超薄矽/鍺複合/合金晶片之超高效率異質界面太陽電池的關鍵技術開發

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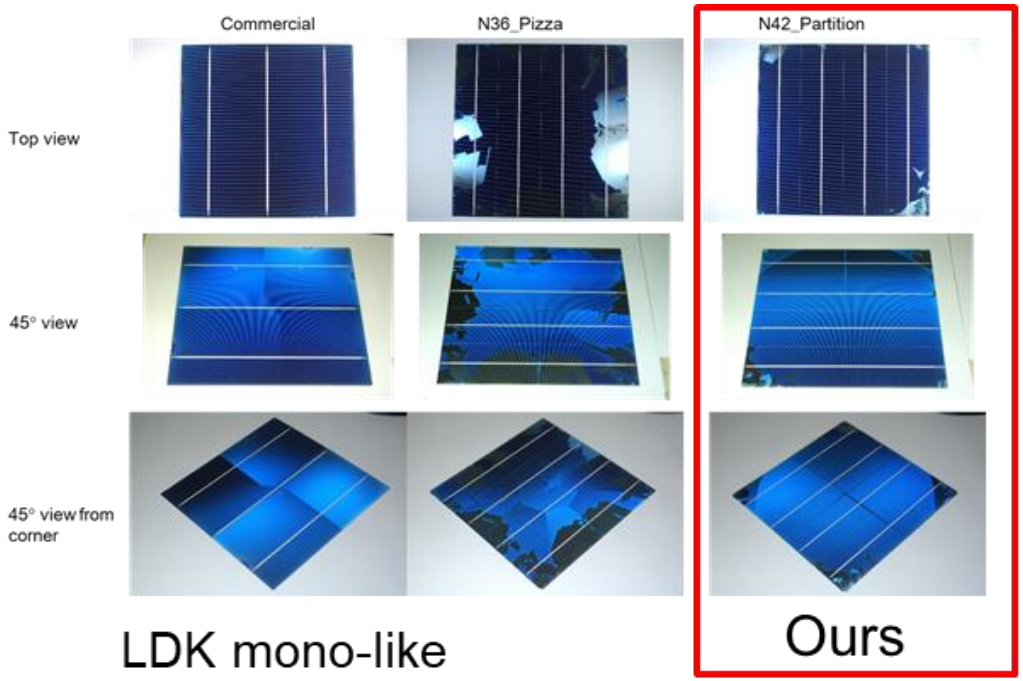
- 未來在太陽能應用上，低成本的高效率電池與高發電效率的模組還是最重要的產品。由於矽晶圓佔電池極高的成本，利用低成本的類單鑄錠技術，耐雜質且有高少數載子壽命的N型材料，薄化的晶片，與適合這些材料的高效率貼合的異質界面電池是最佳的組合。除了可以提升效率外，由於具有高的開放電壓與低的溫度係數，發電效率最佳，在熱帶地區的應用尤為突出。

- ✓ 利用區隔晶種提出專利一項。
- ✓ 已提出阻障層及可回收氮化矽坩堝兩項專利。
- ✓ 專利獲證: 坩堝組合
- ✓ 專利獲證: 可回收利用的坩堝
- ✓ 專利獲證: 結晶矽太陽能電池及其製造方法
- ✓ 專利獲證: 矽晶鑄錠之製造方法
- ✓ 專利申覆: 製造半導體薄片之方法



技術介紹與目前發展情形

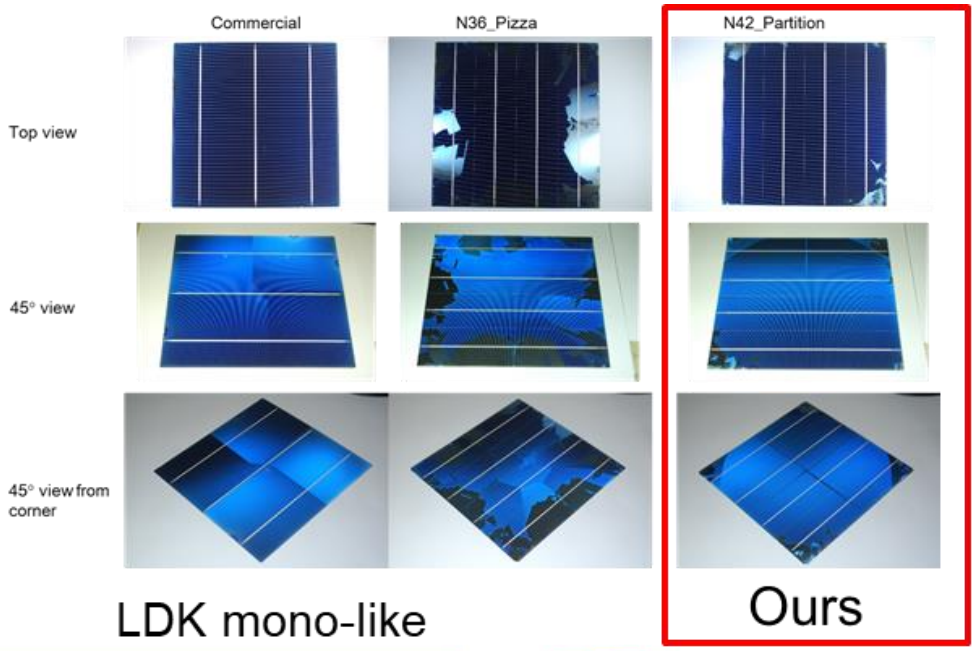
我們此計畫主要提出低成本摻鍺的N型類單晶的鑄錠長晶技術，除了解決晶種誘發缺陷外，大幅提升材料的少數載子壽命，並提升晶錠強度與切片良率。我們更提出坩堝阻障層與非石英坩堝的技術，減少坩堝的污染，進而提升晶錠品質，目前已達3.5 ms的少數載子壽命，是目前文獻報導的最佳類單，開放電壓逼近750 mV，幾乎達單晶的水準。此外，我們也提出乾法與濕法的超薄晶片剝離技術，薄晶片的鑽石線切割技術，矽晶與鍺單晶的接合技術，高效率的異質界面電池技術，對未來台灣在太陽光電產業的技術提升，相當有幫助。我們在鑄錠長晶的成就，獲得2016國際長晶學會的最高榮譽Laudise獎，也獲得2017年亞洲光伏協會的技術成就獎的殊榮。

Key technologies development for ultra-thin and high-efficiency Si on Ge and SiGe alloy heterojunction solar cells

Execution Unit	Dept. of Chem. Eng., NTU	Project Director	Prof. Chung-Wen Lan

- In the future applications of solar photovoltaics, the low-cost high-efficiency solar cells having good performance in electricity generation are still favored. Because wafers are the major cost for these solar cells, the use of mono-like N-type material is necessary. Besides the high minority lifetime, the reduction of silicon consumption using thinner wafers is also inevitable. The heterojunction solar cells using this material, in addition to the high cell efficiency, could also have a high open-circuit voltage and a low temperature coefficient. For such solar cells, their electricity generation outperforms other technology, especially in the tropical area.

- ✓ METHOD OF FABRICATING SEMICONDUCTOR SHEET
- ✓ METHOD OF PRODUCING AN INGOT
- ✓ ARRANGEMENT METHOD OF SEED CRYSTALS AND MANUFACTURING METHOD OF MONOCRYSTALLINE-LIKE INGOT
- ✓ CRUCIBLE ASSEMBLY
- ✓ RECYCLABLE CRUCIBLE AND METHOD OF FABRICATING THE SAME
- ✓ SEED USED FOR CRYSTALLINE SILICON INGOT CASTING



- In this project, we have developed a low-cost germanium-doped N-type mono-like casting technology. The defects generated from seed junctions have been resolved. By suing the diffusion barrier layer and silicon nitride crucibles, we could further reduce the metallic contamination from the crucible, so that the grown ingot could have a very high minority lifetime. The wafer after gettering could reach a minority lifetime up to 3.5 ms having the Sun Voc near 750 mV, which is comparable to that of the Cz grown mono-crystalline wafers. Besides, we have also developed thin wafer technology by using etching and spalling techniques. The diamond wire slicing using additives could also increase the cutting efficiency and reduce surface damages of the wafers. The wafer bonding with the germanium wafers also increased the light absorption spectrum and led to a better efficiency of the heterojunction solar cells. These technologies for low-cost high-efficiency solar cells would be useful to the photovoltaic industry. With the great achievement in the casting technology, Prof. C.W. Lan, the project leader, won the 2016 Laudise Prize form the International Organization for Crystal Growth (IOCG), which is the highest honor in IOCG given triennially. In 2017, Prof, Lan also received the Technological Achievement Award from the Asia Photovoltaic Industry Association in recognizing his significant contribution in the silicon casting technology for the global photovoltaic industry.