

# 國立交通大學

材料科學與工程研究所

碩士論文

超高頻(40.68 MHz)電漿輔助化學氣相沉積  
異質接面太陽能電池於後製程快速退火與後氫  
電漿處理效率改善之研究

**The Efficiency Improvement Study of Heterojunction with  
Intrinsic Thin Layer (HIT) Solar Cell Deposition by  
40.68MHz VHF-PECVD System using Rapid Thermal  
Annealing (RTA) and Post H<sub>2</sub> Plasma Treatment**

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### 摘要

本篇論文中，研究如何利用後製程氫電漿處理、以及快速退火處理，來改善異質接面本質矽薄膜太陽能電池(Heterojunction with Intrinsic Thin Layer Solar Cell, HIT solar cell)的元件特性。一開始，我們調整薄膜沉積條件，最佳化異質接面本質矽薄膜太陽能電池的元件特性，並利用元件模擬軟體 AMPS-1D，找出最合適的元件結構。在一系列實驗中，我們調整後製程氫電漿處理的條件，如：氫氣流量、氫電漿功率、氫電漿壓力、以及後製程氫電漿處理的時間，以找出合適條件。以暗電流量測元件的結果顯示出，於較低的電漿功率(100W)、較低的氫電漿壓力(0.75 torr)、和較長的氫電漿處理時間(50 sec)會提升異質接面本質矽薄膜太陽能電池的元件特性。此外，以光電流量測該太陽能電池的結果表示出，使用後製程氫電漿處理於異質接面本質矽薄膜太陽能電池，其短路電流密度會改善約 5.2 % (由原本 13.92 mA/cm<sup>2</sup> 提升至 14.68 mA/cm<sup>2</sup>)。填充因子也可以增加約 18.9 % (由原本 49.5 提升至 61.0);開路電壓也能大幅提升約 16.7% (由原本 0.75 V

提升至 0.90 V)。此外，異質接面本質矽薄膜太陽能電池的效率可獲得大幅提升約 35.8% (由原本 5.17 % 提升至 8.05 %)。

進一步，我們試著利用快速退火的處理，改善太陽能電池效率。我們使用不同的退火條件，發現退火處理的溫度，約 200°C 可得最佳的元件特性。經由光電流的量測結果，表示使用快速退火處理於異質接面本質矽薄膜太陽能電池，其短路電流密度會改善約 15.4 % (由原本 14.68 mA/cm<sup>2</sup> 提升至 17.36 mA/cm<sup>2</sup>)。填充因子也可以增加約 13 % (由原本 61.0 提升至 70.1)；開路電壓也能提升約 1.1% (由原本 0.90 V 提升至 0.91 V)。此外，異質接面本質矽薄膜太陽能電池的效率可獲得大幅提升約 27.3% (由原本 8.05 % 提升至 11.07 %)。



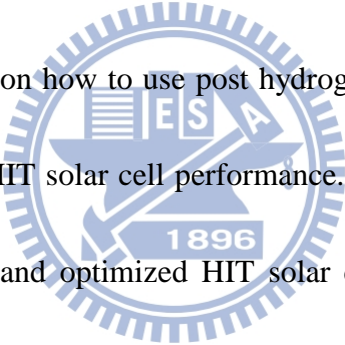
# **The Efficiency Improvement Study of Heterojunction with Intrinsic Thin Layer (HIT) Solar Cell Deposition by 40.68 MHz VHF-PECVD System using Rapid Thermal Annealing (RTA) and Post H<sub>2</sub> Plasma Treatment**

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## **Abstract**



In this work, we studied on how to use post hydrogen (H<sub>2</sub>) plasma treatment and RTA treatment to improve HIT solar cell performance. First, we adjusted the Si thin film deposition parameters, and optimized HIT solar cell characteristics. Then, we used device simulation software (AMPS-1D) to find out the optimized device structure. In these experiments, we tried to adjust the post hydrogen (H<sub>2</sub>) plasma treatment condition, such as H<sub>2</sub> flux, plasma power, pressure and post H<sub>2</sub> plasma treatment time to find the optimization deposition conditions. The dark IV result indicated that a low plasma power (100W), a low ambient pressure (0.75torr), and longer post H<sub>2</sub> plasma treatment time (50 sec) is a preferable condition to enhance the HIT solar cell performance. In the solar cell photo IV measurement, when the post H<sub>2</sub> plasma treatment was applied on HIT solar cell, a short circuit current density (J<sub>sc</sub>)

was improved around 5.2 % (from 13.92 mA/cm<sup>2</sup> to 14.68 mA/cm<sup>2</sup>) and an 18.9 % increased fill-factor (F. F.) were observed (from 49.5 to 61.0). Voc was increased significantly about 16.7 % (from 0.75 V to 0.90 V). Besides, the overall efficiency increased around 35.8 % was also achieved (from 5.17 % to 8.05 %).

In addition, we tried to use the rapid thermal annealing (RTA) treatment to improve HIT solar cell performance. We used different RTA parameters, and found the best device characteristics under RTA temperature about 200°C. In these series of solar cell photo IV measurement, when the RTA treatment was used on HIT solar cell, a short circuit current density (Jsc) was improved around 15.4 % (from 14.68 mA/cm<sup>2</sup> to 17.36 mA/cm<sup>2</sup>) and an 13 % increased fill-factor (F. F.) were observed (from 61.0 to 70.1). Voc was increased about 1.1 % (from 0.90 V to 0.91 V). Besides, the overall efficiency increased around 27.3 % was also achieved (from 8.05 % to 11.07 %).

## 致謝

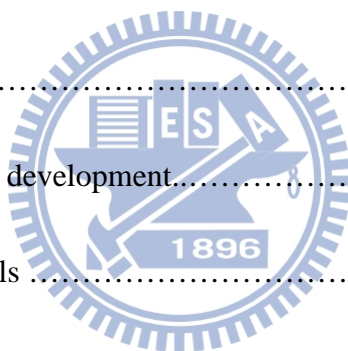
就讀研究所期間，是曼琦生命中一段難忘的時光。在這段時間內，遭遇很多人、事、物。回想起來百味雜陳，有喜、有悲、有歡笑、也有淚水，回想起來，百味雜陳、多采多姿。不過，這也是生命奧妙之處。成長必會帶來些許痛楚，努力之後必定會享受豐饒的果實。

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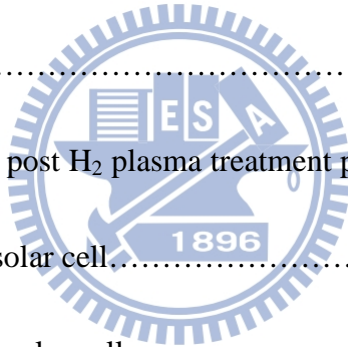
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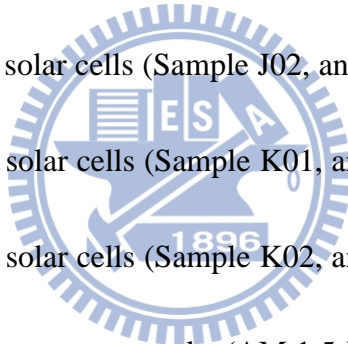
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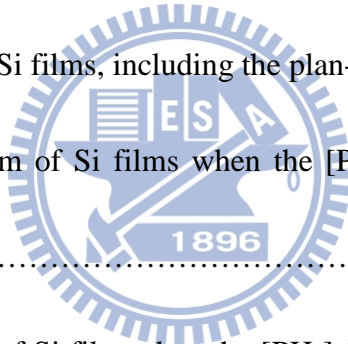
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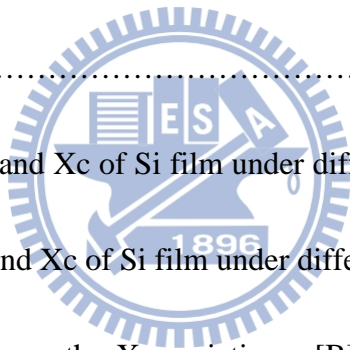
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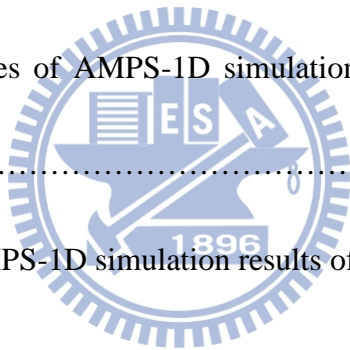
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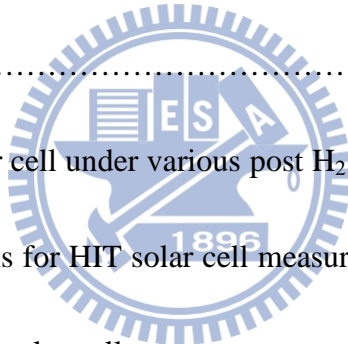
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