Carrier Dynamics in $Al_xGa_{1-x}As$/InAs-based Photon Up-conversion Solar Cells with a Doubled-heterointerface

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海外における研究活動状況

研究目的

This research is aimed at realizing the below-bandgap photon absorption via interface engineering using quantum dots to induce so-called intraband absorption which was theoretically predicted as an approach to improve solar cell efficiency. In this research, we proposed doubled-heterointerface included in our solar cells and study their optoelectronic properties.

海外における研究活動報告

The 50th IEEE Photovoltaic Specialists (PVSC) was held at Puerto Rico Convention Centre, San Juan, Puerto Rico, an unincorporated territory of the United States of America. PVSC is one of the greatest conferences in the world where specialists in the photovoltaic field around the globe gather. This great conference has been running for 50 years beginning in 1961.

On June 12, 2023, morning, I started joining the conference sessions. One of the plenary talks was about current issues in floating photovoltaic (PV) modules and the tendencies of the implementation and research on the floating PV modules. The talk started with the necessity of floating PV modules in countries that have limited territory and need efficient land management. The case study of a floating PV module installed in Singapore, a small island country in Southeast Asia where problems of electricity production take a major role in the energy stability of the country, was introduced. Professor Mauro Pravettoni, the speaker, introduced the tendency of research on the modules. The speaker called it the “Game of Asian Countries” since the research and development of the modules are mainly taken over by Asian countries while China occupies most. Moreover, the speaker provided information regarding the designs of floating PV modules while considering the cost of installation and maintenance. There are 4 main floating PV installation approaches with increasing complexity and durability but construction costs as well. In the case of implementation of the modules in tropical countries like Singapore, durability is one of the most important factors that needs to be considered since the weather of tropical countries is almost stormy for a half year. The speaker also showed the case that a floating PV panel in Singapore was lost due to a strong thunderstorm. Then, the panel was

found in Hong Kong.

On June 15, 2023, afternoon, I gave my presentation on the topic "Carrier Dynamics in $Al_xGa_{1-x}As$/InAs-based Photon Up-conversion Solar Cells with a Doubled-heterointerface". The presentation was focused on the optoelectronic properties of single junction solar cells with two heterointerfaces included in the solar cells. The study regarding below-bandgap photon absorption which provides additional photocurrent at short-circuit conditions was presented. Moreover, the mathematical relationship between the photocurrent gain, when the solar cells were irradiated by infrared (below-bandgap) photons, was demonstrated. Here, I emphasized that a superlinear feature has been observed. This means that an infrared photon provides two photoelectrons contributing to the photocurrent. This feature is different from our previous report on below-bandgap photon absorption in single-junction solar cells with a heterointerface, in which the mathematical relationship is a sublinear feature. In other words, the photocurrent generation can be improved by the addition of a heterointerface. During the Q&A session, several questions were received from the respected audience. Professor Seth Hubbard, a specialist working at Rochester Institute of Technology, asked a question regarding the characteristics of the detected photocurrent as a function of temperature. His concern was the effect of temperature on the photocurrent if such temperature dominates the optical process in photocurrent improvement. His question was valuable since it made me need to learn more about the effect of temperature on my own solar cells.

Having precious experience to discuss with experts in the photovoltaic field is an unforgettable experience. I received suggestions from Professor Gavin Conibeer, a professor at the University of New South Wales, regarding life as a PhD student. He said words that I still remember until now. Quote: "PhD life will not be finished because you will be a researcher. It means you will spend your life studying what you are interested in.".