ISSN 3032-1230
Original Research
The Southeast Asian Journal of Advance Engineering and Technology
Vol. 2, No. 3, September 2025, pp.82-87

The Effect of Adding Structures on the Performance of 100 WP Thin Solar Panels

Achmad Raiski Maulana[1], Andi M. Nur Putra[1], Rafika Andari[1]
[1] Department of Electrical Engineering, Institut Teknologi Padang, Indonesia

Corresponding Author:

Achmad Raiski Maulana
Department of Electrical Engineering
Institut Teknologi Padang
Padang, West Sumatra, Indonesia

E-mail:
achmadraiskimaulana@gmail.com

ABSTRACT

This study aims to increase the efficiency of thin solar panels and identify the causes of low power output in thin solar panels. This is a qualitative study using an experimental method by adding layers and changing the arrangement of solar cells in the structure of thin solar panels. The analysis methods used include measuring electrical productivity under standard testing conditions, electrical power performance, electrical output power, and voltage-current (V-I) measurement results, which will be presented in graphs. Data collection was carried out by measuring the voltage, current, and power generated by thin solar panels in the analysis of the performance of 100 WP solar panels. This research was conducted using acrylic thicknesses of 1,5 mm, 2 mm, and 3 mm using light from a lamp. This test was conducted using conditions of λ_{ref} = 484 W/m^2 and T_{ref} = 56,25^{o}C. The results of the study show that low surface temperatures on thin solar panels influenced by acrylic thickness produce better power output. Acrylic with a thickness of 3 mm and a surface temperature of 56^{o}C produced an output power of 0,22 W. The best voltage value was also produced based on testing using 3 mm acrylic thickness, which was 22,3 V. This study makes an important contribution to understanding and improving output power through the analysis of the performance of 100 WP thin solar panels.

Keywords: Thin solar panel, Acrylic, Structure, Efficiency, Temperature

Article history:

Received Aug 21, 2025
Revised Sep 5, 2025
Accepted Sep 9, 2025

1. Introduction

Energy demand will continue to grow in line with population growth[1]. Electricity demand, in particular, is increasing rapidly, even beyond estimates. This is due to an increase in all activities that use electricity[2]. There is an inexhaustible and non-polluting energy source, namely solar energy. Proper utilization of solar energy can help meet the demand for electrical energy by using solar cells [3][4]. There are three types of solar cells: monocrystalline, polycrystalline, and thin solar panels. Monocrystalline and polycrystalline types have the advantage of higher efficiency and output power but have the disadvantage of being thick and rigid in structure. The thin type has the advantage of being flexible and much thinner in structure but has the disadvantage of low efficiency and output power. In a study [5], the power generated by thin solar panels did not match the nameplate. Therefore, the public has not widely used thin panels due to their low efficiency.

Thinner, more flexible, and lighter weight are the advantages of thin solar panels, making them suitable for use by the public to help meet electricity needs in homes, street lights, and electric vehicles, which are expected to increase power output. Research [6] shows that cell temperature, solar radiation, atmospheric conditions, and the location of solar cells can affect operational results. Then [7] and [8] conducted experiments using a 100 WP polycrystalline type that produced a maximum power of 80 W under optimal sunlight intensity conditions, and a monocrystalline 100 WP type produced a maximum power of 81,77 W under optimal sunlight intensity conditions. According to[9], temperature affects maximum voltage. At a temperature of 27˚C, the maximum voltage is 19,35 V, and at a temperature of 54˚C, the maximum voltage is 17,77 V. In a study on thin solar panels conducted by[10], under sunny conditions, a thin solar panel with a capacity of 100 WP only achieved a maximum power of 15,60 W. The efficiency of thin panels is not as good as polycrystalline or monocrystalline panels, which is around 6%-12%[11]. Therefore, an increase in temperature on the surface of thin solar panels affects the output voltage power, which can decrease[12]. In this study, testing will be conducted using light from a lamp to ensure that the light intensity received is constant. Lamp light is used not because it has better intensity than sunlight, but because lamp light can produce controlled and uniform intensity conditions.

This test was conducted using the STC method under the conditions λ_{ref}= 1000 W/m^2 and T_{ref}= 25ºC [13]. However, in this test, the results obtained were not in accordance with the IEC 61215 Standard Test Conditions. This is due to less than optimal lighting and inadequate room conditions. So the test was continued using the conditions λ_{ref}= 484 W/m^2 and T_{ref}= 56,25ºC. The addition of structural layers and changes in the arrangement of solar cells on thin solar panels aims to determine the maximum power that can be generated and the cause of low efficiency. This research aims to find out how to increase the efficiency of thin solar panels and find out the cause of the small output power on thin solar panels. So that this research is not too broad and does not deviate from the formulation of the problem above, it is necessary to limit the problems reviewed. The limitations of the problem in this study are the panels that will be used only thin panels. Measured variables (P, V, I, N). Tests are carried out under standard conditions and direct testing methods.

2. Research method

2.1 Research Tools and Materials

The tools used in this research are panels with thin solar panel type 100 W_P, acrylic 1,5 mm, acrylic 2 mm, acrylic 3 mm, temperature and intensity measuring instruments using Seaward Solar Survey 200R, voltage and current measuring instruments using Seaward PV150. The specifications of the solar panels used can be seen in Table 1.

Table 1. Solar panel specifications

Thin Solar Panel	
P_{max}	100 W
V_{oc}	23,05 V
I_{sc}	6,78 A
V_{mp}	17,98 V
I_{mp}	5,57 A
Dimensions	920x678

In a qualitative study using experimental methods, the electrical productivity generated by a thin solar panel was determined under standard testing conditions. This study involved adding layers and changing the arrangement of solar cells in the thin solar panel structure. In the test circuit, a thin solar panel with an acrylic layer attached to its outer surface was connected to a measuring device. The test was conducted by placing a lamp as a light source at a distance of 100 cm from the panel, in accordance with the Standard Test Conditions (STC) using a lamp. The thin solar panel test circuit with the addition of acrylic can be seen in Figure 1.

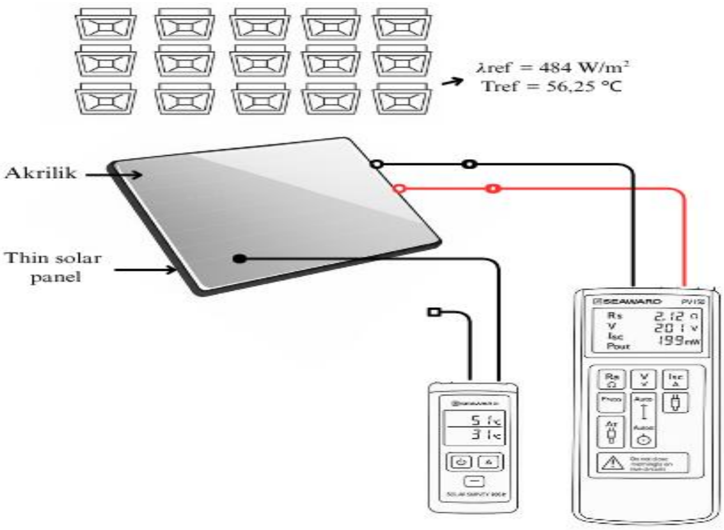

Figure 1. Thin solar panel testing range with acrylic manufacturing

The addition of a structure on the panel surface aims to determine its effect on output power. Acrylic is a hard plastic sheet that resembles glass, but its properties are superior to glass. An illustration of the shape and position of the added structure on the panel can be seen in Figure 2.

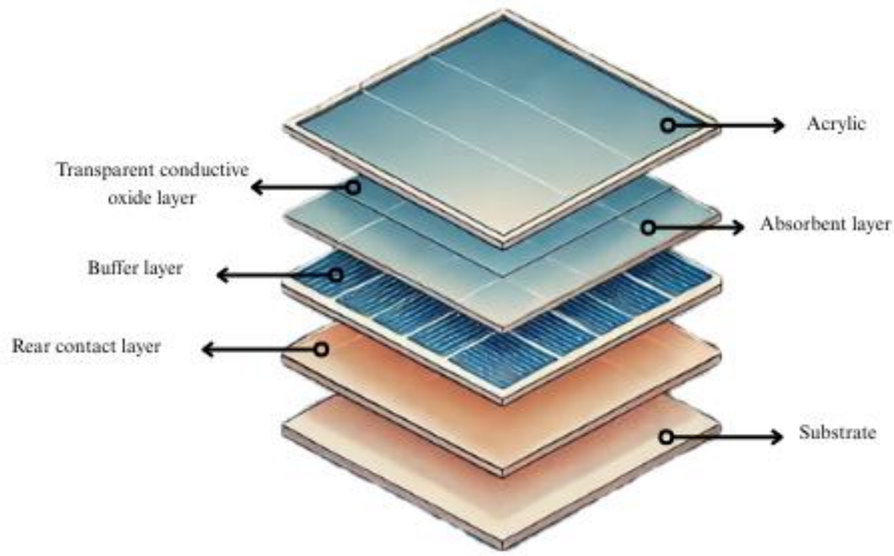

Figure 2. Illustration of the addition of a solar panel structure

Based on Figure 2, the addition of acrylic to the solar panel structure is done by attaching acrylic on top of the transparent conductive oxide layer or on the outer part of the solar panel. Acrylic is added according to its use in this study alternately, namely with a thickness of 1,5 mm, 2 mm, and 3 mm.

2.2 Measurement Variables

In this study there are variables measuring current, voltage, power, light intensity and temperature. Tests will be carried out using lamp light with conditions λ_{ref}= 484 W/m^2 and T_{ref}= 56,25^{o}C. From the conditions obtained the 100 W_P panel produces 48,4 W. In this study thin solar panels were used to analyze the performance of the electric power produced.

2.3 Place and Time of Research

The research location for taking the required variables such as measurements of voltage, current, power, produced by thin solar panels, which are carried out at the Electrical Engineering Laboratory of the Padang Institute of Technology Jl. Gajah Mada Kandis Nanggalo Padang. The data that will be needed in this study, thin solar panel specifications, test conditions, output voltage specifications, data on voltage, current and output power produced.

3. Results and discussion

Table 2 shows that testing using 1,5 mm thick acrylic with the aid of light produced a voltage value of 19,9 V. Furthermore, 2 mm thick acrylic produced a voltage of 20,9 V. When using 3 mm thick acrylic, the voltage produced was 22,3 V, which was the highest value among all the thicknesses tested. The increase in voltage from the tests conducted resulted in a difference of approximately 1 V to 2 V for each type of acrylic used. The difference in voltage between 3 mm and 1,5 mm acrylic was 3 V. The voltage generated was influenced by differences in the surface temperature received. In [9] explained that the lower the temperature on the surface of the panel during measurement, the better the voltage value. This is consistent with the results of the study, where it can be observed that the greater the thickness of the acrylic used along with the decrease in surface temperature, the higher the voltage produced, both in the first and second repetitions. A comparison graph of the V_{oc} (V) values on thin solar panels using light from a lamp can be seen in Figure 3.

Table 2. Results of testing thin solar panels using light lamps

Test Parameters	Acrylic (mm) U_1		
	1,5	2	3
V_{oc} (V)	19,9	20,9	22,3
I_{sc} (A)	0,01	0,01	0,01
Power (W)	0,19	0,20	0,22
Intensity (W/m^2)	484	484	484
Temperature (ºC)	57	56	56

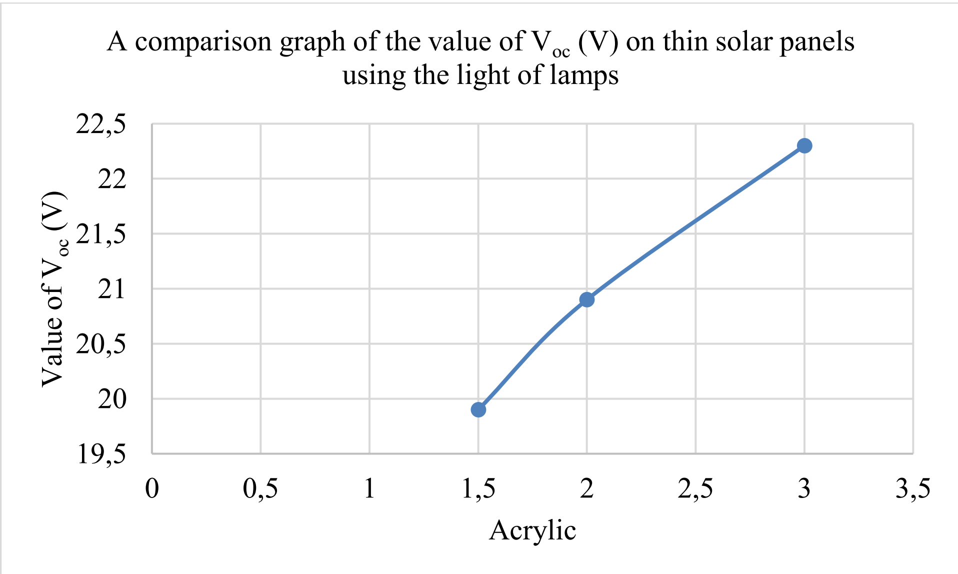

Figure 3. Comparison of V_{oc} (V) values on thin solar panels using light of lamps

The use of 1,5 mm thick acrylic with light from a lamp produces a power value of 0,19 W. Acrylic with a thickness of 2 mm with lamp light produces a power value of 0,20 W. Then, acrylic with a thickness of 3 mm produces a power value of 0,22 W. The difference in power values for each thickness of acrylic used does not show a significant difference. Low output power and Isc can be affected by high temperatures and internal damage to solar panels. This is in line with [14], which explains that internal damage to solar panels can affect the results of solar cell testing, such as cracks in the cells that cause some areas to not receive light intensity properly and cause the cells to become inactive. Cracks in solar cells are a common form of internal damage in photovoltaic (PV) modules. These cracks can occur during manufacturing, transportation, installation, A comparison graph of power values (W) in thin solar panels using lamp light can be seen in Figure 4.

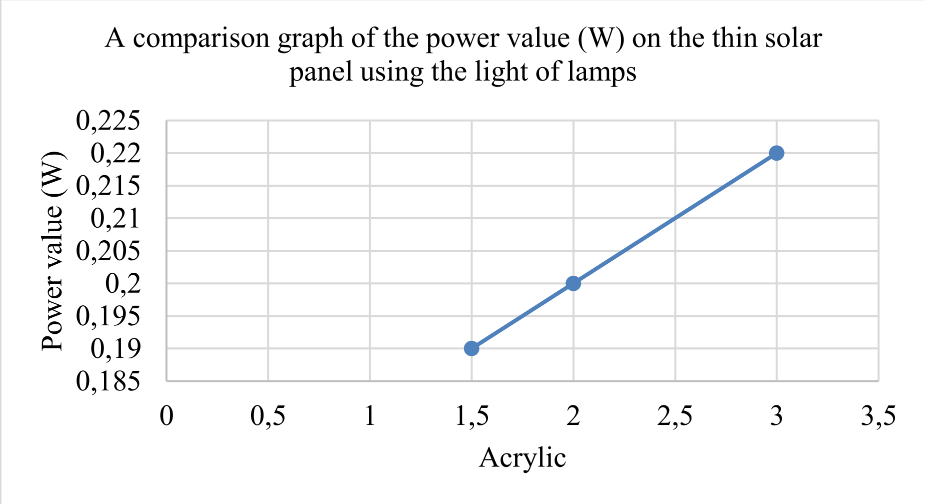

Figure 4. Comparison of Power (W) values on thin solar panels using light of lamps

The use of 1,5 mm thick acrylic under lamp light reached a temperature of 57ºC. Acrylic with a thickness of 2 mm reached a temperature of 56ºC. Acrylic with a thickness of 3 mm reached a temperature of 56ºC. A graph comparing the temperatures (ºC) of thin solar panels using lamp light can be seen in Figure 5.

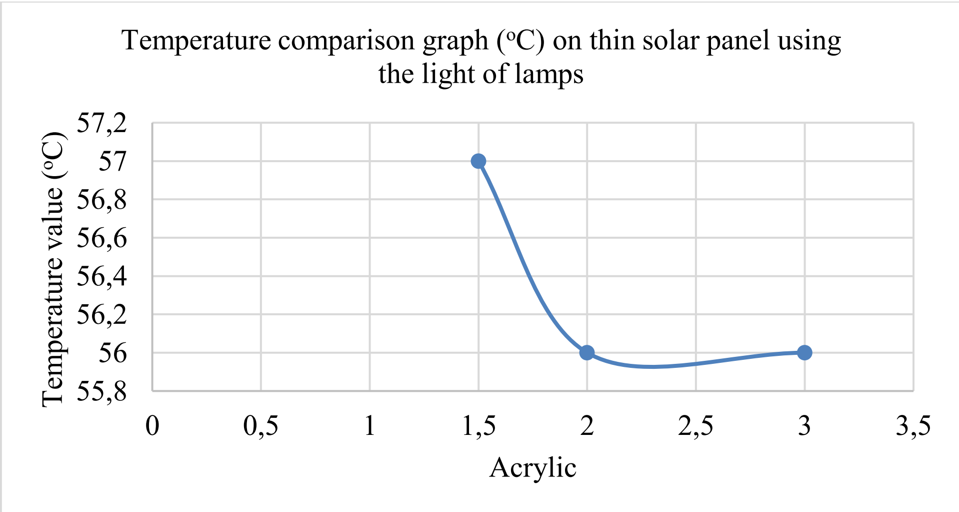

Figure 5. Temperature comparison (ºC) on thin solar panel using the light of lamps

According to [15] [16] damage to one critical part can inhibit the overall flow of current. Cracked or broken cells, even those that are not clearly visible from the outside, can cause loss of electrical contact or open circuits in those cells. If one cell in the series is damaged, it can cut off the flow of current for the entire string of cells. Both microcracks and large cracks affect the efficiency and performance of solar panels. Large cracks can reduce power by up to 60%, and a 1ºC increase in temperature can reduce efficiency by 0,45%. An Isc result of 0,01 A under direct sunlight indicates very high internal resistance in the solar panel due to physical damage to the solar cell.

4. Conclusions

Output power optimization in thin solar panels can be achieved by controlling the panel temperature and maximizing light intensity. The addition of a protective acrylic structure with varying thicknesses affects the efficiency of thin solar panels. Acrylic acts as both a protector and a temperature regulator on the panel surface. Test results show that lower panel surface temperatures tend to produce better voltage and power. The surface temperature of the panel decreases as the thickness of the acrylic used increases. A thickness of 3 mm acrylic produces a better V_{oc} value than other acrylic thicknesses, namely 22,3 V. The power output is also better with a thickness of 3 mm acrylic, namely 0,22 W.

References

[1] R. Yanto, “Implementasi Data Mining Prediksi Kebutuhan Tenaga Listrik Di Kota Lubuklinggau,” *Techno.COM*, vol. 19, no. 2, pp. 197–206, 2020.

[2] S. Manan, “Energi Matahari, Sumber Energi Alternatif yang Effisien, Handal dan Ramah Lingkungan di Indonesia,” *Energi Matahari Sumber Energi Altern. Yang Effisien, Handal Dan Ramah Lingkung. Di Indones.*, pp. 31–35, 2009, [Online]. Available: http://eprints.undip.ac.id/1722

[3] B. H. Purwoto, J. Jatmiko, M. A. Fadilah, and I. F. Huda, “Efisiensi Penggunaan Panel Surya sebagai Sumber Energi Alternatif,” *Emit. J. Tek. Elektro*, vol. 18, no. 1, pp. 10–14, 2018, doi: 10.23917/emitor.v18i01.6251.

[4] G. Widayana, “Pemanfaatan Energi Surya,” *Jur. Pendidik. Tek. Mesin, FTK, UNDIKSHA*, vol. 9, pp. 37–46, 2012.

[5] M. Y. Puriza, W. Yandi, and A. Asmar, “Perbandingan Efisiensi Konversi Energi Panel Surya Tipe Polycrystaline dengan Panel Surya Monocrystaline Berbasis Arduino di Kota Pangkalpinang,” *J. Ecotipe (Electronic, Control. Telecommun. Information, Power Eng.*, vol. 8, no. 1, pp. 47–52, 2021, doi: 10.33019/jurnalecotipe.v8i1.2034.

[6] S. Yuliananda, G. Sarya, and R. Retno Hastijanti, “Pengaruh Perubahan Intensitas Matahari Terhadap Daya Keluaran Panel Surya,” *J. Pengabdi. LPPM Untag Surabaya Nop.*, vol. 01, no. 02, pp. 193–202, 2015.

[7] A. A. Fakhira, Sudarti, and Yushardi, “Analisis Pemanfaatan Panel Surya Tipe Polycrystalline 100 Wp Sebagai Sumber Energi Alternatif Untuk Meningkatkan Kesejahteraan Masyarakat Pedesaan Di Indonesia,” *J. Pendidikan, Sains Dan Teknol.*, vol. 2, no. 4, pp. 982–985, 2023, doi: 10.47233/jpst.v2i4.1318.

[8] R. Duanaputri, I. Heryanto/Eryk, M. F. Sajidan, M. F. Hakim, and A. L. Wardan, “Sistem Monitoring Online Dan Analisis Perfomansi Plts Panel Surya Monocrystalline 100 Wp Berbasis Web,” *Elposys J. Sist. Kelistrikan*, vol. 10, no. 1, pp. 1–6, 2023, doi: 10.33795/elposys.v10i1.715.

[9] D. Darwin, A. Panjaitan, and S. Suwarno, “Analisa pengaruh Intesitas Sinar Matahari Terhadap Daya Keluaran Pada Sel Surya Jenis Monokristal,” *J. MESIL (Mesin Elektro Sipil)*, vol. 1, no. 2, pp. 99–106, 2020, doi: 10.53695/jm.v1i2.105.

[10] A. Ramadhan, A. M. N. Putra, A. Y. Dewi, and S. Bandri, “Electricity Productivity Analysis of Thin Solar Panels,” *Southeast Asian J. Adv. Eng. Technol.*, vol. 1, no. 1, pp. 15–20, 2023.

[11] S. Nurdiansyah, A. Y. Dewi, and A. M. N. Putra, “Analisis Karakteristik Tegangan, Arus dan Daya Thin Solar Panel,” in *Prosiding Seminar Nasional Sains dan Teknologi*, 2022, pp. 337–342.

[12] A. N. Karakilic, A. Karafil, and N. Genc, “Effects of Temperature and Solar Irradiation on Performance of Monocrystalline, Polycrystalline and Thin-Film Pv Panels,” *Int. J. Tech. Phys. Probl. Eng.*, vol. 14, no. 2, pp. 254–260, 2022.

[13] W. B. Pramono, D. Ana, R. Wati, M. Visi, and T. Yadaka, “Simulasi Maximum Power Point Tracking pada Panel Surya Menggunakan Simulink MATLAB,” vol. 1, pp. 176–183, 2013.

[14] P. Rajput *et al.*, “A comprehensive review on reliability and degradation of PV modules based on failure modes and effect analysis,” *Int. J. Low-Carbon Technol.*, vol. 19, pp. 922–937, 2024, doi: 10.1093/ijlct/ctad106.

[15] M. Aghaei *et al.*, “Review of degradation and failure phenomena in photovoltaic modules,” *Renew. Sustain. Energy Rev.*, vol. 159, no. February, p. 112160, 2022, doi: 10.1016/j.rser.2022.112160.

[16] H. R, U. M, S. K V, S. S, J. Kumar K, and P. C. Ramamurthy, “Electroluminescence Imaging For Defect Analysis In Polycrystalline Solar Cells,” *Metall. Mater. Eng.*, pp. 1279–1288, 2025, doi: 10.63278/1705.