

MULTICOLOR LED LIGHTING APPARATUS FABRICATED TO DEMONSTRATE METAMERISM

Takashi Nakagawa^{1*}

(Fukuoka Institute of Technology, Wajirohigashi 3-30-1, Higashi-ku, Fukuoka)

¹ *Department of Information and Systems Engineering,*

Faculty of Information Engineering, Fukuoka Institute of Technology, Japan.

*Corresponding author: Takashi Nakagawa,
e-mail: nakagawa@fit.ac.jp

Keywords: LED: lighting apparatus: metamerism

ABSTRACT

Metamerism is a phenomenon in which colors of two objects appear the same under a lighting condition while they appear different under another lighting condition. Since metamerism have caused troubles among manufacturers and consumers, it is desirable to develop lighting apparatus to produce various lighting conditions. The author reports that we can make such lighting apparatuses using LEDs. An easy way is to use power LEDs which are provided in packages easy to handle. However, they are not always sufficient due to inadequate color variety. More satisfactory apparatuses can be made using deep red, red, amber, green, cyan, blue, and purple (royal blue) chip LEDs. However, chip LEDs need to be handled with care. The author shows jigs and ways to fabricate lighting apparatus with chip LEDs, and demonstrates amazing metamerism.

INTRODUCTION

Performance of LED lighting apparatus depends on the assortment of LED colors. However, wavelength ranges of available LEDs are restricted to those of mass production. Recently, power LEDs of various colors are available in chips. So, the author fabricated multicolor lighting apparatus with chip LEDs. Fabrication with chip LEDs was a tough challenge; chip LEDs are so small that tweezers were necessary to manipulate under a magnifying glass. Another difficulty was due to the fact that chip LEDs were weak to heat; they had to be soldered with temperature under 300 degree centigrade. This paper will show how to make lighting apparatus with chip LEDs.

CHIP LEDS

The lighting apparatuses were made with Philips LUXEON Rebel chip LEDs: deep red ($\lambda_D = 655\text{nm}$ at 350mA), red ($\lambda_D = 627\text{nm}$), red orange ($\lambda_D = 617\text{nm}$), amber ($\lambda_D = 590\text{nm}$), green ($\lambda_D = 530\text{nm}$), cyan ($\lambda_D = 505\text{nm}$), blue ($\lambda_D = 470\text{nm}$), and royal blue ($\lambda_D = 448\text{nm}$). Figure 1 shows their package outline. Light is emitted through the dome lens on the top surface. There are a thermal pad and two electrical contact pads on the bottom surface.

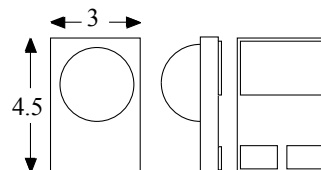


Figure 1. Package outline.

ELECTRONIC CIRCUIT

Figure 2 shows the LED lighting circuit. Power source voltage is 4.8V for a portable apparatus using nickel-hydrogen cells, and 5V for a desktop apparatus using an AC adapter. Current of each LED is around 100mA. Each resistors are 22 Ohms. To obtain adequate brightness, two LEDs are used for each color.

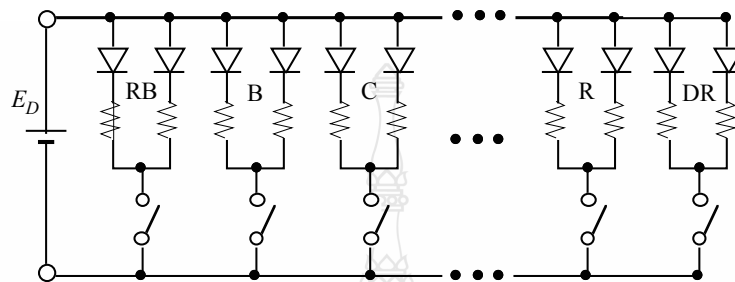


Figure 2. LED lighting circuit.

SOLDERING THERMAL PADS

Solder the thermal pads of chips to the copper radiation plate in the following procedure.

- (1) Cover an end of copper radiation plate with solder on a temperature-controlled hot plate.
- (2) Put a piece of double-sided adhesive tape on an end of paper card of the same thickness as the radiation plate.
- (3) Stick electrical connecting pads of LED chips to the adhesive tape on the paper card so the thermal pads overhang.
- (4) Stick all LED chips as above in line.
- (5) Place the paper card with LED chips next to the radiation plate on the cooled hot plate so that the thermal pad of each chip is on the soldered radiation plate as shown in Figure 3.
- (6) Switch on the hot plate so the solder on the radiation copper plate reflows and thermal pads of LED chips are soldered to the radiation plate.
- (7) Switch off the hot plate as soon as the solder reflows and chip soldering is completed.

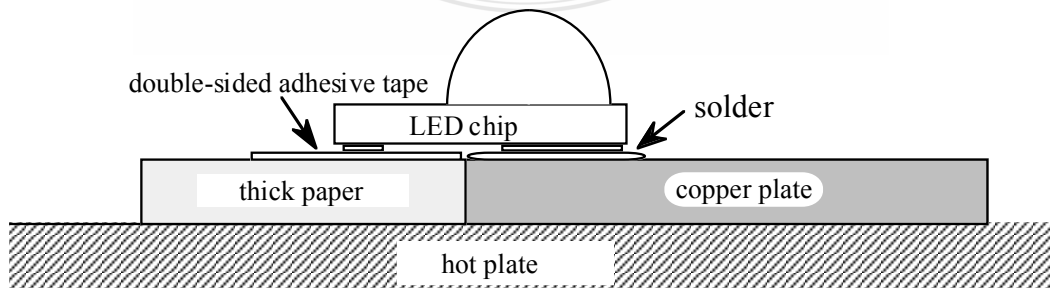


Figure 3. Soldering thermal pads of LED chips on the radiation pad.

(8) After the thermal pad soldering, LED chips are tightly fixed to the radiation plate. So, detach the paper card from the chips.

SOLDERING ELECTRICAL CONNECTING PADS

To solder electrical connecting pads of chips, temperature-controlled soldering iron is necessary. Since the chips are cooled by the radiation plate, the temperature of soldering iron can be set around 320 degree centigrade. Figure 4 shows LED chips soldered to a radiation plate. The radiation plate has been bended round so the light is focused at the distance around 30cm. The radiation plate has been attached to an aluminum plate on which resistors has been glued and wired.

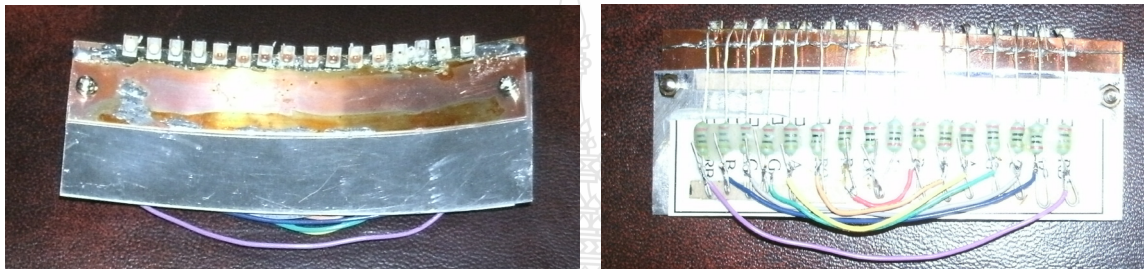


Figure 4. LED chips soldered to the radiation plate.

SAMPLES OF APPARATUS

Figure 5 shows a portable type apparatus (left) and a desktop type apparatus (right). The portable type apparatus is equipped with four battery cases each of which contains four size AA batteries.

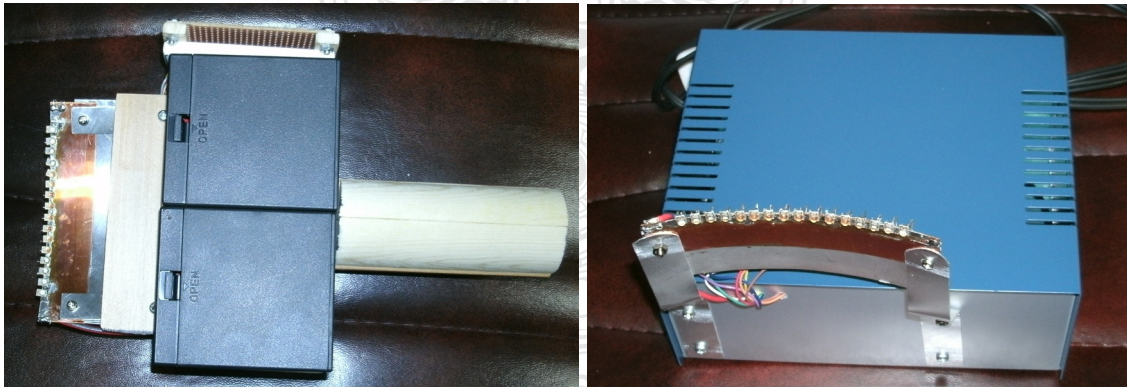


Figure 5. A portable type (left) and a desktop type (right) apparatuses.

PERFORMANCE

With 8 color LEDs, the apparatuses show satisfactory performance. For a brown pair and a green pair of metamerism cards, we can observe metamerism match and metamerism failure.

CONCLUSION

Using chip LEDs of various colors, we can make lighting apparatus with sufficient performance to demonstrate color metamerism.