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A Study of the LED Module Heat Dissipation Structure Suitable

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Abstract

In this paper, reduces the absolute temperature of the LED module, results of the experiments have been derived a method to improve the suitability heat dissipation structure and properties are as follows. First, FR-4 PCB size in consideration of the PCB LED module air-hole 3mm radius of the LED module area 10%, 20%, 30% ratio after a process of simulation to generate the air-hole on the PCB and the surrounding, 30%, 50×30mm intervals, when generating a fifty-two, applying the air-hole 3mm 10% of the radius of the area LED module obtained the results of temperature reduction than max. about 3.5℃ and min. about 3.1℃. Second, LED array interval and to be suitable experimental structure through the PCB air-hole generation plate type heat-sink for LED module to support the air-hole radius 40mm size to create a two and six and four, as a result of the simulation in progress, when air-hole number pairs of the increase, max. and min. temperature was reduced to obtain a formal conclusion by about 1~1.5℃. the air-hole 3mm 10% of the radius of the area applied LED module than max. about 4.5℃, min. about 4.2℃ results was confirmed reduction. As a result, to the suitable of the heat dissipation even if the LED module PCB material no matter how good, if the heat sink is not well designed structural cannot obtain a large effect.

Keywords: *LED, Heat-Sink, Heat Dissipation, Air-Hole*

1. Introduction

In order to improve the heat dissipation performance of the LED package thermal design corresponding to the surface treatment technique with the package material, the study design considering the surrounding environment, such as the structure and operating conditions has been actively proceeding. Recently, using the nano particles such as Cu, Al2O3, Fe, CNT in, many studies on the fluid in the thermal conductivity and heat transfer characteristics has been rapidly progressing [1]. If the CNT were first introduced the concept of nanotubes, as well as several types of nanotubes has been developed so far, study has also been made in the application actively. And, be processed to form fine via-hole that in LED package of the FR-4 PCB, technology for more smoothly, and the thermal flow being studied [2], through the expansion of the LED package junction area, metal PCB and technical progress is also being developed with a nice temperature characteristics [3]. Also, through Sn surface treatment FR-4 material ions migration on the PCB, that is a accelerated tests for failure in experimental models, which research has been conducted as for the improvement and lifetime [4]. In this paper, for reducing the absolute temperature of the LED module, to be experiment to a way to improve the suitable of the heat dissipation structure and characteristics.

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2. Theory

2.1 Thermal Design Process

In consideration of the PCB size on FR-4 PCB LED module, 10%, 20%, 30% ratio create an air-hole 3mm radius on the PCB and surrounding, check the results of the simulation proceeds, Through the creation of LED arrangement pattern and PCB air-hole of optimized, which supports the LED module of the air-hole radius on 40mm size on the plate-like heat-sink 2, 4, 6 units generates to analyzes to the simulation result.

Table 1. Design Procedure of Thermal Analysis Experiments

PCB Air-Hole radius 3mm, 50 × 30mm Spacing 26, Apply, PCB Air-Hole radius 3mm, 50 × 60mm Spacing 26, Apply, PCB Air-Hole radius 3mm, 50 × 30mm Spacing 52, Apply, Comparative Experiment
⇩
Air-Hole radius 40mm on the Heat-sink 2, 4, 6, Apply Comparative Experiment

Table 2. is FR-4 PCB apply to LED Module for improve the thermal conductivity and heat flow to experimental procedure for structural optimization, basic module in the outskirts of the PCB FR-4 to analyze the best way through the air-hole apply the curvature effect.

2.2 PCB Air-Hole Apply Comparative Experiments

This experiment was in the consideration of the PCB size of FR-4 PCB LED module,the air-hole radius of 3mm LED module area 10%, 20%, 30% ratio on the 26 Air-Hole radius 3mm, 50×30mm spacing on the PCB and surrounding, 26 air-hole radius 3mm, 50×60mm spacing, air-hole radius 3mm, 50×30mm spacing 52 to apply the simulation of three type progress and the results are compared. in-put temperature of the LED was set to 130℃, ambient temperature was 27℃, measuring time the experiment was set to about 3 hours.

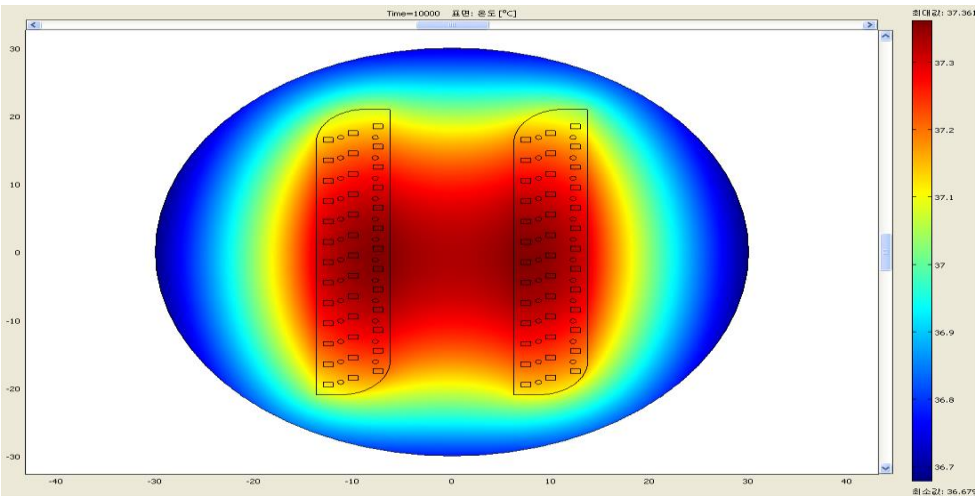

Figure 1. Air-Hole Radius 3mm, 50×30mm Spacing 26 Front View

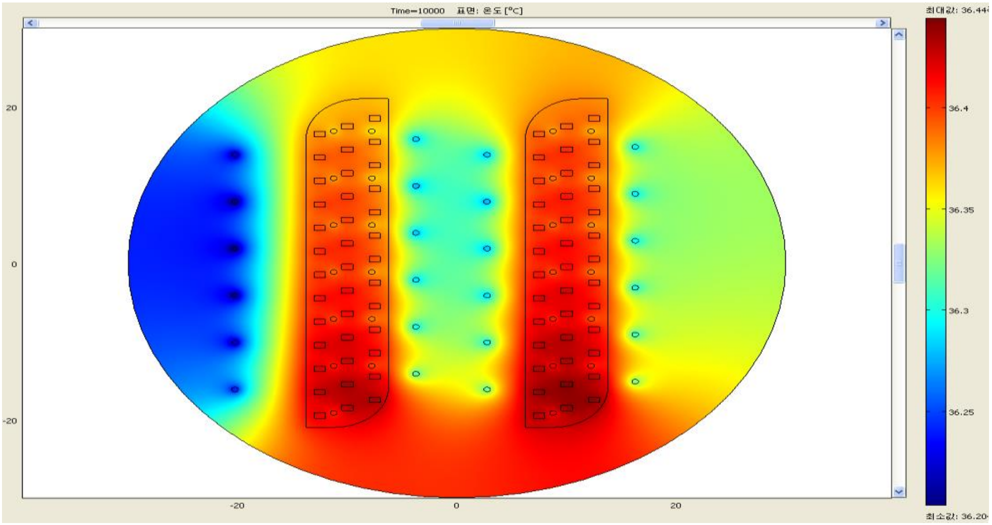

Figure 2. Air-Hole Radius 3mm, 50×60mm Spacing 26 Front View

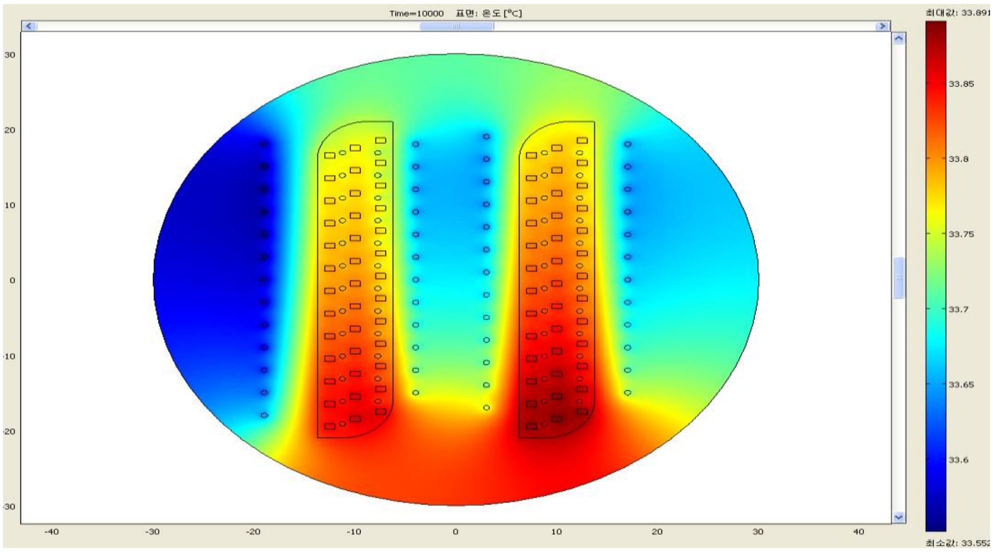

Figure 3. Air-Hole Radius 3mm, 50×30mm Spacing 52 Front View

PCB air-hole applies thermal analysis in the front view Figure 1. of radius 3mm, when applying a 50×30mm spacing 26 (10%), unlike traditional LED spacing experiment as max. About 37.36℃, min. at about 36.67℃ has stabilized, max. About 3℃ rises were measured. Although designed with reference to the advantage of the recent trends and technology conversely the temperature was increased, when Figure 2. apply the radius of the PCB air-hole 3mm, 50×60mm spacing of 26(20%), max. temperature was confirmed that about 1℃ reduced than when about 36.44℃ by applying the air-hole 10%. However, min. temperature is stabilized at about 36.2℃ did not differ significantly from the existing tests. Finally, in Figure 3. when applied to PCB air-hole radius 3mm, 50×30mm spacing 52 (30%), from 10%, 20% and alternatively disposed experiment max. about 33.89℃, min. at about 33.55℃ max. about 3.5℃~ min. showed a temperature reduction of about 3.1℃. In addition, the heat distribution is made uniform.

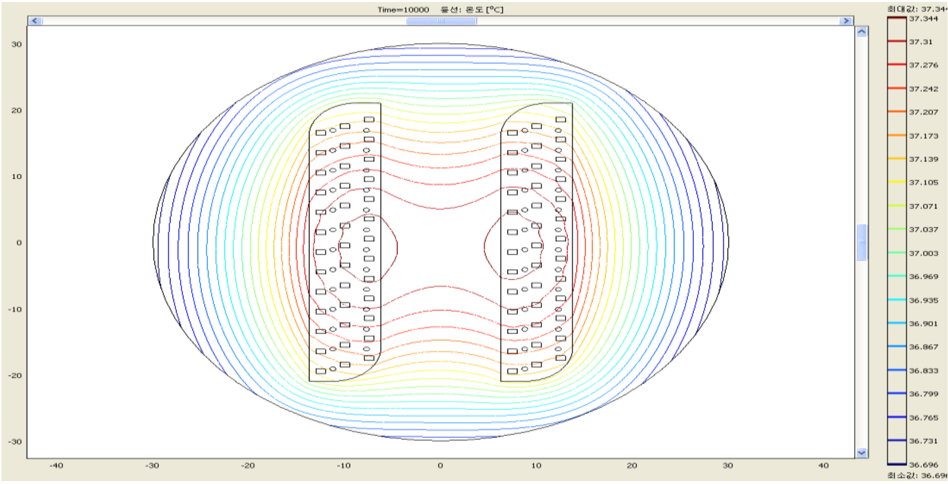

Figure 4. Air-Hole Radius 3mm, 50×30mm Spacing 26 Temperature Constant Linear

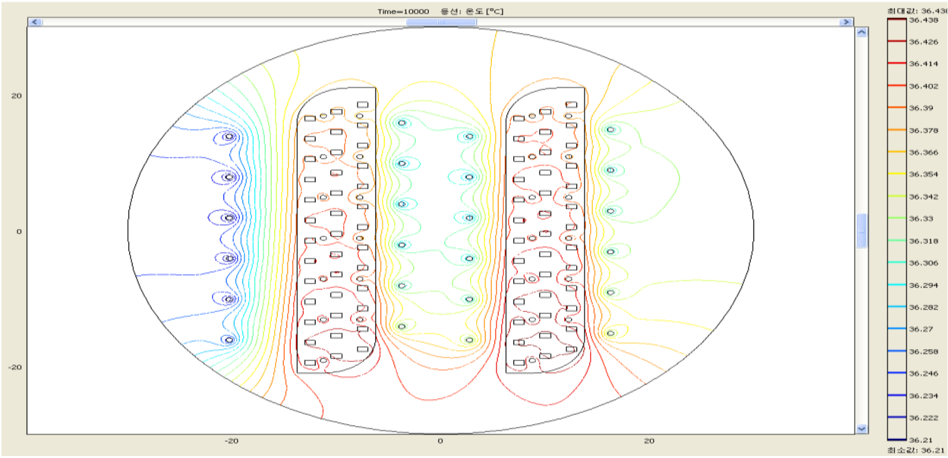

Figure 5. Air-Hole Radius 3mm, 50×60mm Spacing 26 Temperature Constant Linear

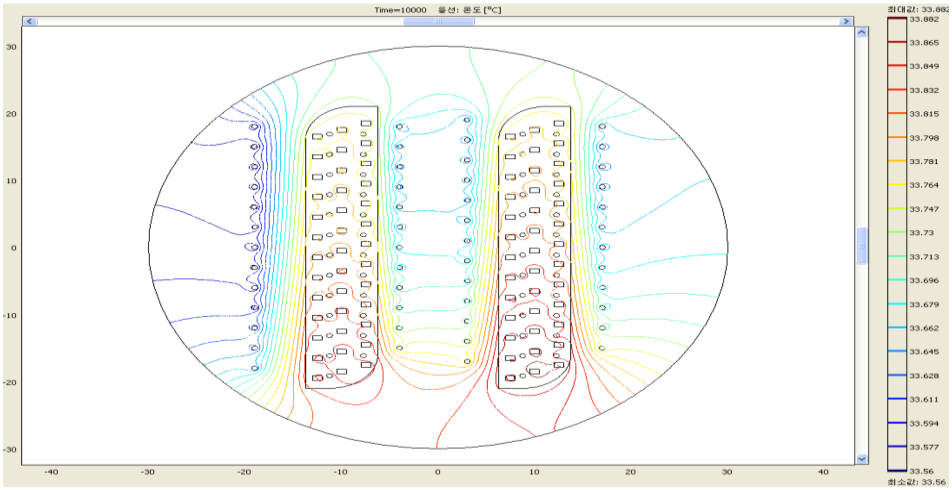

Figure 6. Air-Hole Radius 3mm, 50×30mm Spacing 52 Temperature Constant Linear

Temperature results in the constant linear when to Figure 4. apply the radius 3mm, 50×30mm spacing of 26(10%), constant linear is focused only on the heat source temperature of LED part. Also, when placing the air-hole only at regular intervals in the peripheral LED PCB, rather, adverse effects and action center part of the LED module been to expect an even heat dissipation synergistic effect, max. Temperature rises about 3℃ was confirmed that an error in the design. Figure 5. of the time when applying the PCB air-hole radius 3mm, 50×60mm spacing 26 (20%), in consideration of the size of the LED module air-hole by creating around the inside as well as the PCB with although the same quantity which in different parts of the existing temperature constant linear and the LED portion of the experiment to the center module to the temperature constant linear can be broadly confirm the spread. That was showed an overall reduction in the temperature influence, constant linear arrangement also confirmed the results of spreading more evenly than conventional tests. The last time we apply Figure 6. of the PCB air-hole radius 3mm, 50×30mm spacing of 52(30%), Figure 5. consists of a broader temperature constant linear spacing throughout than the air-hole, plate type heat-sink to the outer part was that the heat transfer can be confirmed.

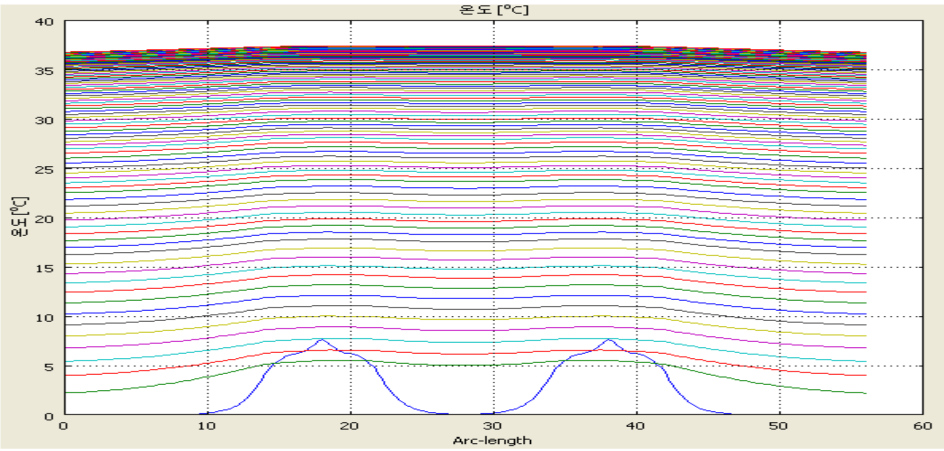

Figure 7. Air-Hole Radius 3mm, 50×30mm Spacing 52 Temperature Change Curve

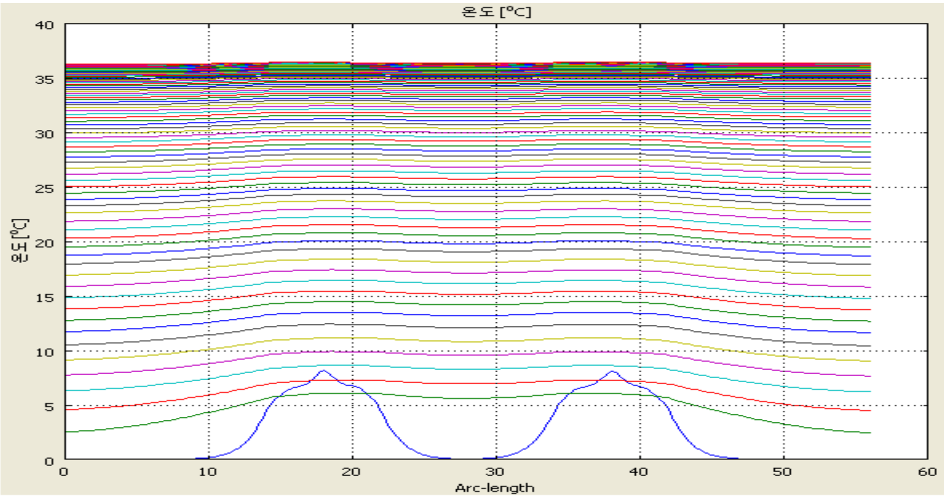

Figure 8. Air-Hole Radius 3mm, 50×60mm Spacing 26 Temperature Change Curve

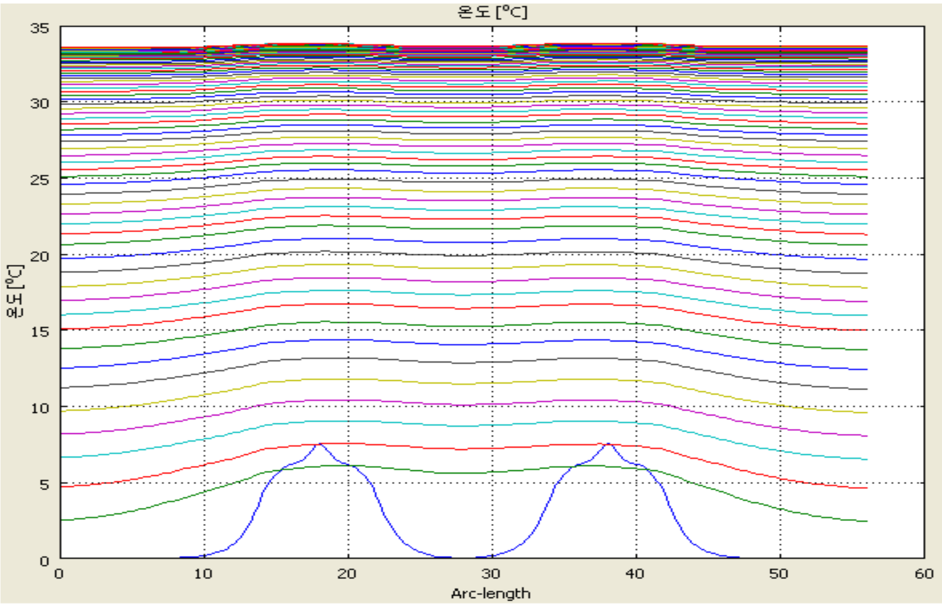

Figure 9. Air-Hole Radius 3mm, 50×30mm Spacing 52 Temperature Change Curve

As a result of comparing the temperature change curve, when in the Figure 7. apply a radius of 3mm, 50×30mm spacing 26(10%), max. about 37.36℃, min. to be has stabilized at about 36.67℃, max. about 3℃ rise was measured. Although designed with reference to the advantage of the recent trends and technology conversely the temperature was increased, when Figure 8. apply the radius of the PCB air-hole 3mm, 50×60mm spacing of 26(20%), max. temperature was confirmed that about 1℃ reduced than when about 36.44℃ by applying the air-hole 10%. However min. temperature was stabilized at about 36.2℃ did not differ significantly from the existing tests. Finally, in Figure 9. when applied to PCB air-hole radius 3mm, 50×30mm spacing 52(30%), from 10%, 20% and alternatively disposed experiment max. about 33.89℃, min. at about 33.55℃ max. about 3.5℃～ min. showed a temperature reduction of about 3.1℃. Thus, PCB air-hole apply on the test when applying the radius 3mm, with 50×30mm spacing 52(30%), the heat radiation characteristics were obtained excellent results. However, to check up on the outskirts of the plate-like heat-sink thermal conductivity and heat flow were weak, the secondary structure changes experiment which supports the LED module optimized through the PCB air-hole generation that radius of the plate type heat-sink was 40mm size to the air-hole 2, 4, 6, units to generate a number and the progress and compare the simulation.

2.3 Heat-Sink Air-Hole Apply Comparison Test

This experiment was a LED module to supports optimized through the PCB air-hole generation that radius of the plate type heat-sink was 40mm size to the air-hole 2, 4, 6, units to generate a number and the progress and compare the simulation. In-put temperature of the LED was set to 130℃, ambient temperature was 27℃, measuring time the experiment was set to about 3 hours.

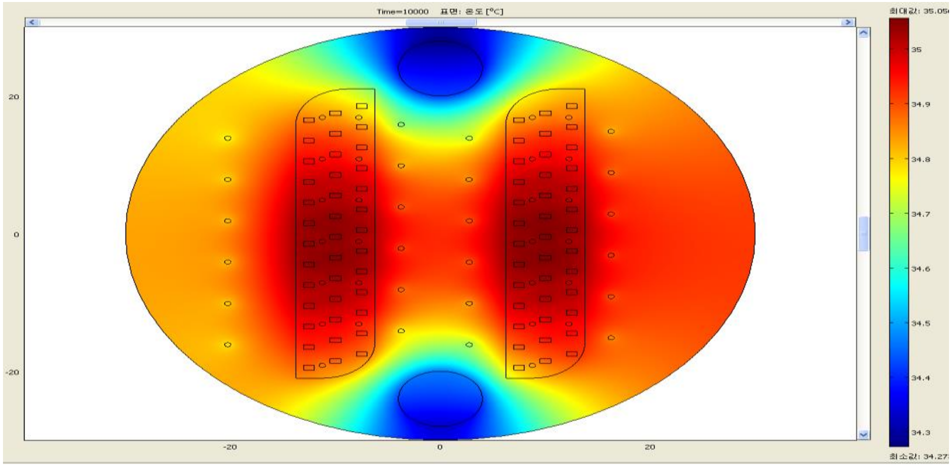

Figure 10. Heat-Sink Air-Hole Radius 40mm, 2 Units Thermal Analysis Front View

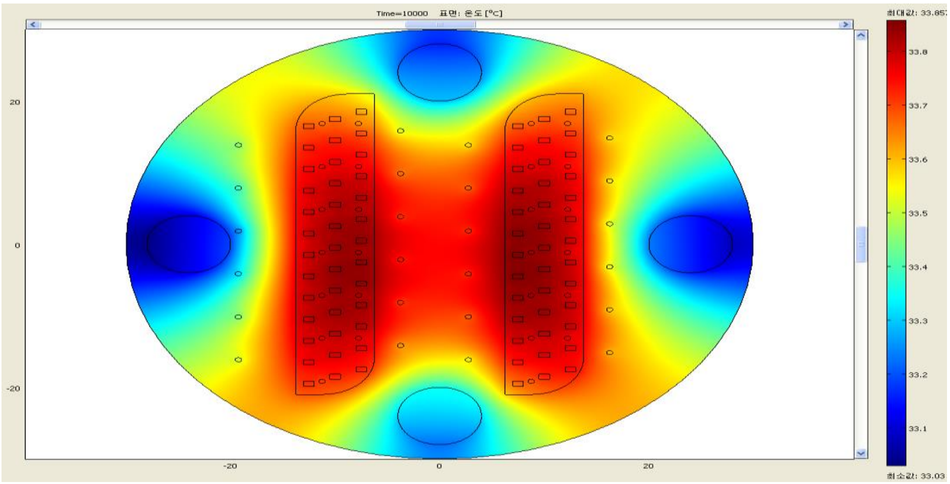

Figure 11. Heat-Sink Air-Hole Radius 40mm, 4 Units Thermal Analysis Front View

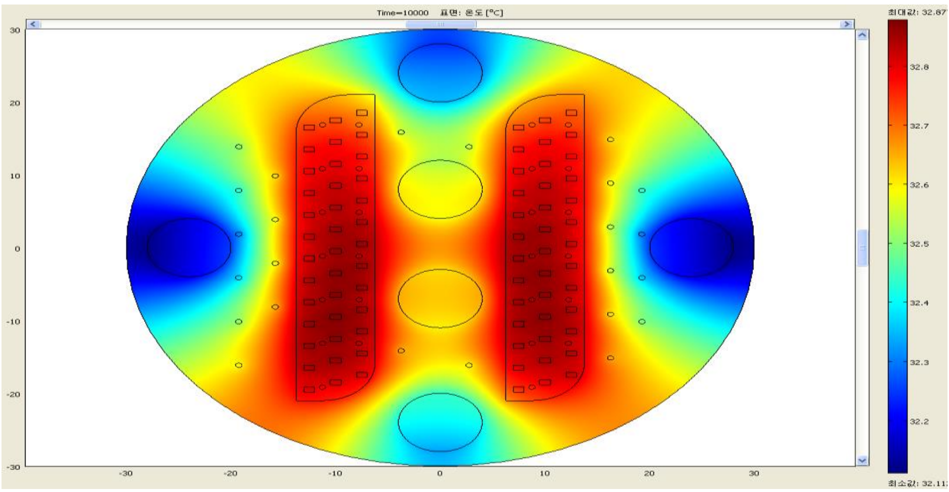

Figure 12. Heat-Sink Air-Hole Radius 40mm, 6 Units Thermal Analysis Front View

Figure 10. air-hole radius of the heat-sink 40mm, 2units has max. about 35.09℃, min. about 35.27℃ were measured. Figure 11. air-hole radius of the heat-sink 40mm, 4units has max. about 33.85℃, min. about 33.03℃ were measured. Finally, Figure 12. air-hole radius of the heat-sink 40mm, 6units has max. about 32.87℃, min. about 32.11℃ were measured. Thermal analysis result, when air-hole units were increased by 2 each, max. and min. it was confirmed that the temperature decreases by about 1~1.5℃. In addition, into the center of the plate-like heat-sink to the outside has the temperature was reduced through the air-hole, heat distribution to obtain a result that is strongly distributed in all directions to the outside of the heat-sink than traditional restructure experiment.

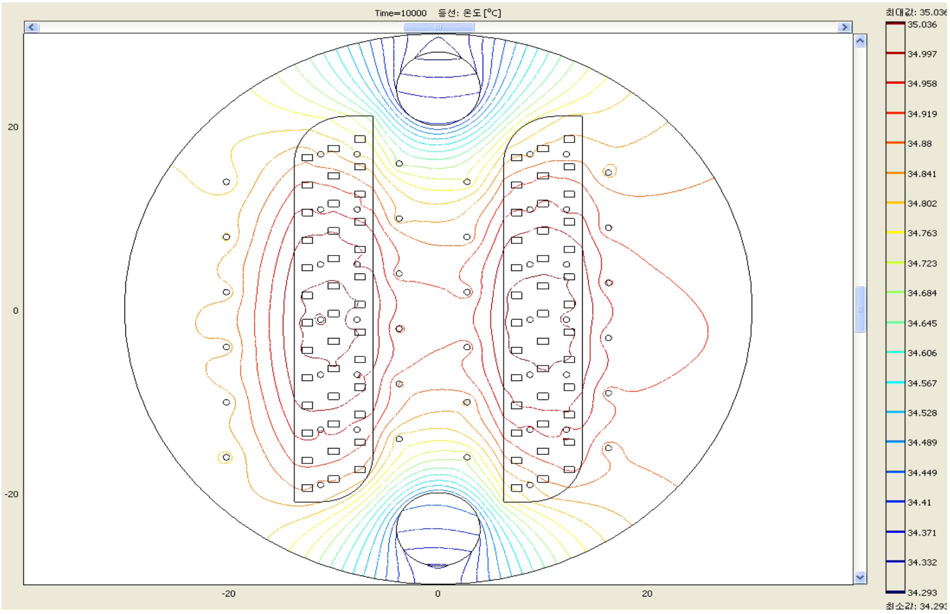

Figure 13. Heat-Sink Air-Hole Radius 40mm, 2 Units Temperature Constant Linear

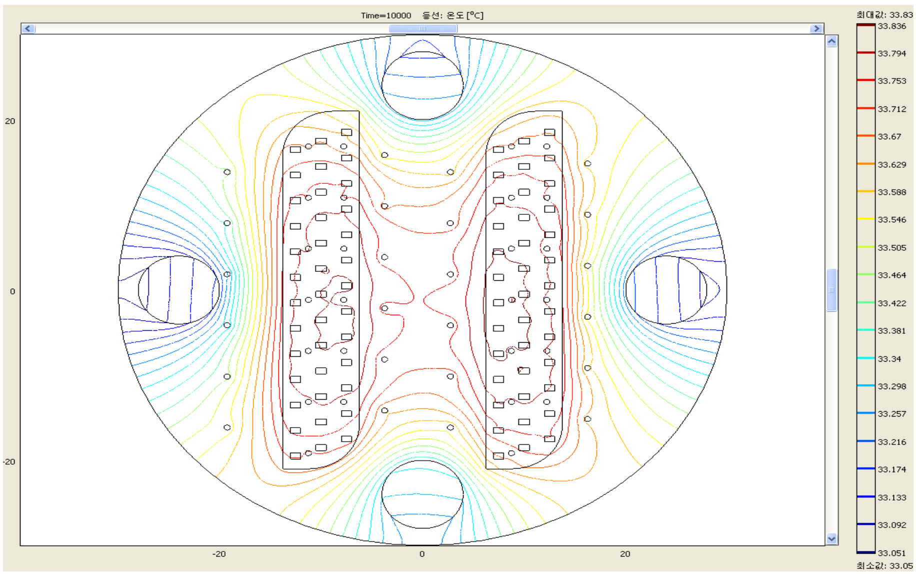

Figure 14. Heat-Sink Air-Hole Radius 40mm, 4 Units Temperature Constant Linear

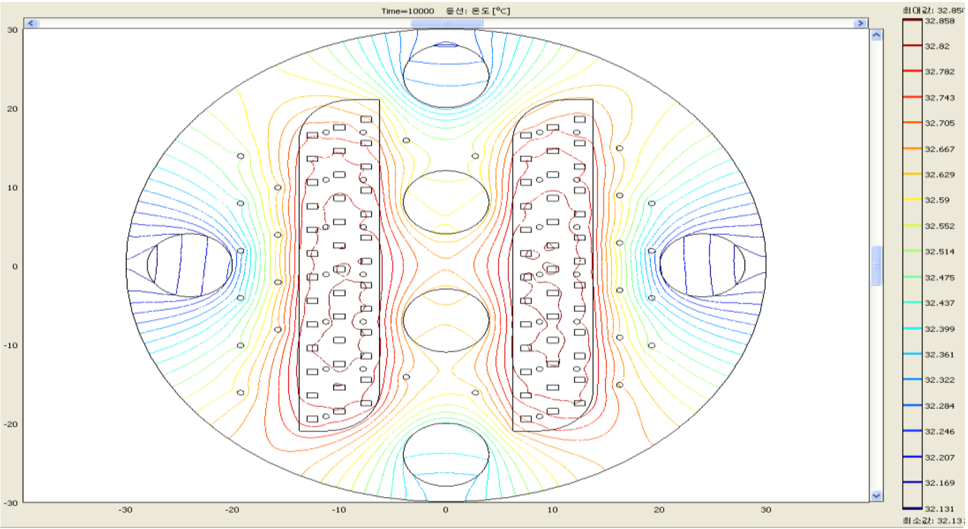

Figure 15. Heat-Sink Air-Hole Radius 40mm, 6 Units Temperature Constant Linear

Temperature constant linear analysis, although the heat generated from the LED was excreted in the air-hole 3mm size of an existing installation, which that stronger heat was discharged through the air-hole in the heat-sink outside, temperature constant linear has been densely formed. Therefore, by analyzing each of the simulation results, Figure 13. air-hole radius of the heat-sink 40mm, 2units air-hole has direction which placed on the heat-sink temperature constant linear has been evenly distributed, but unplaced in place will seems to result which the heat was concentrated around the LED. Figure 14. air-hole radius of the heat-sink 40mm, 4units has different from the outer heat-sink and Figure 13. Radius 40mm air-hole uniformly in the direction of the made temperature constant linear, center section, can be check the heat diffusion was spread more slowly. Finally, Figure 15. air-hole radius of the heat sink 40mm, 6units has a heat source to the LED plate type heat-sink outside to uniformly air-hole direction which temperature constant linear can be confirmed that being made. In particular, Figure 15. has the heat through the air-hole center be located on the heat-sink spread heat dissipation characteristics were represented by temperature decrease showed excellent results.

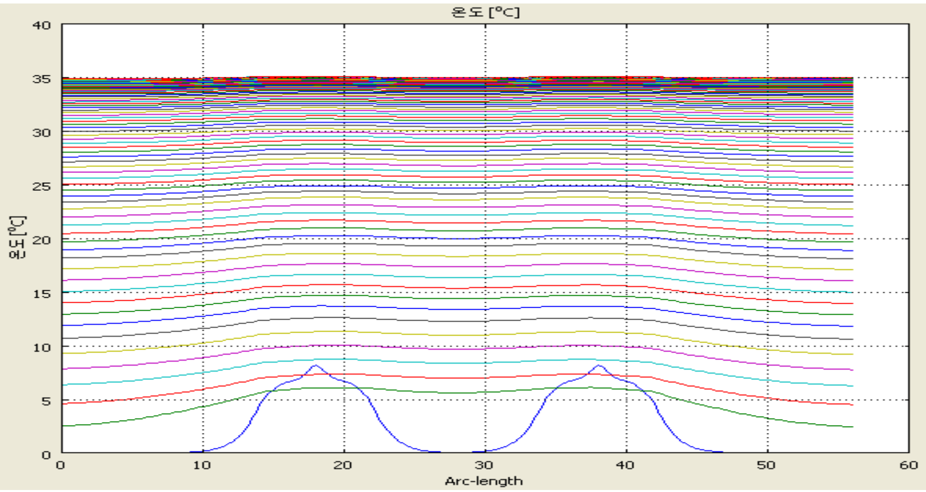

Figure 16. Heat-Sink Air-Hole Radius 40mm, 2 Units Temperature Change Curve

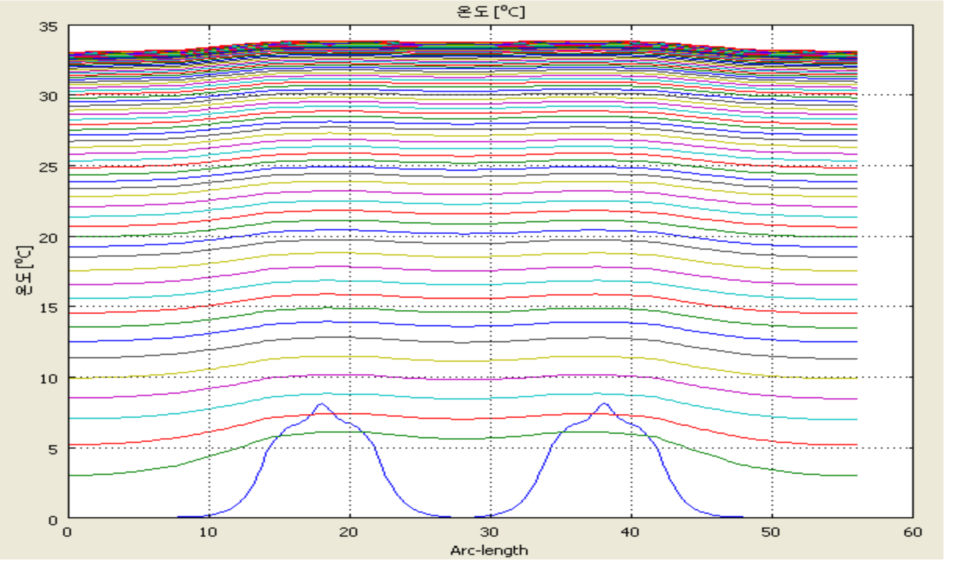

Figure 17. Heat-Sink Air-Hole Radius 40mm, 4 Units Temperature Change Curve

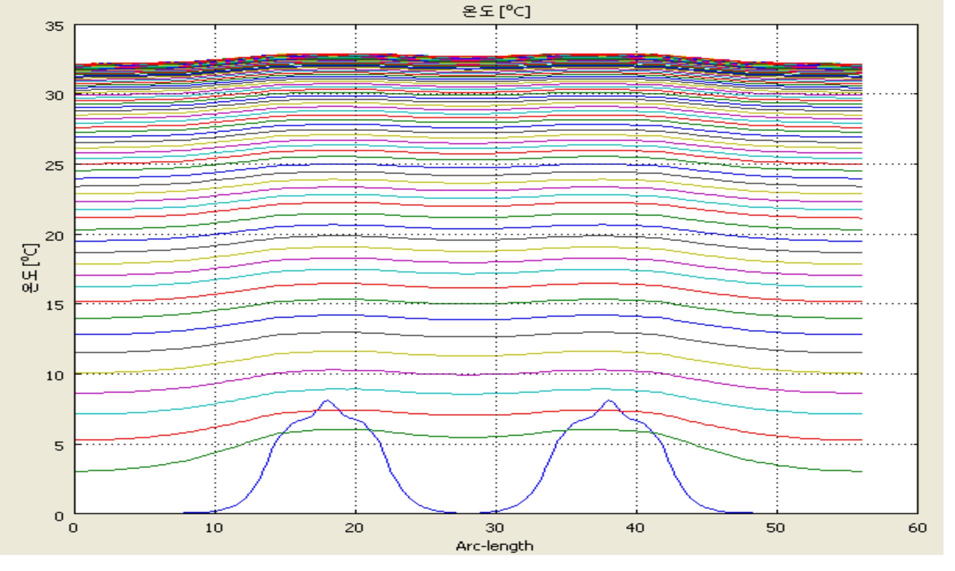

Figure 18. Heat-Sink Air-Hole Radius 40mm, 6 Units Temperature Change Curve

The analysis of temperature change curve, Figure 16. air-hole radius of the heat-sink 40mm, 2units has max. about 35.09℃, min. about 35.27℃ was measured. Figure 17. air-hole radius of the heat-sink 40mm, 4units has max. about 33.85℃, min. about 33.03℃ was measured. Finally, Figure 18. air-hole radius of the heat-sink 40mm, 6units has max. about 32.87℃, min. about 32.11℃ was measured. In addition, Figure 16. than max. temperature was about 2.3℃, min. results showed that temperature decreased about 3℃. Thermal analysis result, air-hole when increase the number of pairs of max. and min. temperature was decreased to obtain a formal conclusion by about 1~1.5℃. Thus heat distribution result was distributed strongly in all directions of the heat-sink than traditional tests, the best results were obtained with excellent heat dissipation characteristics of the experimental structure was optimized.

2.4 Thermal Design Experimental Analysis

In this paper, reduces the absolute temperature of the LED module, results of the experiments have been derived a method to improve the suitability heat dissipation structure and properties are as follows. First, FR-4 PCB size in consideration of the PCB LED module air-hole 3mm radius of the LED module area 10%, 20%, 30% ratio after a process of simulation to generate the air-hole on the PCB and the surrounding, 30%, 50×30mm intervals, when generating a fifty-two, applying the air-hole 3mm 10% of the radius of the area LED module obtained the results of temperature reduction than max. about 3.5℃ and min. about 3.1℃. Second, LED array interval and to be suitable experimental structure through the PCB air-hole generation plate type heat-sink for LED module to support the air-hole radius 40mm size to create a two and six and four, as a result of the simulation in progress, when air-hole number pairs of the increase, max. and min. temperature was reduced to obtain a formal conclusion by about 1~1.5℃. the air-hole 3mm 10% of the radius of the area applied LED module than max. about 4.5℃, min. about 4.2℃ results was confirmed reduction.

3. Conclusion

In this paper, the heat sink structure changes by generating the air-hole LED module increase air contact to improve the heat dissipation capability of rapid air circulation and heat flux enhancement and LED module of analysis was compared to the absolute temperature and decreasing the character by method was as follows.

1. when applied to PCB air-hole radius 3mm, 50×30mm spacing 52 (30%), from 10%, 20% and alternatively disposed experiment max. about 33.89℃, min. at about 33.55℃ max. about 3.5℃～min. showed a temperature reduction of about 3.1℃.

2. LED array interval and to be suitable experimental structure through the PCB air-hole generation plate type heat-sink for LED module to support the air-hole radius 40mm size to create a two and six and four, as a result of the simulation in progress, when air-hole number pairs of the increase, max. and min. temperature was reduced to obtain a formal conclusion by about 1~1.5℃. the air-hole 3mm 10% of the radius of the area applied LED module than max. about 4.5℃, min. about 4.2℃ results was confirmed reduction.

Finally, even if the PCB material, no matter how good the LED module unless been do this well designed structurally to the heat sink to be pointless and can not get a big effect. Further, the plate-like heat-sink increases the conductivity of the surface-emission by using the metal body, which the air-hole to increase air contact as in the present experiment was excellent heat dissipation characteristics. In addition, through the simulation of the LED module modeling and simulation of thermal analysis method was not effective and the actual production of the industry in developing cost saving LED module may reduce the error range of the result through simulation.

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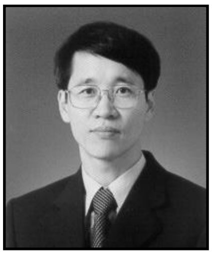

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