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HEAT TRANSFER ANALYSIS FOR GREEN LED BASED INDOOR LIGHTING MODULE

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***Abstract*— As the efficiency of LED (Light Emitting Diode) chip has increased, the more effective thermal radiation is needed. The purpose of this research is to find a right material for green LED indoor lighting module with high CRI (Color Rendering Index) above 95. LED module case was designed with Pro-E CAD software. This case has no heat sink to reduce the manufacturing cost and more competitive in the market. To find an optimal conductive material, heat flow simulation was executed with heat transfer simulation tool, midas NFX software. Heat transfer analysis was performed by experimenting with several materials in natural convention situation. The result showed that the most proper material for LED module with high CRI index above 95.**

Keywords—Heat Transfer Analysis, Green LED, Heat Flow Simulation, Conductive Material, High CRI

I. INTRODUCTION

Reducing the thermal resistance is one of the most important issue for the LED (Light Emitting Diode) module. Various research have been done to solve heat problem. In this research, two methods will be tried to solve the thermal radiation problem of LED module. First, LED module case will be made without heat sink. Second, finding a most suitable material for the LED module case without heat sink.

Optimize the thermal management system is required to design efficient LED. The aim of this study is to find the most efficient conductive material for green LED indoor lighting module with high CRI (Color Rendering Index) above 95. High CRI above 95 LED lights make the appearance of products more clearly and vivid. And also it use less energy dramatically. Our research team developing green LED indoor module with above 95 CRI.

This research will focus on thermal radiation analysis of LED module case to find the most efficient material for the case. Developing LED module case designed with no heat sink. Heat sink could dissipate heat more easily with conduction, convention and radiation. But price of LED module has to be increased. Therefore, developing a high quality LED module with lower price with no heat sink is the purpose of our research.

II. DETAILED EXPERIMENT

A. Materials and Procedures

LED module case designed with Pro-E CAD software and prototype of product is shown in Figure 1. Radiation of heat will be depend on the material of case, because case designed without heat sink. The experiment implemented in natural convention situation, because there is no fan or pump was designed to remove excess heat.

Fig.1. LED Module Case with No Heatsink

Four kinds of material, Al (Aluminum), New Aluminum, PC (Poly Carbonate), and Cu (Copper), were experimented for thermal radiation analysis. General settings for heat transfer analysis is shown on Table 1. Al is 1060 Alloy, New Al is ALDC12, PC is Poly Carbonate and Cu is Cooper.

Table 1: General Heat Transfer Setting

	Thermal Conductivity (W/m·K)	Density (kg/m^3)	Heat Capacity At Constant Pressure (J/kg·K)
Al	220	2700	300
New Al	161	2700	896
PC	0.22	1100	0
Cu	401	8940	384.6

B. Thermal Radiation Analysis

The thermal radiation test was done with four materials. LED module made of PC was compared with real prototype. The prototype shown on Figure 1 was measured with thermo-graphic camera at room temperature. Case surface temperature was 74.8 ℃ and the inside case temperature was measured 88.33 ℃. The result of thermal measurement of prototype shown on Figure 2.

Case Temperature (℃)	74.8
LED Lead Temperature (℃)	88.33

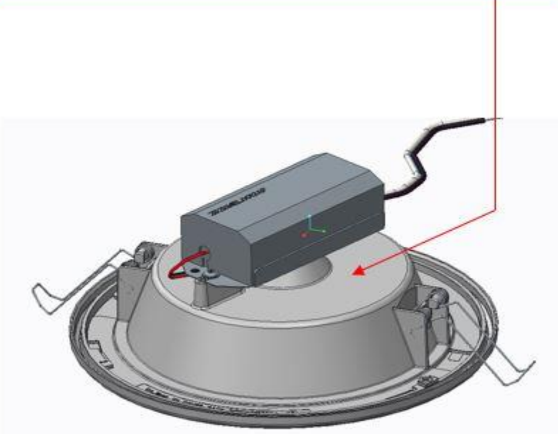

Fig.2. LED Module Case Temperature Measurement (PC)

Heat flow simulation was implemented with, midas NFX software and shown on Figure3 and Figure 4. Both of the results showed almost same result with the real measurement value on Figure 2.

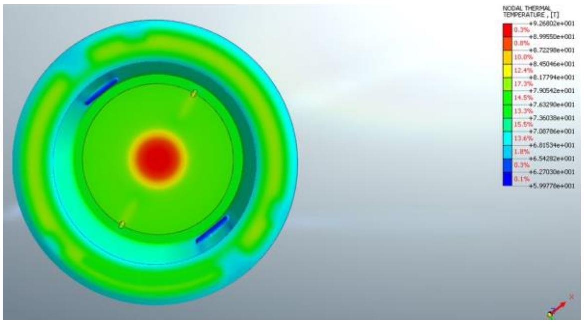

Fig.3. Heat Flow Simulation of PC
(Inside Module)

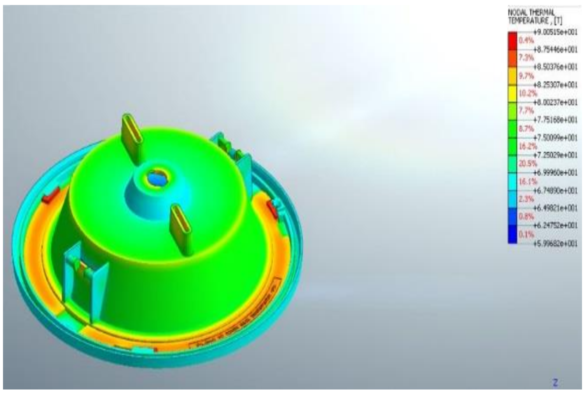

Fig.4. Heat Flow Simulation of PC
(Outside Module)

Figure 5 and Figure 6 showed the thermal flow simulation result of Al.

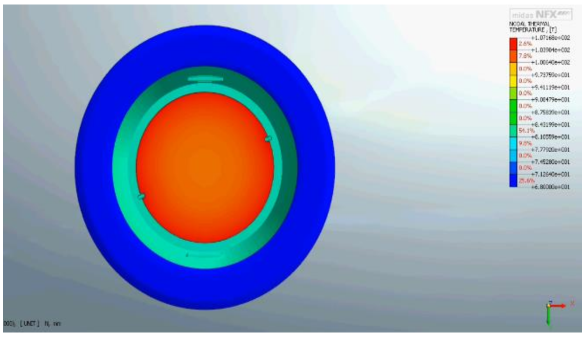

Fig.5. Heat Flow Simulation of Al (Inside Module)

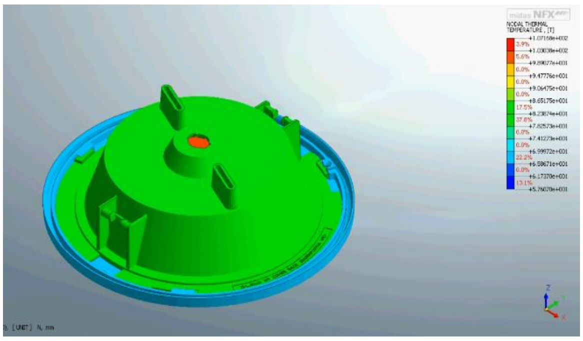

Fig.6. Heat Flow Simulation of Al
(Outside Module)

Figure 7 and Figure 8 showed the thermal flow simulation result of Al.

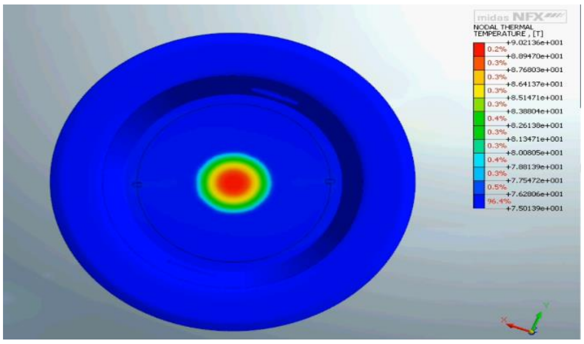

Fig.7. Heat Flow Simulation of New Al
(Inside Module)

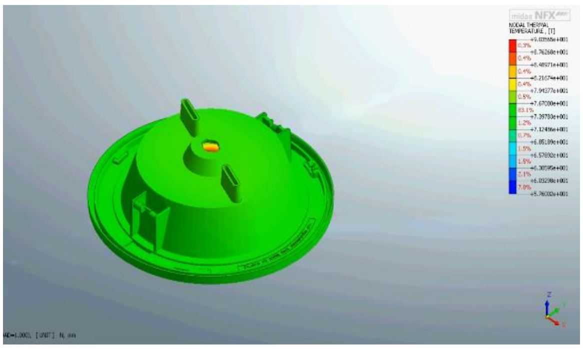

Fig.8. Heat Flow Simulation of New Al
(Outside Module)

Figure 9 and Figure 10 showed the thermal flow simulation result of Al.

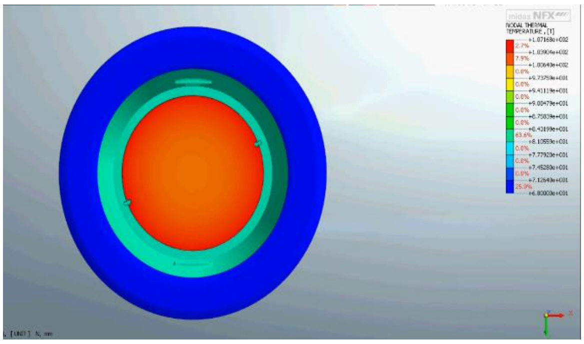

Fig.9. Heat Flow Simulation of Cu
(Inside Module)

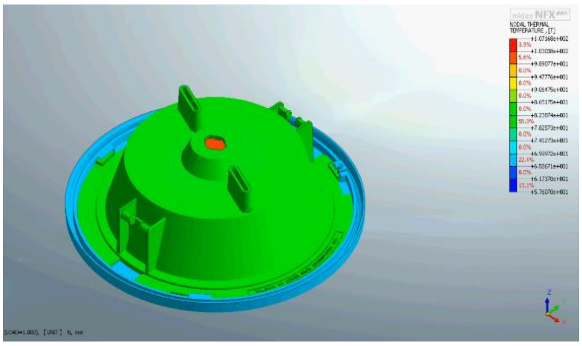

Fig.10. Heat Flow Simulation of Cu
(Outside Module)

III. Results and Discussion

The result of heat flow simulation shown on Figure 11 and Figure 12. As shown on Figure 11, New Al showed lowest values of average and minimum temperature when considering inside case.

In Figure 12, the result of surface heat flow simulation showed that New Al has the lowest value of Max Temperature, but PC showed lowest value.

Overall, when considering inside of the LED module case New Al could be the best material, however, for the outside of LED module case, PC has the lowest value of average. Since New Al and PC present almost the same temperature, best choice would be the material, which has the low price.

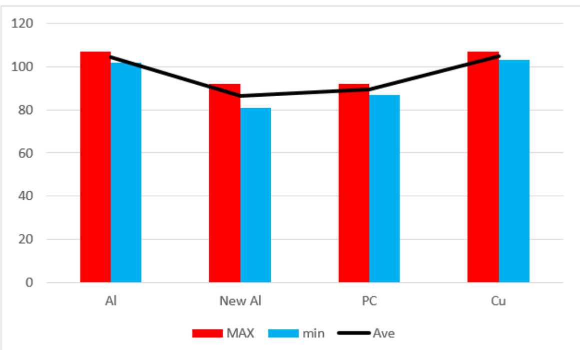

Fig. 11. Result of Heat Flow Simulation
(Inside of Case)

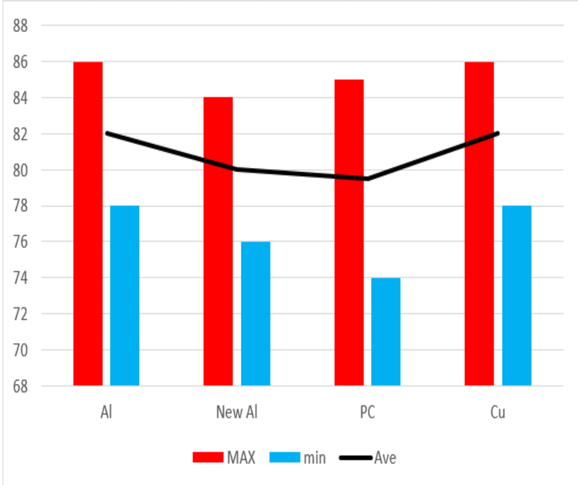

Fig. 12. Result of Heat Flow Simulation
(Outside of Case)

IV. Conclusions

Is this research, several tasks has been done. First, LED module case was designed without heat sink. Second, LED module case prototype was made of PC and compared with heat simulation. Third, four materials of heat simulation implemented to find the best material for LED module case without heat sink.

Prototype, which is made of PC, has the almost the same temperature with heat simulation result of inside and outside of LED module case. Therefore, measuring with real prototype and heat simulation has the same result. Heat simulation is one of the reliable methodology to measure the thermal radiation value.

When comparing with four materials of outside LED module case, PC presents the lowest MIN temperature, New Al showed the lowest MAX temperature and lowest average temperature is also PC.

As for the inside of LED module case, New Al has the lowest average value and New Al and PC presents almost the same of min and max value of temperature.

The experiment results propose that PC is the one of the considerable heat radiation material for the inside LED module. But results of temperature of inside and outside could not satisfied with the standard. One of the reason is this LED module case does not have a heat sink.

In the future research, several approaches is considerable. Redesigning LED module case with heat sink could be the one of the approach. Second approach is finding a new material that could lower the temperature of LED module case.

Since this LED module case has no heat sink to reduce the manufacturing cost and to improve the ability of radiation. One of the known method to lower the temperature is laser sintering adhesive technology. In the previous research showed that laser sintering adhesive technology showed the most efficient, when comparing with the other method.

As for the material, there were many researches has been done. But for our project, the most important factor is the price. Find a cheap and efficient material will be the key factor of this research.

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