WARAKORN LIMSIRI : THE FABRICATION OF CRYSTALLINE SILICON SOLAR CELLS WITH COMBINATION STRUCTURE OF SELECTIVE EMITTER AND LOCAL BACK SURFACE FIELD BASED ON LOW COST.
THESIS ADVISOR : ASST. PROF. THIPWAN FANSUWANNARAK, Ph.D. 81 PP.

Keyword : Selective Emitter, Local Back Surface Field, Selective Emitter and Local Back Surface Field

Crystalline silicon solar cells with a p-n junction structure can generate electricity directly by absorbing light energy. The limitation theory of bandgap energy in crystalline silicon prevents them from converting light energy at wavelengths below 1.1 micrometers. At the same time, there is a loss of up to 40% in light energy conversion in the visible wavelength range. However, the development of Si solar cell technology aims to improve its response to short-wavelength or blue light while simultaneously increasing its back surface field. The technique of using Selective emitters (SE) and creating a local back surface field (LBSF) by opening the pattern of the thin insulating layer at the back are used. The result of this improvement is a higher internal electric field and lower resistivity at the contact interface, which leads to a lower recombination rate of carriers. The pattern of open channels in the insulating layer is created with laser technology in the solar cell manufacturing industry to achieve precise and rapid results. However, laser light can potentially damage the cells. Therefore, this research focuses on the development of solar cells with SE and LBSF structures using a low-cost method by creating SE patterns through screen printing and creating the openings in the insulating layer through stamping to form the LBSF.

This study aims to examine SE and LBSF designs in crystalline silicon solar cells. The demonstration of the p-n Si junction was made by using dopants in a sol-gel solution that was coated on p-type silicon substrates, which is called Spin On Dopant (SOD). The result of this process was an n-silicon layer. Thermal diffusion resulted in the formation of a PSG and a BSG insulating layer on the top and rear of the p-n junction cell. They were later removed in the industrial process, but the PSG and BSG were still used as an insulating layer in this study. The PSG is utilized as a layer of anti-reflection, while the BSG layer was also opened in certain locations. The p-type silicon substrate can become the site of a p^{++} region when an aluminum rear contact diffuses through the BSG opening. According to the test results, the PSG layer had the lowest reflectance value of 20.56%. The SE structure provided the different resistivity values for the n-Si layer in two regions. The n Si area beneath the grid electrode has a sheet

resistivity ρ_{sheet} of 20 Ω/ sheet due to high-concentration phosphorus doping, while the light-receiving area has a ρ_{sheet} of 120 Ω/sheet due to low-concentration doping. A circular pattern covering 12% was covered by a BSG opening pattern in the LBSF structure. The efficiency of the SE and LBSF cell configurations was improved by between 0.52% and 0.98% compared to standard p-n junction structures after metal contacts were formed. When it comes to production costs per watt, the estimated value was roughly 0.1631 USD/Watt, which shows the industry's competitiveness compared to standard structures.

School of Electrical Engineering
Academic Year 2023

Student's Signature Warakorn Limsiri
Advisor's Signature