The Solar Quest for High-Efficiency III-V Cells

Abstract

III-V semiconductors have a great potential for enhancing the efficiency of solar cells using multi-junction and intermediate-band technologies. The Solar Quest project in the University of Tokyo has promoted intensive study on the development of materials, characterization of cell functionality and experimental validation of high-efficiency concepts such as carrier transport in quantum nanostructures and two-step photon absorption in intermediate-band structures. Recently, the project extends its activity toward cost reduction of III-V cells so that they can be cost effective not only under sunlight concentration but also without substantial concentration. This talk will summarize recent progress of the project.

Masakazu Sugiyama is a Professor at the Department of Electrical Engineering and Information Systems, Graduate School of Engineering, the University of Tokyo. He received the B.E., M.S., and Ph.D. degrees in Chemical Systems Engineering, all from the University of Tokyo, Japan, in 1995, 1997, and 2000, respectively. During 1997-2000, he had been a research fellow of the Japan Society for the Promotion of Science (JSPS). In 2000, he became a Research Associate at the Department of Chemical System Engineering, the University of Tokyo. In 2002, he joined the Department of Electronic Engineering as a Lecturer. He became an Associate Professor in 2005 and was promoted to a Professor in 2016.

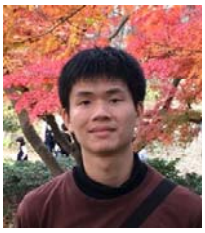
His current research interests is high-efficiency photovoltaic (PV) devices using the nano-epitaxial structures of III-V compound semiconductors, including epitaxial growth by metalorganic vapor-phase epitaxy (MOVPE), characterization on the behavior of carriers and photon management in PV devices. As for MOVPE, his competence is optical *in situ* monitoring to grow epitaxial layers as designed. He is participating in the research and development of program of low-cost and high-efficiency III-V solar cells sponsored by NEDO. His research theme includes also nano-structure light-emitting diodes (LEDs) using III-nitride epitaxial layer and the hetero-epitaxial growth of III-V semiconductors on Si.

Dr. Sugiyama is a member of Japan Society of Applied Physics (JSAP), the Society of Chemical Engineers, Japan (SCEJ), and Japanese Association for Crystal Growth (JACG). In 2003, he received the Young Investigator Researcher Award from SCEJ. He received the best teaching award (2014) and the distinguished researcher award (2016) from the school of Engineering, The University of Tokyo. He authored and coauthored 230 refereed journal publications and 400 international conference papers, and holds 15 patents.

Carrier transport and current collection model in multiple quantum well solar cells

Abstract

Multiple quantum well (MQW) solar cells have been explored as one promising next-generation solar cells toward high conversion efficiency. The dynamics of photogenerated carriers in MQWs are complicated, making it difficult to predict the device performance. An effective-mobility approximation, in which MQW region is approximated as a quasi-bulk material with specific effective drift mobility, will be discussed. This reduces the device complexity and allows us for further quantitative device analysis. A model for photocurrent of MQW solar cells using effective mobilities which provides a new aspect for the device design and optimization will be demonstrated.



Kasidit Toprasertpong received the B.E. and M.S. degrees in electrical engineering from the University of Tokyo, Tokyo, Japan, in 2013 and 2015, respectively, with support from a Japanese Government (Monbukagakusho) Scholarship. He is currently a Research Fellow of the Japan Society for the Promotion of Science and is working toward the Ph.D. degree with the Department of Electrical Engineering and Information Systems, The University of Tokyo.

His current research interests include physics of carrier dynamics inside quantum structures and characterization of nanostructure solar cells. He received the best student presentation award in the 40th IEEE Photovoltaic Specialists Conference, the 36th Young Scientist Presentation Award in the 61st Japan Society of Applied Physics Spring Meeting, and the Dean's Award for Best Master thesis, School of Engineering, the University of Tokyo in 2015.