

新穎高效低成本軟性太陽能電池技術開發

執行單位

國立清華大學

計畫主持人

賴志煌

- 本計畫以軟性CIGS、CZTS 兩種太陽能電池為基礎，分別研發吸收層、緩衝層、光窗層低成本技術，如無氨水緩衝層、微奈米增益技術及奈米銀線光窗層等。亦能應用於其他種太陽能電池以及軟性電子元件。

計畫內容

總計畫：開發高能電漿薄膜技術與設備

- ✓ 富臨科技公司提供高能電漿薄膜系統
- ✓ 清華大學提供CIGS/CZTS相關經驗、薄膜製程與分析技術、太陽能電池製作與分析技術、

子計畫三：軟性低成本光窗層暨奈米增益技術

- ✓ 奈米銀電極取代AZO光窗層
- ✓ 奈米背電極微結構提升光吸收
- ✓ 奈米天線增益技術提升效率

入射光



子計畫一：軟性高效低成本CIGS太陽能電池

- ✓ 低溫CIGS吸收層開發
- ✓ 減薄型CIGS太陽能電池
- ✓ 高能電漿CIGS薄膜技術
- ✓ 無氨水緩衝層技術

子計畫二：軟性新穎低成本CZTS太陽能電池

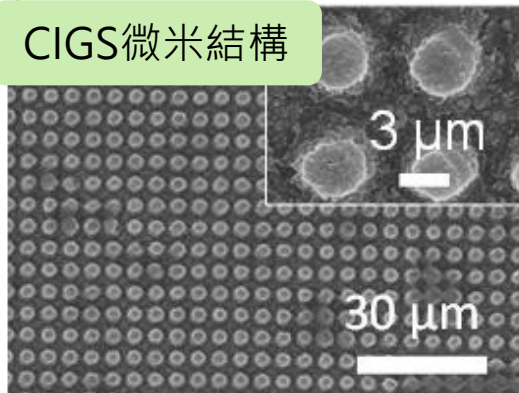
- ✓ CZTS能隙工程研究
- ✓ 快速硒硫化製程
- ✓ 低成本CZTS元件技術
- ✓ 高能電漿CZTS薄膜技術

薄膜太陽能電池的製作方法
(專利號: I583017)

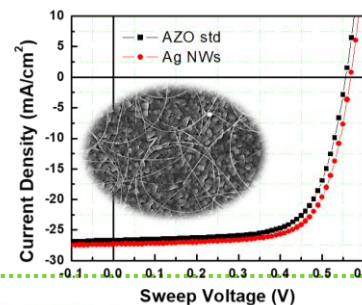
導電結構及其製造方法
(專利號 I533331)

於銅銦鎳製備三維結構的方法
(專利號 I480947)

CIGS微米結構



CIGS奈米銀線光窗層



本計畫以軟性**CIGS**、**CZTS** 兩種太陽能電池為基礎，分別研發吸收層、緩衝層、光窗層低成本技術，各項技術皆符合目前業界需求且具備高製程相容性，亦可垂直整合成新型太陽能電池結構，技術介紹如下：

- 子計畫一開發軟性高效能低成本**CIGS** 太陽能電池技術：
(1) 銻摻雜提升低溫製程元件的轉換效能達10%；(2)背電極鈍化減薄型**CIGS** 電池提升效率(3)無氨水無鎘緩衝層，減少氨水製程成本與毒化物汙染，於軟性基板上效率達10%且隨時能在最佳狀態運作
- 子計畫二開發低成本**CZTSSe** 太陽能電池，以噴霧熱裂解製作之**CZTSSe**元件效率已達7%。
- 子計畫三開發奈米結構增益技術，元件效率增益10%。並且使用薄奈米銀線光窗層應用在軟性**CIGS**元件上，元件效率達11%。

Development of novel high-efficiency low-cost flexible solar cells

Execution Unit

National Tsing Hua University

Project Director

Chih-Huang Lai

- This project develop the low cost technology for the absorber layer, buffer layer, and window layer based on the CIGS and CZTS solar cells. Ex. ammonium and cadmium –free buffer layer, nanostructure, and silver nanowire (AgNW) window layer. These technologies can also be applied to another devices (ex. other solar cells, flexible electronics).

METHOD OF
MANUFACTURING THIN FILM
SOLAR CELLS
(Patent number: I583017)

CONDUCTIVE STRUCTURE
AND MANUFACTURING
METHOD THEREOF
(Patent number: I533331)

METHOD FOR PRODUCING A
THREE-DIMENSIONAL
STRUCTURE ON A COPPER
INDIUM GALLIUM SELENIDE
COMPOUND
(Patent number: I480947)

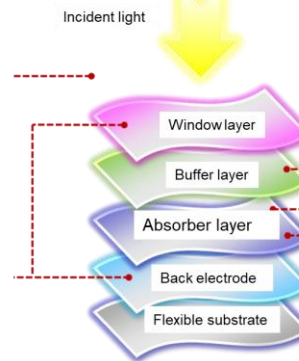
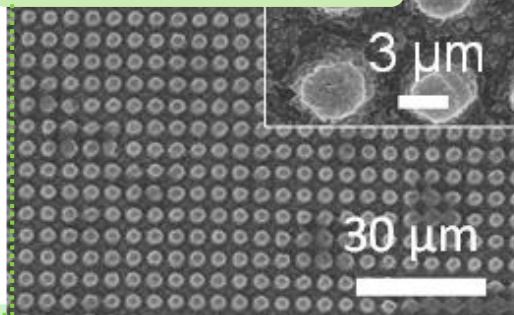
Main-project : High energy plasma technology and facility

- ✓ High energy plasma facility from Fu Lin Tech.
- ✓ Fabrication and analysis experience of CIGS/CZTS thin film and solar cells from NTHU.

Sub-project 3: Flexible low cost window layer and nano-enhancement technique

- ✓ Ag nanowire window layer to replace AZO
- ✓ Enhanced light absorption by back electrode microstructure
- ✓ Increased efficiency by nanoantenna

CIGS microdome



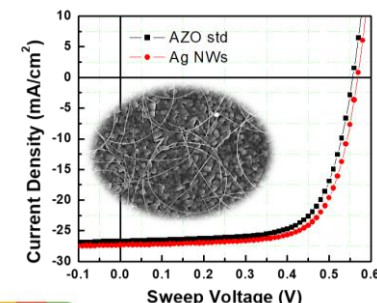
Sub-project 1: Flexible high-efficiency low-cost CIGS solar cells

- ✓ Low temperature CIGS absorber
- ✓ Thinner CIGS solar cells
- ✓ High energy plasma deposition of CIGS thin film
- ✓ Ammonium and cadmium –free buffer layer

Sub-project 2: Flexible novel low-cost CZTS solar cells

- ✓ CZTS band engineering
- ✓ Rapid selenization process
- ✓ Low cost CZTS solar cells
- ✓ High energy plasma deposition of CZTS thin film

Ag-NW window on CIGS



This project develop the low cost technology for the absorber layer, buffer layer, and window layer respectively based on the CIGS and CZTS solar cells. Every technology meets the demand of the industry and is highly compatible for the current process. The technologies can be integrated into novel solar cell structure. The technology are shown as below:

- Sub-project 1 develop large-area, low-cost, flexible CIGS solar cells.
 - (1) Low temperature CIGS exceeds 10% by doping antimony
 - (2) Back contact passivation on thinner CIGS solar cells
 - (3) Ammonium and cadmium –free buffer layer with over 10% efficiency on flexible substrate is achieved without light soaking effect
- Sub-project 2 develop low-cost CZTSSe solar cells over 7% by spray pyrolysis
- Sub-project 3 develop nanotechnology for solar cells
 - (1) Nanostructure enhance solar cell efficiency by 10%
 - (2) Application of Ag nanowire on CIGS solar cells with 11% efficiency