The Characterization of Micro-Channel Structure Poly Silicon Solar Cell Shaped by Laser Carving Technology

Liann B. Chang, Hsin C. Chen, Chao S. Lai, Chung W. Liao

Abstract—**On the increasing efficiency of solar cell manufacturing is a continuous challenge to the photovoltaic industry. This paper discusses using laser carving to shape circular micro channels on the surface of polycrystalline silicon solar cells in order to enhance their efficiency. According to the research findings, when the radius of circular-micro channels structure for 15μm, the efficiency of the solar cell is raised from 14.28% to 15.78%. Detail features of efficiency and IV curve are also discussed.**

***Index Terms*—poly silicon, solar cell, micro channel, laser carving**

I. Introduction

R&D of the solar cell is currently an important and popular issue owing to the future scarcity of conventional energy and the rise of green energy. At present, there exist a wide variety of solar cells on the market made up mainly from silicon series materials such as, (amorphous, polycrystalline, single crystalline), the Ⅲ - Ⅴ series (such as Gallium Arsenic, Indium Phosphide, Gallium Indium Phosphide), and the Ⅱ-Ⅵ series (Cadmium Telluride, Indium Copper Selenium), and so forth. To date, much research has been produced about the solar cells.[1]-[5]

Polycrystalline silicon is a key component in solar panel construction. Because the manufacturing process of the polycrystalline silicon solar cell is simple, the cost is relatively low and therefore the importance of poly silicon solar cell has gradually exceeded the single crystalline silicon solar cell. Solar cell energy conversion efficiencies for commercially available polycrystalline silicon solar cells are around 14-19% at present time.[6]

In the meanwhile, the micro channel structure is often applied to increase the luminous efficiency of the Light Emitter Diode. Although many reports have researched increasing efficiency of the solar cell, few have discussed increasing the solar cell efficiency with the micro-channel structure. This research attempts to use laser carving skill to manufacture circular micro-channels on the surface of the polycrystalline silicon solar cell, and proposes the related results.

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II. EXPERIMENTS

Figure 1 shows the solar cell with micro channel structure and its surface morphology photo. The solar cell substrate is p-type polycrystalline silicon, the anti-reflection layer is coating by Si_3N_4, top electrode are 2.0 mm silver bus bar and back electrode are 4.0 mm silver/aluminum continuous soldering pads. The polycrystalline silicon solar cell is supported by Solartech Energy Corp. The circular micro-channel structure is shaped by laser carving machine(YAG laser, Rofin-Baasel Inc.) on the surface of solar cell. The conversion efficiency is measured with a solar simulator under AM 1.5.

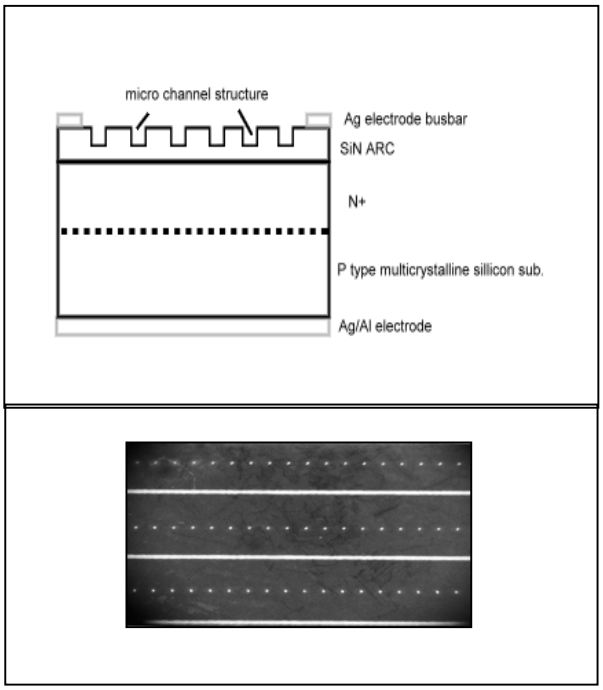

Fig1. Schematic solar cell structure employed and its surface morphology photo.

III. Results

Figure 2 shows the measured radius of micro channel and the correspondent efficiency of fabricated solar cell. The radius of micro channel varies from 15 μ m to 45 μ m. In the case of 15 μ m radius, its efficiency increased from 14.28% to 15.78%. The solar cell with 45 μ m of radius had even lower efficiency than the one without micro channel structure. Efficiency is reduced from 15.25% to 14.45% which reduction is thought to be due to the increase of surface leakage current.

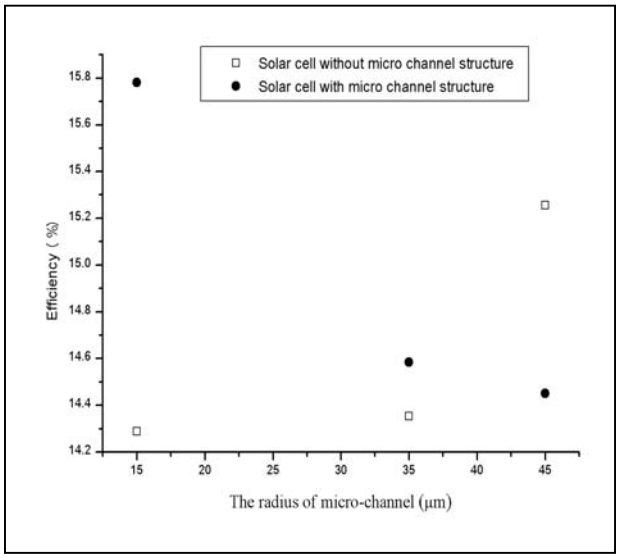

Fig2. Measured radius of micro channel and its correspondent efficiency of solar cell.

Figure 3 shows the solar cell IV curve of the comparison beteen without micro channel and with 15 μ m of radius of micro channel. The short current (Isc) is increased from 0.0344 A/cm^2 to 0.03718 A/cm^2.

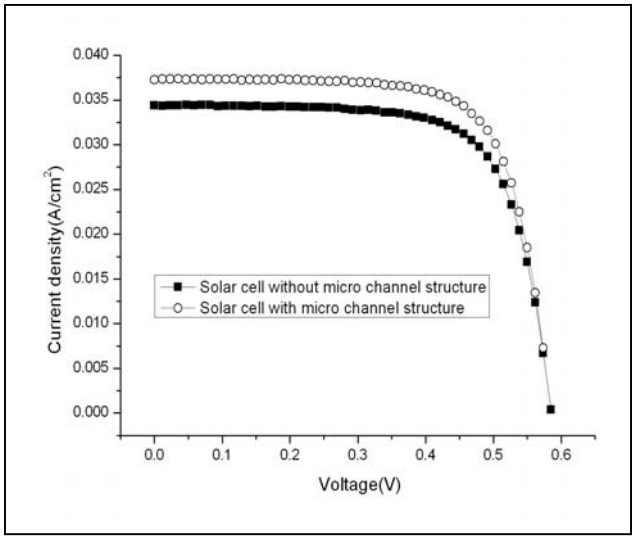

Fig 3. Measured IV characteristic of solar cell with 15 μ m of radius of micro-channel structure and the one without micro-channel structure.

Figure 4 compares dark current with light current characteristic of solar cell with 15 μ m of radius of micro-channel structure. The dark current is 2.129209×10^{-6}A, and the light current is about 38593 times the dark current at 0 voltage.

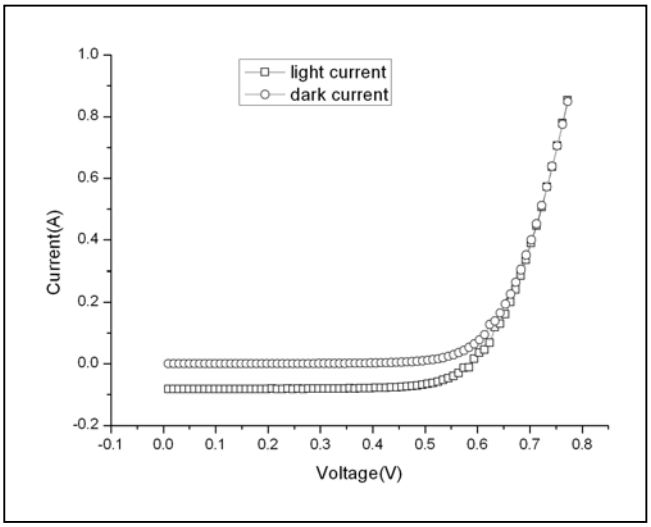

Fig4. Measured the dark current and the light current of solar cell with 15 μ m of radius of micro-channel structure.

IV. Conclusion

The use of the laser carving method that shapes the micro-channel structure on the surface of polycrystalline silicon solar cell has been investigated. This technique is proven can raise the efficiency of polycrystalline silicon solar cell. Efficiency of the solar cell is increased from 14.28% to 15.78%, when the radius of circular micro-channel structure for 15μm. We expect that with the application of creative technology and structure, a rise in efficiency in other type solar cells can be also developed in the future.

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