出國報告（出國類別：發表論文）

出席第二十屆國際真空會議及發表論文

服務機關：國立高雄師範大學
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派赴國家：南韓
出國期間：**105** 年 **8** 月 **22** 日至 **26** 日
報告日期：**105** 年 **9** 月 **30** 日

摘要

本次出國主要參加在南韓釜山舉辦的第二十屆國際真空會議(20th International Vacuum Congress (IVC-20))，並發表論文：High-performance InGaP/InGaAs field-effect transistor typed hydrogen。此會議是在南韓釜山舉辦的國際專業研討會，本人所發表論文主要探討感測半導體元件之技術，參與人員皆來自各方菁英。與會期間除了論文展示時間在場解說外，也積極到各場次聆聽演講、交流資訊，此對於未來研究發展具正面意義。

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1. 目的

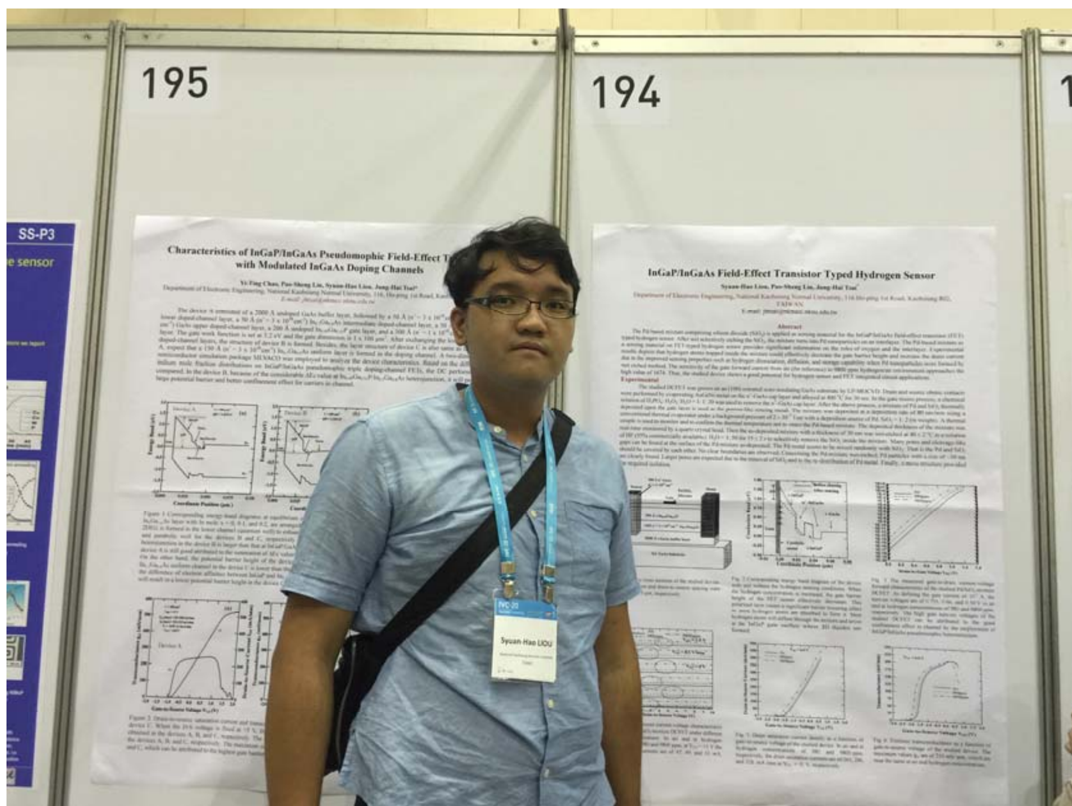
吾人此次赴南韓釜山出席 20th International Vacuum Congress (IVC-20)，並發表論文 High-performance InGaP/InGaAs field-effect transistor typed hydrogen。出席該國際學術會議的主要目的為論文發表，分享研究成果，並與國內外相關研究領域的學者意見交流。

20th International Vacuum Congress (IVC-20)舉辦地點-釜山 BEXCO。

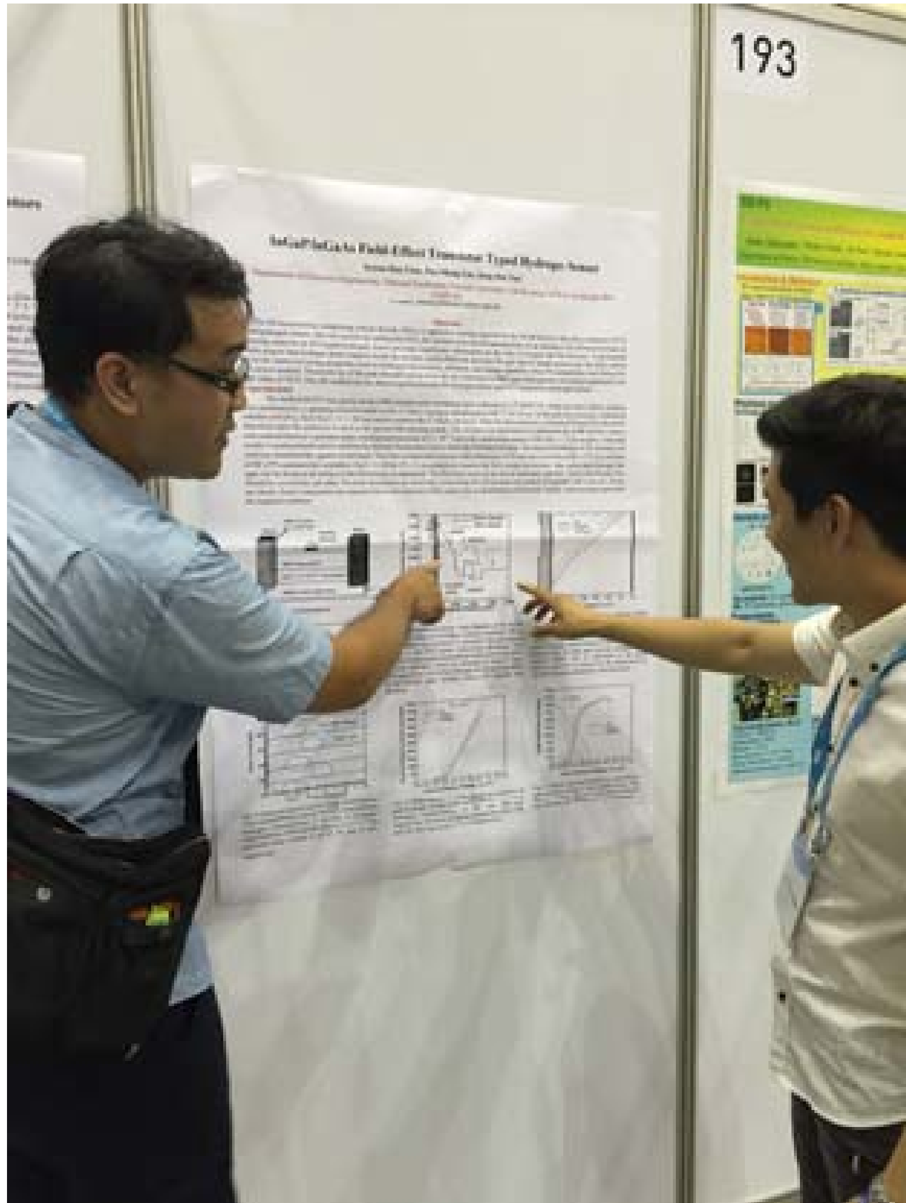
2. 參加會議過程

此次會議吾人於 105 年 8 月 22 日由桃園搭機直飛南韓釜山金海機場。8 月 22 日前往會場報到，領取名牌、會議資料等。8 月 25 日發表研究論文。會議期間根據會議資料，選取相關領域的報告會議參與。會議期間至南韓釜山 BEXCO 參觀。最後於 8 月 26 日回國。

本次國際會議由International Union for Vacuum Science主辦。本次會議地點於南韓釜山BEXCO展覽館舉行。此次會議約有800餘篇論文發表，其會議論文品質及原創性極高。吾人發表一篇論文，屬於Surface Science領域，並與參與學者交換研究心得。所發表論文主題為：High-performance InGaP/InGaAs field-effect transistor typed hydrogen。對於此篇論文，主要是將 Pd-based mixture comprising silicon dioxide (SiO_2)應用觸媒金屬在 InGaP/InGaAs field-effect transistor上，使得FET元件上可以感測氫氣。再使用濕式蝕刻將 SiO_2蝕刻掉，然而觸媒金屬會產生多孔狀，讓FET感測氫氣有更好的效能。實驗結果上，我們降低 the gate barrier height和增加 the drain current，因而改善感測氫氣特性。會議中與會學者對吾人發表之論文深感興趣，特別是韓國及日本學者，且針對FET感測特性提供多項寶貴意見。



Poster 展示會場



和與會學者討論發表之論文

3. 心得及建議

(1) 所參與之 section 中，學者們對於 FET 元件與半導體材料方面有優異之研究成果，且展示其研究方法及過程。

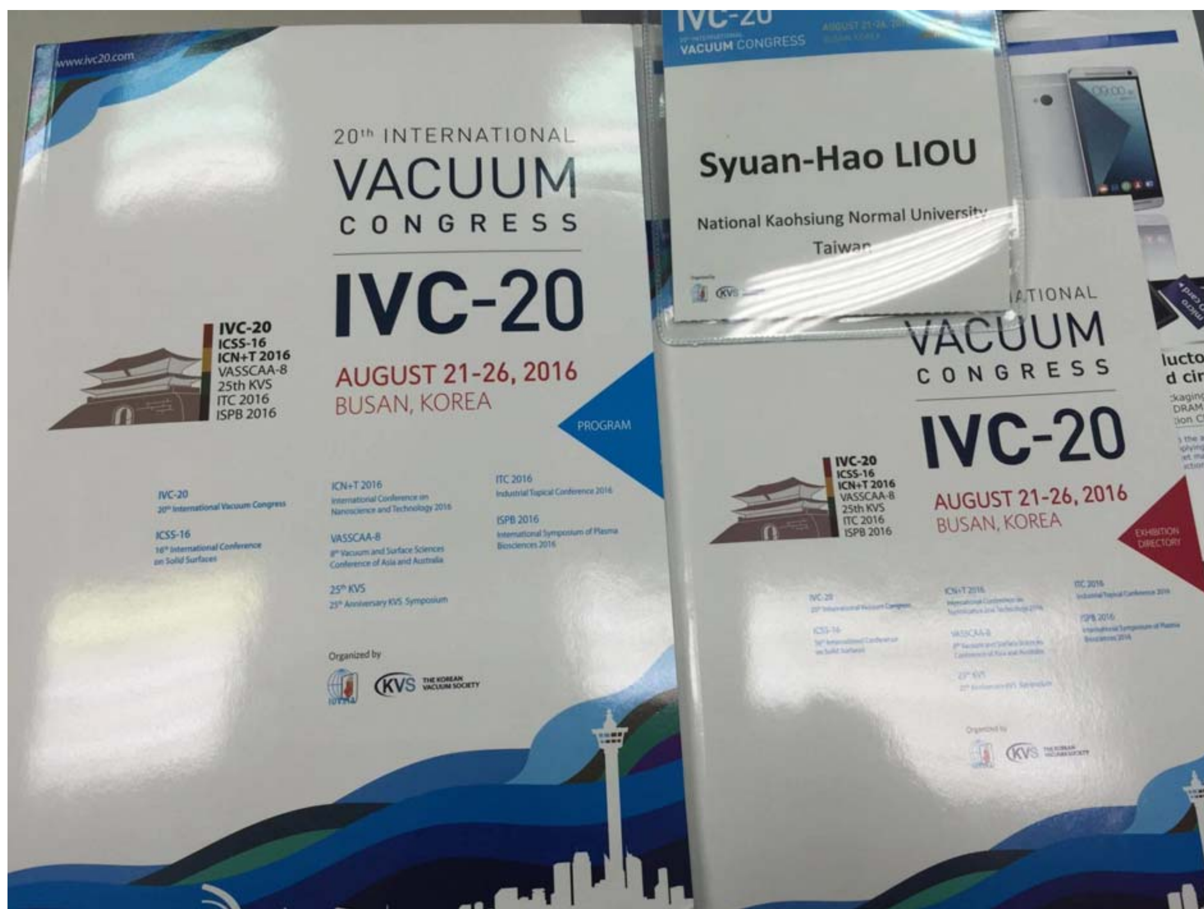
(2) 與會過程中有一篇關於 H_2O_2 effect on local structure 之論文發表，本人對於其利用 H_2O_2 應用於 Pt nanoparticles 上，達到不錯的效果，而該論文對於使用 H_2O_2 在 Pt nanoparticles 製造方法探討詳盡。而此雖與吾人最近製作的 FET 結構與機制不同，此可以增進元件發展方向與應用範疇。

(3) 與會過程中，和與會學者熱烈討論吾人發表之論文，對於含有 SiO_2 之 Pd 混合物應用觸媒金屬在 InGaP/InGaAs 場效電晶體上，可以將 Pd 與 SiO_2 的重量比做改變，產生更明顯多孔狀的觸媒金屬，此可增進元件特性。

(4) 對於主辦單位熱情接待印象深刻，及與會學者熱烈討論，讓吾人可以在研究方法及過程有更多運用方法。

(5) 本國應多舉辦半導體元件與材料相關之國際學術會議，使各國學者對我國之研究環境及成果有深刻認識，並可提升我國研究之質與量。

4. 攜回資料



研討會資料—論文集

SS-P3-194

High-performance InGaP/InGaAs field-effect transistor typed hydrogen sensor

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The epitaxial structures of the DCFET consisted of a 0.5 m undoped GaAs buffer layer, a 150 A n^+-$In_{0.15}Ga_{0.85}As$ doped-channel layer, a 300 A undoped $In_{0.49}Ga_{0.51}P$ gate layer. Finally, a 500 A n^+-GaAs cap layer was deposited on the gate layer. After the above process, a mixture of Pd and SiO_2 thermally deposited upon the gate layer is used as the porous-like sensing metal. Then the as-deposited mixture with a thickness of 30 nm was wet-etched in a solution of HF: H_2O = 1: 50 to selectively remove the SiO_2 inside the mixture. Pd particles with a size of ~30 nm are clearly found. When the hydrogen concentration is increased, the gate barrier height of the FET sensor effectively decreases. This polarized layer causes a significant barrier-lowering effect as more hydrogen atoms can be absorbed to form it. Most hydrogen atoms will diffuse through the mixture and arrive at the InGaP gate surface where 2D dipoles are formed. Rough surface together with pores formed by Pd nanoparticles offers an increased surface-to-volume ratio for hydrogen molecules being dissociated. In addition, micro-MOS diodes directly located upon the InGaP gate surface also prevent hydrogen atoms from escaping out of interface. This dipole layer can decrease the depletion width and further lower the gate Schottky barrier height. The polarization of the dipole layer either neutralizes the donor level, decreasing the pinning effect, or causes the reversible reduction of barrier height in the H_2 environment. At room temperature, the measured gate-to-drain current-voltage forward characteristics of the studied Pd/SiO_2-mixture DCFET under different hydrogen concentrations are illustrated. As defining the gate current of 10^{-5} A, the turn-on voltages are of 0.755, 0.66, and 0.59 V in air and at hydrogen concentrations of 980 and 9800 ppm, respectively. The high gate turn-on voltages can be attributed to the good confinement effect in channel by the employment of InGaP/InGaAs heterostructure. In addition, the common-source current-voltage (I-V) characteristics depict that the drain saturation current distinctly increases with increasing hydrogen concentration. All I-V curves show good pinch-off and cut-off behavior. In air and at hydrogen concentrations of 980 and 9800 ppm, respectively, the maximum drain currents at VGS = +1 V are of 47, 49, and 51 mA, respectively. In summary, A high-performance hydrogen sensor based on a InGaP/InGaAs DCFET structure with Pd/SiO_2 catalytic mixture is fabricated successfully. Pd nanoparticles upon an interlayer were formed by wet selectively etching method. The Pd nanoparticles is employed to effectively decrease the gate turn-on voltage and enhance the hydrogen detection sensitivity. Therefore, the device studied shows great promise for high-sensitivity hydrogen sensor and FET integrated circuit applications.

[1] N. Yamazoe, Sens. Actuators B 108, 2, (2005).
[2] J. Fogelberg, M. Eriksson, H. Dannetun, and L. G. Petersson, J. Appl. Phys. 78, 988 (1995).
[3] C. W. Hung, H. C. Chang, Y. Y. Tsai, P. H. Lai, S. I. Fu, T. P. Chen, H. I. Chen, and W. C. Liu, IEEE Trans. Electron Devices 52 1224 (2007).

發表之論文