行政院原子能委員會
委託研究計畫研究報告

高效率化合物半導體太陽電池磊晶技術開發

(Epitaxial Growth for High Efficient Compound Semiconductor Solar Cell)

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中文摘要

為了提高化合物半導體太陽電池之效率，於 multi-layer 結構中，增加一層高效率吸收 1.0eV 附近光子之材料，是目前之主要研發課題。本研究係使用低壓有機金屬氣相磊晶法(LP-MOCVD)，探討使用 GaNAs/InGaAs 超晶格於吸收 1.0eV 附近光子之可行性，一方面利用其應力補償之優越效應，減少材料缺陷，另一方面可增加其臨界厚度，以提高 1.0eV 附近之吸光量，而達到提高太陽電池效率的目的。經由磊晶生長實驗，找出超晶格之最佳組成與厚度，以及對太陽電池元件特性的影響，為日後結合國內業界已建立之 3 層接面太陽電池元件技術，製作高效率 4 層接面太陽電池元件奠定基礎。

結果顯示，適當調整 GaAsN/InGaAs 超晶格之細部結構，可讓其效率達 InGaAs cell 的同一水準，當 GaAsN/InGaAs 超晶格之厚度增加時，由於 p-n junction 產生的內建電場變弱之緣故，p-i-n cell 之總效率會隨著下降，兩者大致呈線性關係，而長波長之吸收卻會增加。又 cell 元件效率常隨 In 含量之增加而急速下降，但同時增加 N 含量則可提升元件效率，因為它可讓超晶格之內應力減輕。

Abstract

In order to enhance the efficiency of 3-junctions solar cell, it’s currently a major trend to add an extra junction with the band gap around 1.0eV. In this study, low pressure MOCVD method was used to grow GaNAs/InGaAs superlattice, instead of InGaNAs, for the 1.0eV absorption. The potential advantages of the superlattice are (1) better in crystal quality, (2) lower in band gap energy, (3) thicker in thichness by using the strain compaensate effect, (4) higher in photon absorption.

In this experiment, those factors like the numbers of pairs, total thickness, and the percentages of In and N in the GaAsN/InGaAs superlattice, were tuned, and their effects to the efficiency of thesuperlattice cells were realized. The total efficiency of the superlattice cells will go down linearly with the increase of the thickness, due to the built-in field from the p-n junction going weaker. But , the absorption in long wavelength area will be enhanced by introducing thicker InGaAs/GaAsN superlattice. The cell efficiency decreases also with the increase of In content. However, add suitable amount of N atoms into the InGaAs/GaAsN superlattice will improve the efficiency of the cell by release of the internal stess in the superlattice.