論文 / 著書情報
Article / Book Information

題目(和文)	カーボンナノチューブ電極を用いたペロブスカイト太陽電池に関する研究
Title(English)	Study on Hole-conductor-free Perovskite Solar Cells with Carbon Nanotubes Electrodes
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
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論 文 要 旨

THESIS SUMMARY

専攻： Department of	創造エネルギー　専攻	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of　（工学）
学生氏名： Student's Name	GONG Bo	指導教員（主）： Academic Supervisor(main)	准教授　脇　慶子
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Human society heavily depends on fossil fuels which often followed by environment problems. To protect our living environment and prevent the energy crisis, to find endless and environment friendly alternative energy resources is the only solution. Solar cell as a device converting sun light into electricity without polluted emissions have been studied for long time. Perovskite solar cell as a rising star in the solar cell industry attracts much attention from scientific community. This type of solar cells is honored by the low cost and high power conversion efficiency showing great commercialization potentials. Many efforts have been made to further reduce the cost and improve the performance and stability of this type of solar cells. Carbon nanotube based hole transport material free perovskite solar cell (CNT-based HTM-free PSCs) is produced to eliminate the precious back contact metal and the hole transport material (HTM) in this study. Since the work function of carbon nanotubes (CNT) could not fit the energy alignment in the solar cell because it is close to the conduction band of perovskite absorber (CH3NH3PbI3). An increase of work function is a necessary pathway to improve the performance of CNT-based HTM-free PSCs.

The work function is an important character for many electronic devices to achieve a desired performance. Many investigations have been conducted on the work function engineering of multi-walled carbon nanotubes (MWNTs). Oxidation of carbon nanomaterials is a simple approach to control MWNTs' work function without bringing foreign metallic elements or altering the nanotubes' morphology. Systematic experiments were designed and carried out to investigate the influence of the overall oxygen content, structure disorder, and two individual types of functional groups on work function changes. The results demonstrate that the work function is not simply associated with the overall oxygen concentration, that structure defects without functional groups are unlikely to change the work function, and that carbonyl group located in the carbon hexagonal structure is the dominant contributor to the increase in the work function of MWNTs. These results provide distinctive insights into work function engineering of MWNTs and guide the application of MWNTs in functional devices for photovoltaic and optoelectronic devices.

After developing the work function engineering approaches, in order to fabricate CNT-based HTM-free PSCs, the most important component--- perovskite absorber layer is examined. There are three strategies forming perovskite, solo-solvent dipping, mixed-solvent dipping and chemical vapor phase reaction, these different fabrication methods resulting in very different crystal morphologies. Solo-solvent produced a typical cubic CH3NH3PbI3 crystal, but with the appearance of empty space between each crystal. This indicated that solo-solvent dipping was not the best method to make the high quality perovskite absorber layer for CNT-based HTM-free PSCs. This statement was further proved by solar cell performance measurement. Both mixed-solvent and and MAI vapor process generated CH3NH3PbI3 absorber layer had a better morphology and less grain boundaries from well-connected perovskite crystals.

To fabricate CNT-based HTM-free PSCs, CNT thin films were deposited on perovskite absorber layer by sticking CNT bucky paper or ink solution drop-casting. Because of the weak interaction between perovskite and CNT bucky paper, the ink solution was the best way to deposit CNT thin film at this stage. A CNT-based HTM-free PSCs' fabrication method was established and cells performances close to the current highest efficiency with a similar structure by applying defective carbon nanotube. Furthermore, the effects of carbon nanotube electrode from functional groups, coverage and work function on the critical parameters of CNT-based HTM-free PSCs' performance were investigated. According to the results, a predication of how to make even higher efficiency CNT-based HTM-free PSCs was proposed.

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。
Note : Thesis Summary should be submitted in either a copy of 2000 Japanese Characters and 300 Words (English) or 1copy of 800 Words (English).

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