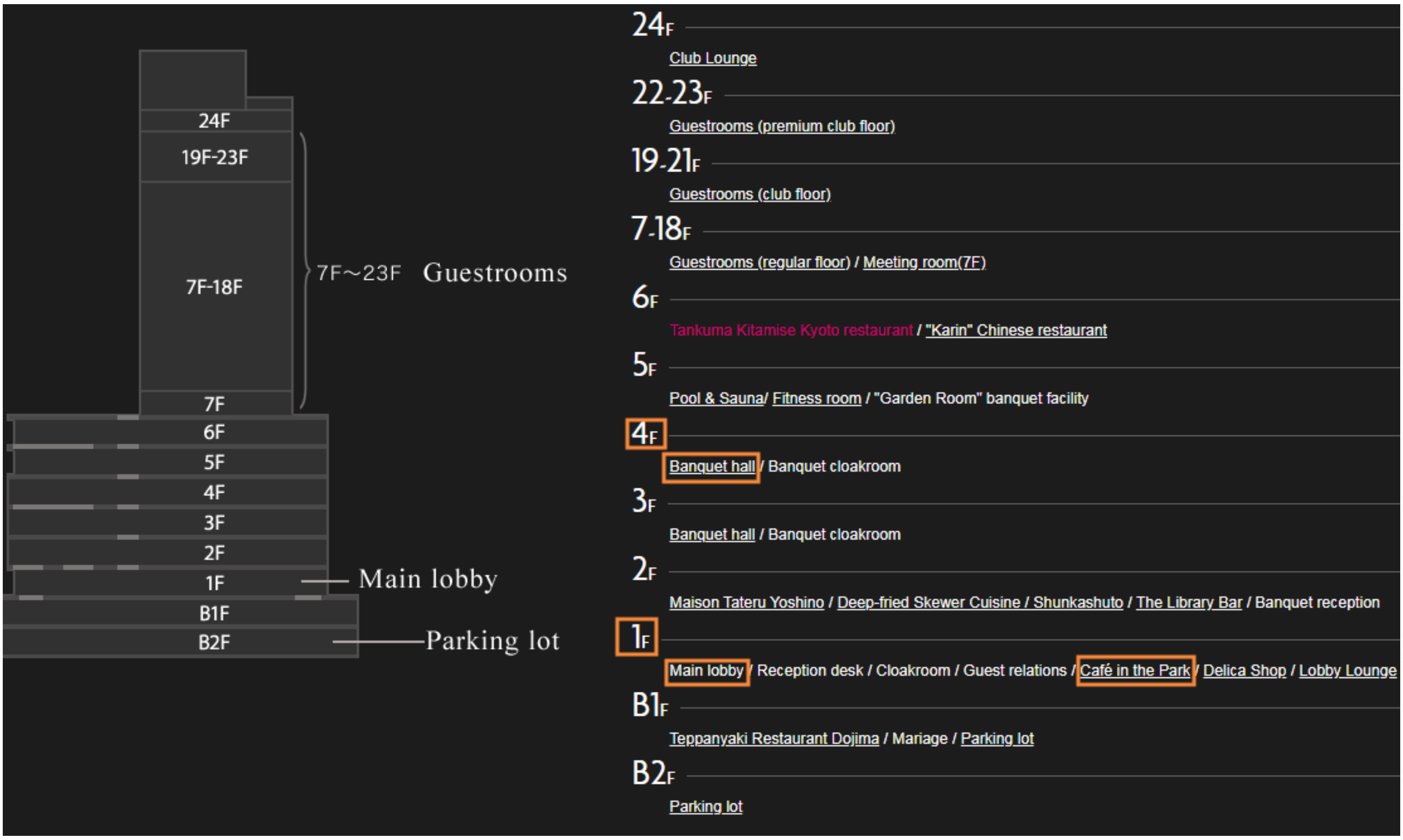
- About 10 minutes by car from the JR shinkansen Shin Osaka station.
- About 30 minutes by car from Itami Airport (Hanshin Expressway Ikeda route → Umeda Exit)

※ When using taxis at night (22:00-01: 00), excluding Sundays and public holidays, detours may be required under traffic regulations.
※Our parking lot can accommodate 140 cars.

Accessing hotel from Kansai International Airport

Hotel Location Map

Simple lay



24F
Club Lounge

22-23F
Guestrooms (premium club floor)

19-21F
Guestrooms (club floor)

7-18F
Guestrooms (regular floor) / Meeting room(7F)

6F
Tankuma Kitamise Kyoto restaurant / "Karin" Chinese restaurant

5F
Pool & Sauna/ Fitness room / "Garden Room" banquet facility

4F
Banquet hall / Banquet cloakroom

3F
Banquet hall / Banquet cloakroom

2F
Maison Tateru Yoshino / Deep-fried Skewer Cuisine / Shunkashuto / The Library Bar / Banquet reception

1F
Main lobby / Reception desk / Cloakroom / Guest relations / Café in the Park / Delica Shop / Lobby Lounge

B1F
Teppanyaki Restaurant Dojima / Mariage / Parking lot

B2F
Parking lot

HEET 2019 OSAKA CONFERENCE

HEET2019 OSAKA CONFERENCE

HEET 2019 will be held at ANA Crowne Plaza Osaka, Japan as below

December 12th, 2019 (Thursday)

Lobby (1st Floor) of ANA Crowne Plaza Osaka, Japan

09:00 AM--11:00 AM	Registration and Reception

December 12th, 2019 (Thursday)

Momoyama room(4th Floor) of ANA Crowne Plaza Osaka, Japan

13:00 pm--13:30 pm	Keynote Speech	John Hu
13:30 pm- 14 : 00 pm	Oral presentation	Lan Yang
14:00 pm- 14 : 30 pm	Oral presentation	Stanislav Chicherin
14:30 pm--14:50 pm	Oral presentation	Adel Megriche
14:50 pm- 15 : 20 pm	***Coffee Break***	
15:20 pm – 15:50 pm	Oral presentation	Guoqing Huang
15:20 pm – 15:50 pm	Oral presentation	C H Peng
16:20 pm – 16:50 pm	Oral presentation	Xin Zhao

December 13th, 2019 (Friday)

Momoyama room(4th Floor) of ANA Crowne Plaza Osaka, Japan

09:00 am-09:30 am	Keynote Speech	Prof. Chung-Jen Tseng
09:30 am-09:55 am	Oral presentation	Wilhelm Wiebe
09:55 am-10:20 am	Oral presentation	Zhentong Wang (Wei Wang)
10:20 am-10:45 am	***Photos & Coffee Break***	

10:45 am-11:10 am	Oral presentation	Rahat Javaid
11:10 am-11:35 am	Oral presentation	Nadia Yousfi Steiner
11:35 am-12:00 pm	Oral presentation	RAMIN VISVANICHKUL
12:00 pm-13:20 pm	***Lunch***	

December 13th Afternoon

Momoyama room (4th Floor) of ANA Crowne Plaza Osaka, Japan

13:20 pm-13:45 pm	Oral presentation	Yuting Wang
13:45 pm-14:10 pm	Oral presentation	Sasinun Thirabunjongcharoen
14:10 pm-14:35 pm	Oral presentation	Congying Nie
14:35 pm-15:00 pm	***Coffee break***	
15:00 pm-15:20 pm	Poster presentation	Yuta Hori
15:20 pm-15:40 pm	Poster presentation	Po-Chun Cheng
15:40 pm-16:00 pm	Poster presentation	Chia-Chun Lang
16:00 pm-16:20 pm	Poster presentation	Chin-Chang Shen
16:20 pm-16:40 pm	Poster presentation	Kuikui Wang
16:40 pm-17:00 pm	Poster presentation	Jie Dai
17:00 pm-17:20 pm	Poster presentation	Wan-Hao Zhang
17:20 pm-17:40 pm	Poster presentation	Yu-Hsien Lai
17:40 pm-18:00 pm	Poster presentation	Xindi Liu

Note:

1. All the participants are strongly advised to arrive before 9:00 AM, December 13, 2019.

2. Certificate of Participation can be offered at the registration counter.

3. Please copy PPT files of your presentation to the secretary when registration.

4. The organizer doesn't provide accommodation, and we suggest you make an early reservation.

5. If you want to deliver oral presentation or poster but your paper is not in the session list, please contact us by Email: conf@heet-18.org or daisy-lee@heet-18.org

Instruction about Oral Presentation

➢Devices Provided by the Conference Organizer:

- Laptops
- Projectors &Screen
- Laser Sticks

➢Materials Provided by the Presenters:

- PowerPoint or PDF files Duration of each Presentation:
- Regular Oral Session: about 15 Minutes of Presentation and 5 Minutes of Q&A

Plenary Speech

Plenary Speech 13:00 PM--13:30 PM

John Hu, Ph.D.,

Dr. Hu specializes in catalysis and reaction engineering. He has demonstrated strong leadership in both academic research and industrial R&D, leading multi-disciplinary teams while working at PNNL, BP and Koch Industries. Dr. Hu has been undertaking a number of U.S. federally funded projects. While working at Koch Industries, Dr. Hu had led the innovation of natural gas upgrading and second generation biomass conversion, resulting in significant savings in capital investment and operating cost. Dr. Hu has published more than 120 journal articles, conference papers and received 30 US patents, all related to catalysis and reaction engineering.

Keynote topic: Development of Novel Hydrogen Production Processes for the Transition from Fossil to Renewable Energy Sources

Speaker: Dr. John Hu

Abstract: Conventionally, major source of hydrogen production in the US has been natural gas, a fossil energy source. Transition from fossil fuels to renewable technologies is extremely challenging as renewable energy sources like solar, wind, and biomass are highly unreliable, subject to variation in geography and local climatic conditions. Apart from the technological challenges in utilization of renewable energy sources, they are not cost-effective and their return on investment index (ROI) is quite low. However, there is growing need for COX free hydrogen as conventionally produced hydrogen generates high concentrations of CO, CO_2 and require expensive separation units like solvent / sorbent based technologies. Researchers at West Virginia University have developed a novel methane catalytic pyrolysis process which produces COX free hydrogen with the formation of high carbon nanotubes (CNTs) and carbon fibers (CNFs) which can be separated from the catalyst and obtained as commercial product or reutilized as an active support for the catalyst. This catalytic methane decomposition (CMD) process utilizes Ni-Pd/CNT catalyst where the CNT is obtained from methane decomposition. Hydrogen production on the Ni-Pd/CNT catalyst was demonstrated over multiple cycles for 180 minutes time on-stream. About 50 to 60% methane conversion was observed in 5 cycles for 180 minutes TOS on the Ni-Pd/CNT catalyst. Transition from fossil hydrogen to renewable hydrogen is bridged by the unique 'natural gas – biomass co-processing. At WVU, hydrogen rich syngas production through renewable hardwood biomass gasification was obtained through synergistic natural gas – biomass co-processing. About 5% methane co-processed with biomass at 850oC on Fe-Mo/CNF catalyst produces H_2:CO ratio of 6 with a very low CO_2 concentration of < 5% in the syngas. About 60 to 80% hydrogen was obtained in the product gas on the Fe-Mo/CNF, Ni-Mo/CNF, and Mo-Pd/CNF catalysts. Synergistic methane activated biomass gasification could be a promising technology for hydrogen rich syngas production as it

requires very low concentrations of methane which could be obtained from flare gas. Flare gas is natural gas flared during commissioning of new wells or maintenance of existing wells in shale gas field. On-site utilization of flare gas with biomass could greatly curb CO_2 emission while producing hydrogen rich syngas. CO_2 utilization in the methane activated biomass gasification was studied by adding 1% CO_2 to the gas feed. CO_2 and CH4 activation at high temperature was performed on Fe, Ni, and Pd active sites while Mo active sites are responsible for deoxygenation of oxygen rich biomass. Adding 1% CO2 allows for controlled production of syngas with H2:CO between 2 to 2.5 and CO_2 concentration of 10 to 15%. Syngas with H_2:CO ratio of 2 to 2.5 is ideal for downstream chemical synthesis. In-situ conversion of raw biomass co-processed with 5% methane produces H2-rich syngas on the carbon nanofiber supported catalyst. CNF support is also obtained from the biomass feedstock by impregnation with metals and pyrolysis at 700oC. This process is 95% renewable with net reduction in CO_2 emissions by recycling of CO_2. Application of renewable technologies is on the rise especially in power generation but is still far from being a mainstream source of hydrogen and power. Development of high efficiency COX hydrogen production processes like catalyst methane decomposition and renewable-fossil based processes like synergistic natural gas – biomass co-processing is a logical transition from fossil to renewable hydrogen production.

HEET 2019 OSAKA CONFERENCE

Session Oral presentation

1-Paper ID: HE-015 (13:30 PM- 14:00PM)
Title: Efficient oxygen evolution electrocatalysis in acid by a perovskite with face-sharing IrO6 octahedral dimers
Authors: Lan Yang ,Jie-Sheng Chen, Xiaoxin Zou,Isaline Boulven, Isabelle Houlbert, and Agnès Henri
Speaker: Lan Yang
Abstract: The widespread use of proton exchange membrane water electrolysis requires the development of more efficient electrocatalysts containing reduced amounts of expensive iridium for the oxygen evolution reaction (OER). Here we present the identification of 6H-phase SrIrO3 perovskite (6H-SrIrO3) as a highly active electrocatalyst with good structural and catalytic stability for OER in acid. 6H-SrIrO3 contains 27.1 wt% less iridium than IrO2, but its iridium mass activity is about 7 times higher than IrO2, a benchmark electrocatalyst for the acidic OER. 6H-SrIrO3 is the most active catalytic material for OER among the iridium-based oxides reported recently, based on its highest iridium mass activity. Theoretical calculations indicate that the existence of face-sharing octahedral dimers is mainly responsible for the superior activity of 6H-SrIrO3 thanks to the weakened surface Ir-O binding that facilitates the potential-determining step involved in the OER (i.e., O* + H2O→HOO* + H+ + e¯).

2- Paper ID: HE-014(14:00 PM – 14:30 PM)
Title: Transition to Low-Temperature District Heating: Adjusting Load Profiles by Setting Supply Temperature and Using a Multiple-Source Arrangement
Authors: Stanislav Chicherin, Lyazzat Junussova and Timur Junussov

Speaker: Stanislav Chicherin
Abstract: We study three district heating (DH) systems development scenarios: the current scenario, and the prospective scenario with a design supply temperature of 80C, whereby, for instance, a heat pump can be used to raise the supply temperature to the required space heating (SH) level. The third scenario entails the design supply temperature of only 70C and a yearly average supply temperature of circa 50C to be raised to the proper temperature. A DH system model has been developed in the form of a spreadsheet to provide numerical results concerning the performance of the proposed low-temperature district heating (LTDH) solution in a certain heat distribution area located in Omsk, Russia. The authors herein show the relevance of investing in an individual heat source, as such investment help improve the DH network in the long term. We compared reference cases against simulated cases to show that, for instance, having a low-temperature network with only a 25% reduction in the supply temperature will result in a mean heat demand of 95 MW compared to a more ‘traditional’ value of 108 MW. A shorter heating season will reduce the operating costs, while that of a normal duration will result in a better year-round performance.

14:30 PM--14:50 PM	Photo & Coffee Break

Momoyama room (4th Floor)

Session Oral presentation

3-Paper ID: HE-034 (14:50 PM- 15:20PM)
Title: Waste Conversion to Hydrogen: Process Review
Authors: Adel Oueslati , Adel Megriche

Speaker: Adel Megriche
Abstract: Pollution of the environment has reached critical levels threatening man's well-being and even its existence. Solid waste is of different types and is still in increasing quantity despite the valuation and conversion into usable products. Some processes of recovery and conversion of waste are polluting. Indeed, the conversion of CO2 for example into bio methanol represents an innovation in terms of waste conversion but the disadvantage lies in the production of CO2 after the combustion of methanol. In this paper, we will present a review of the processes for converting waste into usable gas and especially the production of hydrogen.

4- Paper ID: HE-016 (15:20 PM – 15:50 PM)
Title: Ultrafine Cobalt Doped Iron Disulfide Nanoparticles in Ordered Mesoporous Carbon for Efficient Hydrogen Evolution
Authors: Guoqing Huang, Shaonan Xu, Zhipeng Liu, Shisheng Yuan, Cong Zhang, Jing Ai, Nan Li, Xiaotian Li

Speaker: Guoqing Huang
Abstract: Designing earth-abundant and efficient electrocatalysts to replace noble metals is highly desired for the hydrogen evolution reaction (HER) in water electrolysis. In this study, we constructed a self-supported electrode with ordered mesoporous carbon film coated carbon fibers as a substrate and Co doped FeS2 nanoparticles as catalytically active phase for the HER. The ordered mesoporous carbon served as nanoreactor to restrict the growth of sulfide particles and prevent them from agglomeration, leading to the formation of ultrafine and highly dispersed sulfide of ~5 nm, which enables the exposure of abundant active sites. Meanwhile, the Co atom doping enhanced the adsorption of the catalyst towards hydrogen, thereby improving its intrinsic activity. As a result, the electrode exhibited outstanding catalytic activity for the HER in acid electrolyte, manifesting a current density of 10 mA cm^{-2} at an overpotential of 92 mV and a small Tafel slope of 59 mV dec^{-1}.

5-Paper ID: HE-010 (15:20 PM – 15:50 PM)
Title: Experimental analysis and numerical simulation of melting process of vertical tin cladding
Authors: W H Wang, S Wang, C H Peng, and Y Guo

Speaker: C H Peng
Abstract: The melting phenomenon and the effect of different factors on melting process of tin cladding were studied. Experimental results show melting process consists of three stages, one of which can be subdivided into three phases. Numerical results show melting process can be divided into four stages. The melting stage is guided by two heat transfers, namely, the heat transfer from inside to outside and the heat transfer related to transporting the heat to the lower region by liquid tin flowing downward along the solid tin layer..

6- Paper ID: HE-028 (16:20 PM – 16:50 PM)
Title: Efficiency enhancement of H2 production by a newly isolated maltose-preferring fermentative bio-hydrogen producer of Clostridium butyricum NH-02
Authors: Xin Zhao, Liyan He, Nan Qi, Zhongtian Fu, Tianfang Han, Xiaomin Hu

Speaker: Xin Zhao
Abstract: Bio-hydrogen production with fermentative bacteria provides environmental-friendly pathways for renewable bio-energy recovery and wastes reutilization from organic biomass wastes and wastewater. In present study, a maltose preferring fermentative bio-hydrogen producing strain was isolated from humus-rich soil and identified as Clostridium butyricum NH-02. The optimal fermentation substrate, culture temperature and initial pH for strain NH-02 were studied for hydrogen production efficency enhancement and further investigations. The maximum cumulative H2 production of 1.80 L-H2/L-medium, H_2 yield of 1.90 mol-H_2/mol-RS (reducing sugar), RS utilization of 93.09% and cell dry weight of 1.88 g/L were obtained after a 23 h fermentation under the optimal condition of 10 g/L maltose, initial pH 7.0 and 35°C. To our knowledge, strain NH-02 was the first reported bio-H_2 producer within C. butyricum having a higher production efficiency from maltose than that from glucose. The experimental results indicated that C. butyricum NH-02 is an efficient and promising candidate for bio-hydrogen energy recovery from maltose-rich wastewater.

HEET 2019 OSAKA CONFERENCE

Plenary Speech

Plenary Speech 1   09:00 AM--09:30 AM

Chung-Jen Tseng, Ph.D.,

Professor Chung-Jen Tseng received his B.S. and M.S. degrees in Mechanical Engineering from National Chiao Tung University (Taiwan) in 1986 and 1988 respectively, and his Ph.D. degree in Mechanical Engineering from The University of Texas at Austin (U.S.A.) in 1995. He received NEDO (New Energy and Industrial Technology Development Organization) Fellowship from the Japanese government and worked on hydrogen energy in Yokohama from 1995 to 1998. He joined the Department of Mechanical Engineering of National Central University in 1998. Professor Tseng is now the President of Taiwan Association for Hydrogen Energy and Fuel Cells, and the Combustion Institute of Taiwan. He also serves as an Associate Editor of the Journal of Energy Engineering. His research was honored by the University with Research Excellence Award from 2013 to 2016, and Distinguished Professorships since 2017.

Keynote topic: High performance low Pt-catalysts for proton exchange membrane fuel cells
Speaker: Prof. Chung-Jen Tseng

Abstract: Pulsed laser deposition (PLD) in Ar atmosphere is used to deposit Pt nanoparticle onto gas diffusion layer (GDL), and its application in PEM fuel cell is optimized and characterized. When used at anode side, with a Pt loading of 17 μg/cm^2, the current density at 0.6 V in fuel cell test reaches 1100 mA/cm^2, and the performance is almost the same as the commercial E-TEK Pt/C catalyst with 200 μg /cm^2 Pt loading.

Using accelerated degradation test, it is found that the PLD sample retains 60 % of its initial ECSA after 5000 potential cycles, much higher than that with E-TEK Pt/C, which retains only 7 % of its initial ECSA. The higher electrochemical durability can be attributed to the higher degree of graphitization in the GDL, which leads to a stronger binding of the Pt nanoparticles onto the carbon support.

When applying this technique to the cathode side, the current density at 0.6 V in fuel cell test reaches 1200 mA/cm^2 with only 100 μg/cm^2 Pt loading. The performance is close to the commercial E-TEK Pt/C, but the amount of Pt was reduced by 75 % as compared with E-TEK Pt/C.

Furthermore, we used picosecond laser to fabricate grooves on the GDL surface to greatly increase the effective surface area for Pt deposition, thereby reducing the local Pt film thickness. The power density is further increased by using laser micro-machined periodic grooves of 20 µm depth, reaching a 0.6-V power density of 853 mW /cm^2 and a maximum power density of 1.2 W /cm^2 with a cathode Pt loading of 200 µg /cm^2.

HEET 2019 OSAKA CONFERENCE

Session Oral presentation

1-Paper ID: HE-010 (09:30 AM- 09:55 AM)
Title: Hydrogen pump for hydrogen recirculation in fuel cell vehicles
Authors: Wilhelm Wiebe, Sven Schmitz
Speaker: Wilhelm Wiebe

Abstract: A promising alternative to fossil-fuelled vehicles are battery powered vehicles and fuel cell (FC) vehicles. The major differences between fuel cell and battery-powered vehicles are the range and refueling times of each vehicle type. With a hydrogen (H_2) fuelling time of approx. 5 minutes it is possible to cover a distance of up to 800 km with a fuel cell vehicle. These properties make a fuel cell vehicle comparable to a fossil fuel powered vehicle. Furthermore, due to short fuelling times and long range capabilities, fuel cell vehicles are more suitable for long-distance, trucking and agriculture than battery-powered vehicles. The aim of current research is to increase the profitability of fuel cells by reducing costs and improving performance. To ensure a high performance of the fuel cell stack, more hydrogen is supplied to the stack than is needed for the reaction. Therefore, unused hydrogen is pumped back to the anode inlet of the FC-stack using a jet pump or a recirculation blower. In this study, the application of an electrochemical compressor or hydrogen pump (HP) for hydrogen recirculation is suggested. The hydrogen pump is an innovative H_2 transport technology with the additional functions of compression and purification in the recirculation system. Hydrogen pumps are very efficient compared to mechanical compressors due to the almost isothermal conditions they operate under. Furthermore, due to the modular design, hydrogen compressors can utilize a minimal amount of space in vehicles.

2- Paper ID: HE-028 (09:55 PM – 10:20 PM)
Title: A novel hydrogen production process: short-cut chemical looping hydrogen generation
Authors: Iwei Wang, Zhentong Wang, Yusan Turap, Zhang Zhe and Wei Wang

Speaker: Zhentong Wang

Abstract: Hydrogen, a clean energy carrier with zero-CO2 emission, is ideal to be used in many fields. Chemical looping hydrogen generation (CLHG) is a promising technology to obtain inherently CO2 with high purity hydrogen. In recent years, CLHG process has been obtained great attention in thermochemistry and iron-based oxygen carrier (IOC) becomes a potential candidate with low cost and environmental friendly. However, in the high temperature zone, IOC would sinter and inactivate due to its intrinsic property. Regarding feedstock of IOC, we adopt iron dust from steelmaking industry which has high iron content to replace traditional IOC, and utilize the electric furnace steelmaking route to treat the iron dust. Hence, short-cut chemical looping hydrogen generation (S-CLHG) process has been proposed in this study. Besides, due to the fresh iron-based material from iron dust, the purity of hydrogen could achieve 99% in the process. Knowledge of S-CLHG process is potentially helpful in understanding the mechanism of Fe-H-O system and might provide theoretical support for scaling up the packed bed and developing new technology for high purity hydrogen production.

10:20 AM--10:45 AM	Photo & Coffee Break

Momoyama room (4th Floor)

Session Oral presentation

3-Paper ID: HE-020 (10: 45 AM – 11: 10AM)

Title: Catalytic synthesis of CO_2-free ammonia as a hydrogen and energy carrier

Authors: Rahat Javaid, and Tetsuya Nanba

Speaker: Rahat Javaid

Abstract: Ammonia is a potential hydrogen and energy carrier. It has a high capacity for hydrogen. As an energy carrier, ammonia is considered as energy-dense and zero-carbon fuel. Industrially, ammonia is synthesized by the Haber-Bosch process using iron-based catalyst. The significant drawbacks of this process include the requirement of high temperature (425-600 °C) and pressure (20-30 MPa) conditions as well emission of green-house gases. Green ammonia can be synthesized with hydrogen produced from electrolysis of water using renewable energy. To utilize renewable derived hydrogen, it is required to develop efficient and stable catalysts capable of operation under fluctuated supply of hydrogen and mild reaction conditions. Therefore, it is essential to evaluate the efficiency of a catalyst at various reaction conditions and stability for long term processing. Ru catalysts are known for their higher activity at mild reaction conditions. In this study, CeO_2 supported Ru catalyst was synthesized by impregnation method. The activity of Ru/CeO_2 catalyst for ammonia synthesis was determined using hydrogen and nitrogen as reactants. An effect of reaction conditions was studied. Below 400 ºC, higher rate for ammonia synthesis was obtained by a decrease in H_2/N_2 ratio. This detailed study is necessary for establishing ammonia as a hydrogen/energy carrier

4-Paper ID: HE-011 (11: 10 AM -11:35 AM)

Title: Fuel Cell Systems: main challenges linked to durability

Authors: Nadia Yousfi Steiner, Daniel Hissel, and Marie-Cécile Péra

Speaker: Nadia Yousfi Steiner

Abstract: Fuel cells are very promising clean and high efficiency power generation systems. They, however, still face the challenge of reduced costs, improved performance and extended durability. Prognostics and Health Management is a recent dynamic discipline that aims to master the lifespan of industrial systems, with the objective to maximize equipment return on investment by (i) ensuring safety (ii) increasing reliability, availability and reducing operating costs and (iii) improving the decision-making process in order to increase the lifespan of the equipment. It combines control reconfiguration, mission re planning and maintenance planning (scheduled maintenance, condition-based maintenance, and predictive maintenance) to enable effective cost / performance/ lifetime tryptic. In the practical case of fuel cells, three main stages are necessary: Surveillance, Analysis and Action: the system is monitored and data are collected in the surveillance stage. The current state of the system is then analysed and the future state can be investigated. Finally, the Action stage allows proper decisions on control or maintenance to be taken, and the information to be exchanged and transmitted. These three stages are commonly achieved through Diagnostics, Prognostics and Control actions. Diagnostics means that we are able to detect, isolate and identify a fault once it occurs. We talk about FDI Fault Detection and Identification and Prognostics means that we are able, not only to project in the future the behaviour of a system, but also to be able to assess at each time, its health status, with regard to the way we are using it. While diagnosis refers to detecting and identifying a fault after it occurs, prognosis deals with predicting its occurrence before it actually happens. In general, diagnostics is posterior event analysis and prognostics is prior event analysis. In order to be effective, proper diagnosis could be used within a tolerant control strategy, that is, a state of health (SOH) based control actions that allow to maintain the PEM system at the expected performance and fault-free level, by detecting and identifying the faults, and finding the optimal operating point to recover or mitigate them.

Session Oral presentation

5-Paper ID: HE-021 (11: 35 AM – 12:00PM)

Title: Fabrication and performance of alloy foam-supported solid oxide electrolysis cell (SOEC) for hydrogen production

Authors: Ramin Visvanichkul, Pramote Puengjinda, Tara Jiwanuruk, Saranya Peng-Ont, Nichaporn Sirimungkalakul, Watcharin Ngampuengpis, Thana Sornchamni, Pattaraporn Kim-Lohsoontorn

Speaker: RAMIN VISVANICHKUL

Abstract: Hydrogen is a promising energy carrier for clean and sustainable energy. The demand tends to increase continuously. Steam electrolysis through solid oxide electrolysis cell (SOEC) can produce high purity hydrogen. The challenge of SOEC development is to improve performance and durability of the cell. Using an alloy as a support to fabricate a thin cell can provide lower resistance and oxidation rate and help enhance mechanical properties of cell. In this study, metal-foam supported SOEC is fabricated. Nickel-iron (Ni-Fe) alloy foam (Porosity: 5-130 ppi) is used for the cell support. Single thin-cell composed of Ni-$Sc_{0.1}Ce_{0.005}Gd_{0.005}Zr_{0.89}$ (SCGZ) cathode, SCGZ electrolyte and $Ba_{0.5}Sr_{0.5}Co_{0.8}Fe_{0.2}O_{3-\delta}$ (BSCF) anode is fabricated. Electrode powders are mixed with additives forming as slurry for wet chemical coating. Multi-layers of cathode are fabricated having a gradient of thermal expansion coefficient (TEC) between the support and the electrolyte to overcome TEC mismatch during heat treatment process. After cathode and electrolyte coating, the half cell is co-sintered at suitable temperature and heating rate to avoid defect formation and provide sufficient densifiation of the electrolyte. Anode is deposited by screen-printing. The rheology of slurries, morphology and mechanical properties of the cell are characterized by rheometer, scanning electron microscopy (SEM) and universal testing machine (UTM), respectively. The electrochemical performance of the SOEC is measured under H_2O/H_2 feed with varied steam content in a controlled temperature from 600˚C to 900 ˚C.

Lunch

12:00 PM-13:20 PM	Lunch

Lunch Buffet
(Café in the park, 1st floor)

6- Paper ID: HE-022 (13:20 PM – 13:45 PM)

Title: Economic Analysis of Frequent PV Fluctuation Smoothing: A Comparison Study between Thermal and Electric Storage

Authors: Yuting Wang

Speaker: Yuting Wang

Abstract: Standalone photovoltaic (PV) generation is promising in future buildings, especially in the remote area without utility grid supply. However, it suffers from frequent daytime fluctuation caused by randomized perturbation. To this end, this paper utilizes the widely-existing building chiller as thermal energy storage (TES) device and compares it with the conventional electrical energy storage (EES) device namely batteries. The chilled water in both strategies is circulated to different rooms to maintain the internal air temperature in an energy efficient manner. Under the TES strategy, the compressor speed is adjusted in accordance to the maximum PV power output and the room temperature is regulated via adjusting the heat exchange between the water tank and indoor air. Thereby, the fluctuation is filtered by the water tank by absorbing the extra refrigeration amount and releasing it when insufficient. Under the EES strategy, the compressor speed oscillations are reduced. Extra PV energy is stored in the battery and discharged when necessary. For the convenience of calculation, the PV power output is simplified as a sinusoidal fluctuation using quasi-steady state method. A stable state model is developed for initialization by analyzing chiller's refrigeration cycle. Moreover, dynamic simulations of the chiller systems have been built based on energy conservation law. Results show that even though average Coefficient of Performance (COP) in TES strategy is 11.08% lower than EES strategy, its average cooling capacity increment is 43.6% larger. In addition, when the water volume triples in TES, the increment will reach its maximum, that is, 76.92% larger than EES strategy. Therefore, TES strategy, independent of water volume, has a larger energy storage potential ranging from 43.6% to 76.92% compared to EES system, which suggests its optimistic economic performance.

7-Paper ID: HE-029 (13: 45 PM – 14:10PM)

Title: EFFECT OF IMPURITY ON A SCALED UP THERMALLY SELF-SUSTAINED DOUBLE REACTOR COUPLING HYDROGEN PRODUCTION FROM GLYCEROL REFORMING AND METHANOL PRODUCTION FROM CARBON DIOXIDE AND GENERATED HYDROGEN

Authors: Sasinun Thirabunjongcharoen, Palang Bumroogsakulsawat1, Suttichai Assabumrungrat, Piyasan Praserthdam, Sumittra Charojrochkul, Pattaraporn Kim-Lohsoontorn

Speaker: Sasinun Thirabunjongcharoen

Abstract: Thermally self-sustained double reactor (TSSDR) operating without external heat source consists of dual channels for endothermic and exothermic reactions. Hydrogen (H_2) is produced from wasted glycerol by aqueous-phase glycerol reforming at 200-250 ^{0}C and 20-25 bar when carbon dioxide (CO_2) is a by-product. Produced H_2 and CO_2 are used as raw materials for methanol synthesis (200-250 ^{0}C, 50-80 bar). Methanol synthesis and glycerol reforming occur at inner and outer channels of TSSDR, respectively. The TSSDR is fully packed with catalyst. Generated heat of exothermic reaction is sufficient for endothermic reaction. Main products of glycerol reforming in gas phase are H_2 and CO_2 while CO, CH_4, and small-chain hydrocarbons are by-products. All products are recycled as a feed stream for exothermic channel. CO and CH_4 can affect methanol yield and catalyst performance ($Cu/ZnO/Al_2O_3$). TSSDR is simulated in order to scale up the reactor. The effect of diameter to length ratio (D/L) of TSSDR on the reaction zone and heat transfer area is investigated. Scaling up the production capability by increasing the dimension ratio of the reactor is compared with stacking up of multi channels under the same operating conditions.

8- Paper ID: HE-024 (14:10 PM – 14:35 PM)

Title: Study on Hybrid Energy Storage Configuration and Control Strategy of Grid-connected Wind Hydrogen System

Authors: Shen Xiaojun, Nie Congying, Lv Hong，Wang Wei

Speaker: Nie Congying

Abstract: The randomness and volatility of wind energy bring great challenges to wind power grid-connected. The hybrid energy storage technology based on electrolysis cell hydrogen production and super capacitor has become an effective way to stabilize wind power fluctuations. Based on the establishment of the grid-type wind-hydrogen coupling system working characteristic constraint and the minimum initial investment cost of the hybrid energy storage system, an alkaline electrolytic cell-super capacitor hybrid storage based on low-pass filtering-fluctuation observation is proposed. The method can be configured, and a hybrid energy storage coordinated control strategy based on the super capacitor SOC (state of charge) is developed. The case study results show that the hybrid energy storage system configuration method and control strategy proposed in this paper are effective, which can reduce the fluctuation of wind power grid-connected power to meet the grid connection standard.

14: 35 PM – 15:00 PM	Coffee Break

Momoyama room (4th Floor)

9-Paper ID: HE-019 (15:00 PM – 15:20 PM)

Title: Theoretical Study of Local Structures and Molecular Motions in the Proton-Conduction Composite Material

Authors: Yuta Hori, Toshiya Suetake, Tomonori Ida, Motohiro Mizuno, and Yasuteru Shigeta

Speaker: Yuta Hori

Abstract: This work examines the local structures and molecular dynamics of imidazole (Im) molecules in the proton-conducting poly(vinylphosphonic acid) (PVPA)-Im (PVPA-Im) composite material by using theoretically molecular dynamics (MD) simulations. The peaks of radial distribution functions indicate that the strongest hydrogen bonds are formed between acidic oxygen of the phosphonic acid group and imidazolium hydrogen. The diffusion coefficient and correlation time of Im molecules show that the diffusion of protonated Im is suppressed in the PVPA-Im composite, and the proton conduction obeys the Grotthuss diffusion process rather than the Vehicle diffusion process. The calculation results for the hydrogen bonding environment and Im dynamics demonstrate that the proton conduction process consists of the following steps: proton transfer in the segment where Im are affected by phosphonic acid group and the segment where Im are affected by an excess proton; the Grotthuss diffusion process with the reorientation of Im in the segment where only Im are bonded to each other.

10-Paper ID: HE-035 (15: 20 PM – 15:40PM)

Title: Effect of Microstructure on the Electrochemical Performance of $Bi_{0.5}Sr_{0.1}La_{0.4}MnO_{3-\delta}$-$Bi_{0.67}Ca_{0.15}Zr_{0.18}O_{1.5-\delta}$ Composite Cathode for Intermediate - Temperature Solid Oxide Fuel Cell

Authors: I-Ming Hung, Yuan-Ting Huang, Azam Khan, Sheng-Wei Lee, Chung-Jen Tseng and Po-Chun Cheng

Speaker: Po-Chun Cheng

Abstract: $Bi_{0.5}Sr_{0.1}La_{0.4}MnO_{3-\delta}$-$Bi_{0.67}Ca_{0.15}Zr_{0.18}O_{1.5-\delta}$ (BSLM-BCZ) composite cathode was investigated as a highly active cathode for intermediate-temperature solid oxide fuel cell (IT-SOFCs). The phase structure of this composite cathode was characterized by X-ray diffraction (XRD). The results show the coexistence of perovskite structure BSLM and fluorite structure BCZ, but impurity phase La_2ZrO_7 was obtained. The electrode was fabricated into three different types T-type, E-type and I-type. The T-type is mixing BSLM and BCZ powders by tradition ball milling method and screen print on the SDC electrolyte. E-type is for electrical conductor skeleton which was screen printed on the SDC electrolyte then BCZ particles were added by ion infiltration method. For I-type, BCZ particles were screen printed on the SDC electrolyte then BSLM particles were added by particle infiltration method. The morphology is characterized by Scanning Electron Microscopy (SEM). A well-connected skeleton (BSLM for E-type and BCZ for I-type) is formed in the cathode electrode after infiltrating the nano-particles (BCZ for E-type and BSLM for I-type). The polarization resistance (R_p) was determined by Electrochemical Impedance Spectrum which shows that the R_p of I-type has the lowest value is $0.158\ \Omega\cdot cm^2$ at $750\,^{o}C$.

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Session Poster presentation

11-Paper ID: HE-013 (15:40 PM – 16:00 PM)
Title: Application of Laser Process to Improve Alloy Catalyst for Polymer-Electrolyte-Membrane Fuel Cell
Authors: Chia-Chun Lang, Szu-yuan Chen and Chung-Jen Tseng

Speaker: Chia-Chun Lang

Abstract: Pulsed laser deposition (PLD) is one of the powerful technologies for reducing the catalyst loading in polymer-electrolyte-membrane fuel cell (PEMFC), compared with commercial chemical coating method. In fabrication of nanostructures by PLD process, laser is used to ablate the target, generating the target plasma. The plasma is directly scattered on the carbon paper and cooled in-flight to form nanoparticles. So, it has a high target utilization rate along with ease of fabrication of catalyst at various sizes.

Previously, Huang et al. [1] used PLD to prepare nanoporous cathode catalyst for PEMFC. The cell performance of 1200 mA/cm^2 at 0.6 V was achieved with a platinum (Pt) loading of only 100 μg/cm^2, whereas 400 μ g/cm^2 Pt loading is required for commercial chemical coating method to achieve similar performance. To further reduce the Pt loading and cost of catalyst, PLD technology combined with continuous-wave laser processing (CWLP) is used to form core shell structure of $PtCo_3$ nano catalysts.The goal of this work is to reduce the Pt loading while maintaining the PEMFC performance. We use PLD to prepare 100 μg/cm^2 $PtCo_3$ (Pt: 52.4 μg/cm^2) alloy nanoparticles and then use CWLP to anneal and sinter the alloy to form a Pt-Co core shell. Initial results (Fig. 1) show that, with proper scan speed, CWLP can increase the electrochemical specific area up to 64%. More details will be discussed in the presentation.

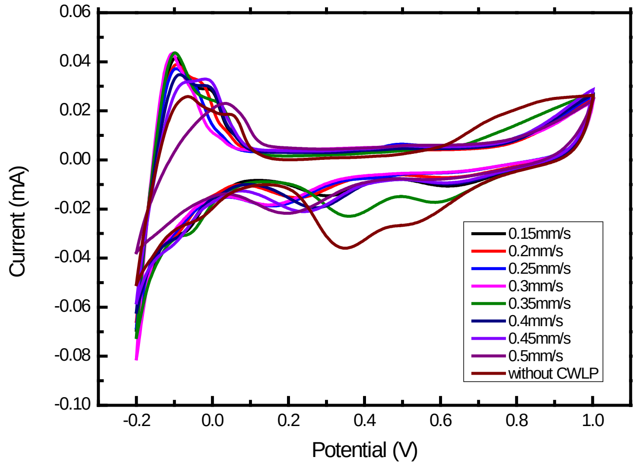

Figure 1. Cyclic voltammetries for samples with CWLP using different scan speed.

Reference. [1] T.W. Huang, H. Qayyum, G.R. Lin, S.Y. Chen, C.J. Tseng, Production of high performance and improved durability Pt catalyst/support for proton exchange membrane fuel cells with pulsed laser deposition”, J. Phys. D. 49, pp.255601, 2016.

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Session Poster presentation

12-Paper ID: HE-030 (16:00 PM – 16:20 PM)

Title: The study of solar to hydrogen pilot system by photocatalyst and CO_2 thermal reduction by CeO/NiO/MCM catalyst

Authors: Chin-Chang Shen, Yu-Zhen Zeng, Yu-Chang Liu, Jen-Chieh Chung

Speaker: Chin-Chang Shen

Abstract:

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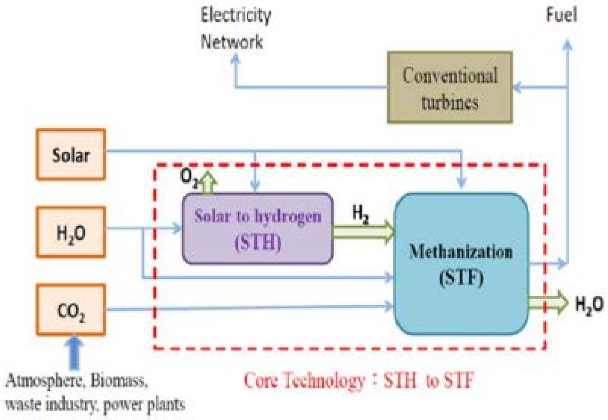
A.

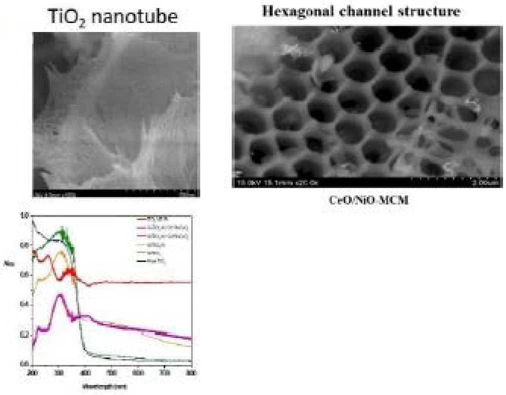


B.

A. The concept of STH and STF

B. solar to hydrogen pilot system

C.



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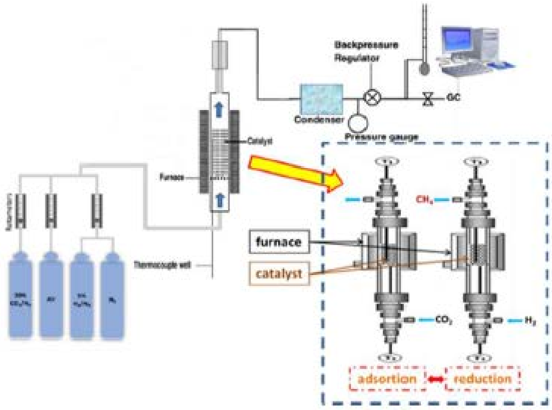

C. The TiO_2 nanotube and CeO/NiO/MCM catalyst D. CO_2 thermal reduction system.

We had synthesized the various TiO_2 nanotube and study the characterization of Pt/TiO_2 nanotube catalyst. The production by photocatalytic water splitting over Pt/TiO_2 nanotube had test by solar to hydrogen pilot system. The pilot system in 56.1mW/cm2 sunlight condition reach STH efficiency 2.1 and produce hydrogen 2.5L/hr. For CO_2 thermal reduction, we used the CeO/NiO/MCM catalyst which had synthesized by Impregnation method.

The analysis result of CO_2 thermal reduction by CeO/NiO/MCM catalyst in 400℃with the 96% CH_4 yield. The prepared samples were characterized by X-ray diffraction, X-ray photoelectron spectroscopy, nitrogen adsorption-desorption isotherms, UV-vis diffuse reflectance spectroscopy, and SEM-EDS.

Session Poster presentation

13-Paper ID: HE-031 (16:20 PM – 16:40 PM)

Title: Improved reversible dehydrogenation performance of $2LiBH_4$-MgH_2 by the synergistic effects of porous boron nitride and NbF_5

Authors: Yanxin Liao, Haijie Cao, Jing Cui, Mengtian Chen, Yuxin Liu, Kuikui Wang

Speaker: Kuikui Wang

Abstract: In this work, porous boron nitride (pBN) and NbF_5 were used to improve the hydrogen storage performance of the $2LiBH_4$–MgH_2 composite, especially the reversibility and dehydrogenation kinetics. We also carried out a series of control experiments to optimize the sample preparation method and addition amount of pBN. Comparing with the pristine $2LiBH_4$–MgH_2 system, the as-prepared 2LiBH4–MgH_2/NbF_5@pBN sample exhibits promoting dehydrogenation kinetics and shorten dehydrogenation time. The dehydrogenation temperature is also obviously lowered. A series of phase and chemical state analyses was used to study the enhanced effects of NbF_5@pBN on the reversible hydrogen storage performance of $2LiBH_4$–MgH_2. And the study demonstrates pBN is an effective additive as confinement medium and catalysis of the surface dangling-bond for improving the reversible dehydrogenation of $2LiBH_4$–MgH_2. NbF_5 could also act as catalysts. Therefore, the prominently improved dehydrogenation performance of MgH_2 should be ascribed to a synergistic effect of nanoconfinement and catalysis.

14-Paper ID: HE-032 (16:40 PM – 17:00 PM)

Title: The multiple selections of fostering applications of hydrogen energy by integrating economic and industrial evaluation of different regions

Authors: Man-WenTian, Hiu-ChunYuen, Shu-RongYan, Wei-Lun Huang, Jie Dai

Speaker: Jie Dai

Abstract: There are three major applications (portable, stationary, transportation) of hydrogen energy (HE), and each application play a unique and important role in the sustainable development of energy system. In different regions within a country, different applications of HE are preferred. This paper therefore explores the process to decide the optimal region to develop each of the three subtypes of HE applications. To this end, the Analytical Hierarchy Process (AHP) and a fuzzy Technique the Order of Preference by Similarity to Ideal Solution (TOPSIS) method are used in the present study. Based on a literature review and in-depth interviews with officers, experts, the managers of HE-related enterprises, and consumers, the present study comes up with two selection criteria, namely, the acceptance on the applications of hydrogen energy (i.e., market entry barriers and customer's acceptance), and the integrity of hydrogen energy industrial chain on three applications (i.e., production stage, distribution stage, and marketing stage). This paper uses a case study to explore the functioning of three applications of hydrogen energy in the industrial, cultural and restricted residence regions. Four main findings emerges from this study: (1) the market structure of the portable, stationary and transportation application of HE should be pure competitive, oligopolistic, and monopolistic competition respectively; (2) the customer's acceptance for different applications is different, due to different neighborhood concerns about the quality of life; (3) the cost and benefit of different applications depend on different factors, including government policy, technological improvements and social preferences; (4) in order to promote all HE applications, the process to decide the optimal region to develop a specific HE application depends on the comparative advantages of the application.

15-Paper ID: HE-033 (17:00 PM – 17:20 PM)
Title: The effect of CO_2 emissions and economic performance on hydrogen-based renewable production in 35 European Countries
Authors: Ran Xu; Li-Chen Chou; Wan-Hao Zhang

Speaker: Wan-Hao Zhang

Abstract: This study applies the OLS and panel data approach to estimate the influence of variables such as greenhouse gas emissions, per capita income, the scale of labor force input, the portion of added value in manufacturing industry and government mechanism on hydrogen-based renewable production in 35 European countries. The empirical results show that the nation's economic input and its income level have a positive effect on hydrogen-based renewable energy, which indicated that the economic growth has promoted living standards, inspired environmental awareness, and influenced the use of alternative energy and renewable energy. Moreover, the empirical results also show that deepening democracy (government mechanism) has a positive impact on hydrogen-based renewable energy in OECD countries, but the impact on non-OECD countries is not clear.

16-Paper ID: HE-012 (17:20 PM – 17:40PM)
Title: Clamping Force Optimization for Proton Exchange Membrane Fuel Cells with Metal Foam Flow Field
Authors: Yu-Hsien Lai , Li-Fang Weng , Jhe-Wei Jhuang, and Chung-Jen Tseng

Speaker: Yu-Hsien Lai

Abstract: In this study, we investigate the effects of clamping force during cell assembling on the performance of proton exchange membrane fuel cells (PEMFCs) with metal foam (MF) flow fields. MF flow fields have been found to increase mass transport efficiency and catalyst utilization. However, as the cell surface area increases, the contact between the MFs and the carbon paper becomes non-uniform with traditional bolts-and-nuts alone. A clamping force is used to help maintain uniform contact between the MFs and the carbon paper. The clamping force is varied from 0 to 400 kgf and applied on the center of the cell during assembling.

Polarization curve results show that cell performance increases with the increasing clamping force from 0 to 200 kgf. After that, cell performance decreases by further increasing the clamping force. Compared with the 0 kgf case, the current density at 0.6 V of the 200 kgf case reaches 1236.3 mA/cm^2, enhanced by 40%. AC impedance measurements show that the 200 kgf case has the lowest ohmic resistance and mass transfer resistance due to good contact between MF and the carbon paper and proper porous structure for mass transfer. The carbon paper is overly compressed in the 400 kgf case, and therefore the mass transfer resistance increases. These will be discussed in detail in the presentation, along with pressure drop measurement and SEM microscopy results to unveil the underlining physical phenomena.

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Session Poster presentation

17-Paper ID: HE-036 (17: 40 PM – 18:00PM)
Title: Public Willingness to Hydrogen Cars - A Survey of Chinese Consumers
Authors: Man-Wen Tian, Wanhao Zhang, Li-Chen Chou, Xindi Liu

Speaker: Xindi Liu
Abstract: With the rapid growth of China's economy and the improvement of per capita income, Chinese people pay more and more attention to environmental protection and sustainable development. In this context, the development of alternative energy makes its derivatives gradually emerge in the commercial market. Hydrogen cars have been the focus of research and development in many countries because they react with oxygen in the air and emit through water vapor as they run, effectively reducing the air pollution that other fuel-powered vehicles cause. The public's acceptance of current and future hydrogen energy products marks the development prospect of hydrogen automobile industry in China, and can further reflect the problems encountered in the energy transformation. The purpose of this paper is to study the acceptance of hydrogen vehicles by Chinese consumers and their willingness to replace traditional vehicles with new types of hydrogen vehicles. Through the investigation of the Chinese market, this paper considers the energy demand, product substitution, complementary factors, economic conditions and related variables. In this study, the multi-logit model is used to analyze consumers' willingness to consume hydrogen cars.

Note:

If you would like to deliver oral presentation but your paper is not in the session list, please contact us by Email: conf@heet-18.org or daisy-lee@heet-18.org ASAP. Thanks again for all your great attention and kind support to HEET 2019.

Thank you for all of your participation and contributions!