Fabrication of roughen transparent conductive layer on solar cells by anodic aluminum oxide technique

Chun-Ming Liu, Da-Xiang Hu, Hong-Bin Xiao
E-mail: 322110@mail.dyu.edu.tw

ABSTRACT
This thesis is to study the effect of micro-structure on anti-reflection for a transparent conducting layer (TCL). The process to form micro-structure on a TCL is as following. First, an Al film was deposited on TCL by E-beam evaporation. Then, porous alumina membrane pores were formed by anodic oxidation technology. Next, TCL was wet etched to form micro-structure on surface by using porous alumina membrane as mask. The aperture size can be controlled with different anodic oxidation conditions, such as oxidation time, oxidation voltage, barrier layer removal and pore widening time. Both surface morphology and aperture size were examined by field emission scanning electron microscopy. Finally, TCL with micro-structure was applied to solar cells for anti-reflection.

Keywords: Anodizing, porous alumina

Table of Contents

1. Introduction
1.1 Background and Motivation
1.2 Theoretical Introduction
1.2.1 Solar cell theory
1.2.2 Anti-reflective layer design and classification
1.2.3 Anodic aluminum oxide
1.2.4 Formation mechanism of porous alumina
1.2.5 Increasing the regularity of the porous alumina

2. Experiment
2.1 Preparation of porous alumina
2.2 Anodic oxidation process
2.3 Transfer the pores to the transparent conductive layer

3. Results and Discussion
3.1 Regular porous alumina
3.2 Oxidation conditions discussion
3.3 Changing the aperture size
3.4 Application of porous alumina in solar cells

4. Conclusion

References

Appendix

Figures

Figure 2.1: Solar spectrum
Figure 2.2: AMm interpretation
Figure 2.3: Solar cell working principle
Figure 2.4: Solar cell I-V characteristics
Figure 2.5: Equivalent circuit of the solar cell
Figure 2.6: Gradually varying antireflection design
Figure 2.7: Rasterized surface can provide multiple reflections and light scattering effects to improve transparency
Figure 2.8: Aluminum in the anodic oxidation phase
Figure 2.9: Local electric field concentration process
Figure 2.10: Secondary oxidation method
Figure 2.11: Plate printing method
Figure 2.12: Using FIB to pre-pattern on the Al film
Figure 3.1: Anodic oxidation apparatus
Figure 3.2: Anodic oxidation fixture
Figure 3.3: Anodic oxidation alumina formation process
Figure 3.4: SEM device
Figure 3.5: RIE device
Figure 3.6: Thermal evaporation system
Figure 4.1: Secondary oxidation method generated aluminum film
Figure 4.2: Aluminum film generated without secondary oxidation method
Figure 4.3: SEM image of the aluminum film with working voltage of 40V
Figure 4.4: SEM image of the aluminum film with working voltage of 60V
Figure 4.5: Surface of the aluminum film after different anodic oxidation times
Figure 4.6: FESEM image of immersion in phosphoric acid solution
Figure 4.7: SEM image before and after RIE thinning
Figure 4.8: ITO surface after removing the aluminum film
Figure 4.9: Actual image of the film around it is protected with light blocking
Figure 4.10: Crushed aluminum film
Figure 4.11: Using tape method to generate nanoholes on the ITO surface
Figure 4.12: GaAs solar cell I-V results
REFERENCES


