Measurement and Analysis of Si and GaAs Solar cell Device Parameters

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ABSTRACT

The aim of the thesis is to build various measurements and characterize the device parameters of solar cells. The basic structure of a solar cell is a p-n junction diode. The electron-hole pairs generated by absorption of the incident light will diffuse toward the depletion region and then are swept through depletion region by the built-in electric field. For high efficiency, the lifetime of minority carriers shall be long enough to diffuse and arrive at the edge of the depletion region. So, we can understand the solar cells belong to the minority carrier dominated devices. In order to understand the performance of solar cells, the characteristics of minority carriers in semiconductor material have to be measured and evaluated. In this work, surface photovoltaic technique, internal quantum efficiency method and open-circuit voltage decay technique were installed and developed to characterize the diffusion length or lifetime of minority carriers at various temperatures. On the other hand, both conversion efficiency and ideality factor were measured at various temperatures. The relationships between conversion efficiency and carrier lifetime or diffusion length were analyzed.

Keywords : internal quantum efficiency ; open circuit voltage decay

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REFERENCES

[1] 莊嘉琛,“太陽能工程(太陽電池篇)”,全華科技圖書股份有限公司.

[2] M. P. Deshmukh, R. A. Kumar, and J. Nagaraju,“Measurement of solar cell ac parameters using the time domain technique,”Americal Institute of Physics, 75. , pp.2732-2735(2004) [3] M .P . Deshmukh, J. Nagaraju,“Measurement of silicon and GaAs/Ge solar cell device parameters,”Solar Energy Materials & Solar Cells,89. , pp.403-408(2005).

[4] J.E.Mahan, T.W. Ekstedt, R. I. FRANK,and R. Kaplow,“Measurement of Minority Crrier Lifetime in Solar Cells from Photo-Induced Open-Circuit Voltage Decay,”IEEE Transactions On Electron Devices, 26, pp.733-739(1979).

[5] M .P. Deshmukh, J. Nagaraju,“Measurement of silicon and GaAs/Ge solar cells ac parameters,”Solar Energy,78. , pp.1-4(2005)..

[6] Hans J. Moller,“Semiconductors for Solar cells”, Artech House Publishers ,1993.

[7] S. M. Sze,“Physics of Semiconductor Drvices 2nd Edition”,Published and Reprinted by CENTRAL BOOK COMPANY,Second printing,1985.

[8] J. M. Zhu, W. Z. Shen, Y. H. Zhang, H. F. W. Dekkers,“Determination of effective diffusion length and saturation current density in silicon solar cells”, Physica B,355. , pp.408-416(2005).

[9] J. H. Reiss, R. R. King, K. W. Mitchell,“Characterization of diffusion length degradation in Czochralski silicon solar cells”,Appl. Phys. Lett68. , pp.3302-3304(1996).

[10] Takashi Fuyuki, Hayato Kondo, Tsutomu Yamazaki, Yu Takahashi, Yukiharu Uraoka,“Photographic surveying of minority carrier

diffusion length in polycrystalline silicon solar cells by electroluminescence ”, Appl. Phys. Lett86. , pp. 262108, (2005).
[12] 施敏, 黃調元, “ 半導體元件物理與製作技術(第二版) ”, 國立交通大學出版社,pp.180(2002).