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The Effect of Electrode Grid Pattern on Concentrated GaAs Solar Cells Efficiency

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1. Introduction

Global-warming issues coupled with high oil prices have become a major driving force for the use of advanced solar power technology. III-V solar cell is so far the commercial solar cell with highest efficiency at the will play an important roll for future [1][2]. For the concentrated solar cell, the design of the contact pattern to quite different from convention silicon solar cell. In fact, various shadowing factor for the incident light and series resistance for the solar cell were influenced by the geometry of the front contact pattern. In this respect, how to choose an optimal front contact for solar cell in order for the best conversion efficiency becomes more and more important, especially when a solar cell is operated under a high concentration ratio of light. The aim of this study is to increase the conversion efficiency of GaAs single-junction solar cell under a high concentration of solar radiation by using a suitable circle-grid front contact.

2. Device Fabrication

The single-junction solar cell structure was grown by the low pressure (50 torr) using metal-organic chemical vapor deposition (MOCVD) technology. Back-side n-contact metal was formed by evaporating Ni/Ge/Au/Ni/Au, while the front p-contact was consisted of evaporated Ti/Pt/Au. The top circle-grid patterns were subsequently plated with Au to a total thickness of about 5μm. Finally, a 750 Å silicon nitride antireflection coating (ARC) film was deposited by plasma-enhance chemical vapor deposition (PECVD) system on the solar cell. The area of the samples tested was 4.4 × 4.4 mm^2 with illuminated active area of about 0.125 cm^2. Then the I-V characteristics were measured under one sun AM1.5 (100mW/cm^2) solar simulator.

3. Result and Discussion

Figure 1 shows the schematic structure of the single-junction solar cell used in this study. Figure 2 and Table 1 show the illustrations and shadowing factors of five different circular grid patterns for the device front contact. In this study, figure 3 shows the measured I-V in order for the curve at 1 sun (100mW/cm2, AM1.5G) with different circle-grid patterns. In this study, the device with Pattern A exhibited the best efficiency due to the smallest shadowing factor of the contact pattern. The efficiency of the solar cell with different contact patterns was also investigated under different concentration ratio. Figure 4 shows the measured results. Due to thermal effect, the device with Pattern B, i.e., a ring-type front contact with a shadowing factor of 7.1%, showed the highest efficiency of 27.3% at higher concentration ratio (CR>75x, AM1.5G). These results give a guideline for the selection of the geometry of the front contact pattern. In order to obtain the best conversion efficiency, especially under higher concentration ratio, both the shadowing factor at thermal effects need to be considered at optimized.

4. Conclusion

In this paper, we have been implemented for the optimization of grid dimensions by finding a compromise between the shadow effect and series resistance effect. The results show that in the low concentration ratio (CR<50x, AM1.5G), the device with front grid pattern A (shadowing factor = 6.22%) has the best cell efficiency of about 28.5%. However, in higher concentration ratio (CR>60x, AM1.5G), the device with front grid pattern B (shadowing factor = 7.1%) shows the best cell efficiency of 27.05% due to the improvement of heat dissipation rate at the center spot. From previous experiment results, these kinds of grid pattern designs of the solar cell devices can be obtained the best conversion efficiency.

Reference

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[2] E.T.Franklin, and J.S Coventry, *Proceedings of Solar 2002* - Australian and New Zealand Solar Energy Societ.

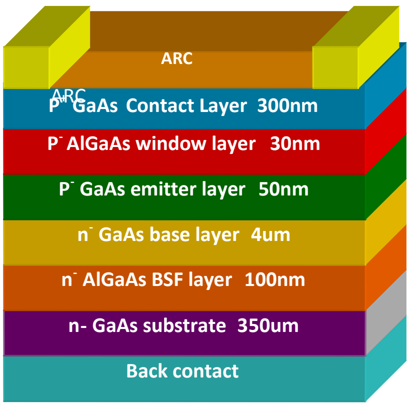

Fig. 1 The schematic structure of the single-junction GaAs solar cell.

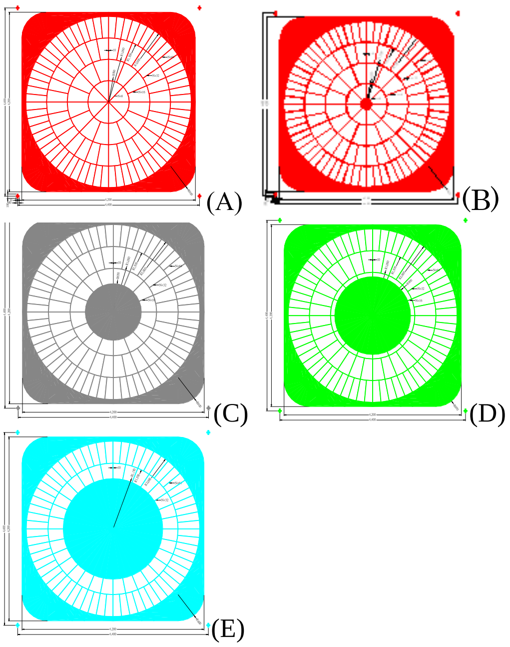

Fig. 2 Fabricated circular grid patterns for the front contact of solar cell.

Table 1 The shadowing factors of different front contact patterns

Grid Pattern	A	B	C	D	E
Shadowing Factor (%)	6.224	7.1	14.74	24.1	36.4

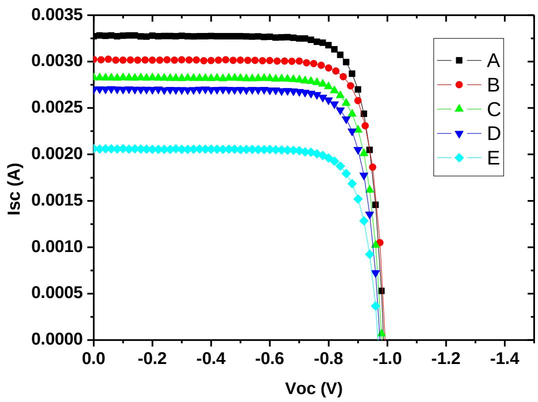

Fig. 3 Current-Voltage cha4racteristics of single junction GaAs solar cell with different grid patterns.

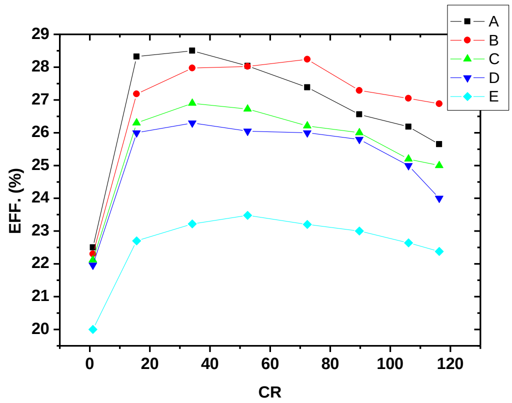

Fig. 4 The Efficiency vs concentration ratio of single-junction GaAs solar cell with different grid patterns.