論文 / 著書情報
Article / Book Information

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論 文 要 旨

THESIS SUMMARY

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

The need for advancing photovoltaic technology arises urgently due to the pressing concerns of climate change, sustainable energy sources, and energy accessibility. Photovoltaic systems, which convert sunlight into electricity, hold great potential in transforming the global energy landscape by lessening our reliance on fossil fuels and mitigating greenhouse gas emissions. Progress in enhancing PV efficiency and cost-effectiveness can lead to improved energy accessibility, especially in remote and disadvantaged regions, empowering communities and stimulating economic opportunities. Additionally, embracing photovoltaic solutions strengthens energy security, reducing susceptibility to geopolitical tensions and fluctuations in oil prices. Furthermore, PV advancement fosters innovation, economic growth, and job creation, promoting a sustainable future. To effectively tackle climate challenges and secure a cleaner, more prosperous world, it is imperative for governments, businesses, and individuals to collaborate in accelerating research, innovation, and the implementation of photovoltaic technologies.

Among the photovoltaic technologies, thin-film technology offers a unique application prospect ranging from flexible photovoltaic to tandem photovoltaics. Chalcogenide materials such as Cu(In,Ga)(S,Se)2 (CIGSSe) are well known in the thin film photovoltaics technology. However, CIGSSe material still has a lot of untapped potential, especially the wide band gap materials with $E_g \geq 1.4\, eV$. Wide band gap CIGSSe material may offer a material with the ideal band gap for single junction solar cells or a top cell for multijunction solar cells. Unfortunately, research into the wide band gap materials have yet to result in a high efficiency device, likely due to the incompatible n-type material for the heterojunction coupling.

In this work, a numerical study on the n type layer of a CIGSSe based photovoltaics were conducted to understand the contribution of the n type materials on the device performance, the physical mechanisms, and the design rules for a suitable n type material. It was found that a low electron affinity material is crucial to achieve a high V_{OC} by the improvement of interface passivation and contact selectivity.

In addition, a novel n-type material was developed through the alloying of ZnO and GeO2, resulting in an alternative low electron affinity material for wide band gap CIGSSe-based photovoltaics. The film was produced through the MOCVD method, utilizing tetramethoxygermanium as the Ge-precursor. By characterising the Zn-Ge-O films, it has been verified that higher [Ge]/([Zn]+[Ge]) lead to lower electron. The crystallography of the single films was also affected, resulting in a polycrystalline structure at lower [Ge]/([Zn]+[Ge]) and the aggregation of nanocrystals at higher [Ge]/([Zn]+[Ge]). Initial evaluations of the samples' electronic properties and its potential application in chalcogenide solar cells indicate promising outcomes, suggesting that the Zn-Ge-O thin film could serve as a viable alternative for the n-type layer in these solar cells in the future. The preliminary trial of Zn-Ge-O transparent conductive oxide as buffer layer material for a narrow band gap $CIGSe_2$ absorber also indicated the positive effect of the low electron affinity material on open-circuit voltage.

備考 ： 論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
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