Reflection loss investigation on nanowire-textured-pyramid structure of silicon-based photovoltaic devices

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I. Abstract

This paper presents analysis of the optical and electrical property in Silicon nanowire (SiNW) textured pyramids crystalline-Si (c-Si) structures of photovoltaic devices. The growth of SiNWs on a textured c-Si photovoltaic device via the one step Metal-assisted electroless etching is investigated. The average diameter and length of the SiNWs are around 70nm and 100–700nm, respectively. Experimental results indicate that a textured c-Si photovoltaic device with length of 694 nm SiNWs has the lowest reflectance (~3.41%) among the tested substrates, especially in the range of ultraviolet (UV) and green light (350 nm to 590 nm). After optimal design, the NWs/pyramids c-Si photovoltaic device with aspect ratio of 5.1 has the highest performance in conversion efficiency.

II. Image

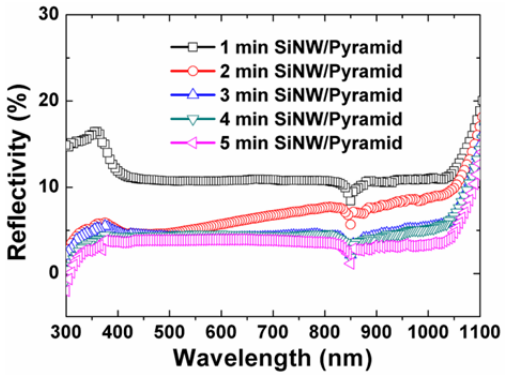


Fig. 1 The reflectance spectra of NWs/pyramids c-Si substrates with different lengths.

III. Reference

1. D. Kumar, S.K. Srivastava, P.K. Singh, M. Husain, V. Kumar, Sol. Energy Mater. Sol. Cells 95, 215 (2011)
2. K. Peng, Y. Xu, Y. Wu, Y. Yan, S.T. Lee, J. Zhu, “Aligned single-crystalline Si nanowire arrays for photovoltaic applications,” Small 1(11), 1062-7 (2005)
3. F. Toor, H.M. Branz, M.R. Page, K.M. Jones, H.C. Yuan, “Multi-scale surface texture to improve blue response of nanoporous black silicon solar cells,” Appl. Phys. Lett. 99, 103501 (2011)
4. H.F. Li, R. Jia, C. Chen, Z. Xing, W.C. Ding, Y.L. Meng, D.Q. Wu, X.Y. Liu, T.C. Ye, “Influence of nanowires length on performance of crystalline silicon solar cell,” Appl. Phys. Lett. 98, 151116 (2011).

IV. Biography

Nai-Jen Cheng obtained his master's degree and PhD degree from the Department of Optics and Photonics, National Central University in 1992 and 1999. After obtaining his master's degree, he joined the Digital Signal Processing Division of Chunghua Telecom Laboratories in 1992 as an assistant researcher. He is currently an assistant professor in the Institute of Photonics and Communications at National Kaohsiung University of Science and Technology, Kaohsiung, Taiwan. His research interests involve physics education, optical information processing, and 3-D optical profilometry.

Dr. Shang-Chao Hung graduated from the University of Alabama in Huntsville (UAH) in June 1992, with a degree of Master of Engineering in Electrical Engineering and work at MATRA (France) Co. branch in Taiwan as an Electrical Engineer responsible for constructing the first subway in Taiwan. He got the Ph.D degree in institute of microelectronics of NCKU in Taiwan in 2006. Dr. Shang-Chao Hung has published more than 55 papers in SCI journals and interesting in renewable energy, nano-structure design, fabrication, and characterization and device application on photodector and sensor.

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