International Journal of Research and Review
Vol.9; Issue: 4; April 2022
Website: www.ijrrjournal.com
Research Paper *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

The Manufacturing of Tri-Chromatic White LED for LED Desk Lamp

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DOI: https://doi.org/10.52403/ijrr.20220454

ABSTRACT

The pollution of the environment and demand for energy are more and more serious because of the speedy development in scientific technology. The new scientific technology of economizing energy and environmental protection is everyone's striving goal. Solid-state lighting source, such as white-light LED, is a light source component which accords with this goal.

White light can be produced by mixing differently colored light, the most common method is to use red, green and blue (RGB). Hence the method is called multi-colored white LEDs (sometimes referred to as RGB LEDs).

This paper uses tri-chromatic white LED of RGB system to produce LED desk lamp. This paper also investigates different kinds RGB LED quantity and arrangement to find the optimal combination of white-light LED. Finally, we do not only use constant-voltage IC circuits to provide the LED brightness consistency and achieve approximate the white-light consistency, bust also employ the experiments to validate the characteristics of the lamp developed in this paper.

Keywords: White LED, light emitting diode, LED desk lamp tri-chromatic

1. SYSTEM STRUCTURE

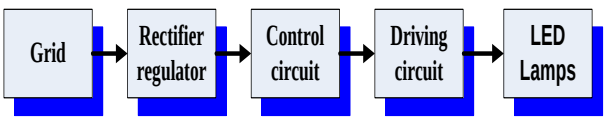

Figure 1: The hardware architecture of this paper

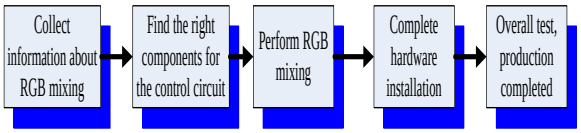

Figure 2: The action flow diagram of this paper

Figure 1 is the schematic diagram of the structure of this paper, first of all, we can supply electricity under normal circumstances, through the rectified grid power, through the control circuit to drive the LED luminaires to emit light, the method flow chart is shown in Figure 2. In this paper, we propose to produce multi-wavelength LED desk lamp to make it more similar to natural light and softer light, and to achieve energy saving and power saving effect.

2. PRACTICAL CIRCUIT ANALYSIS

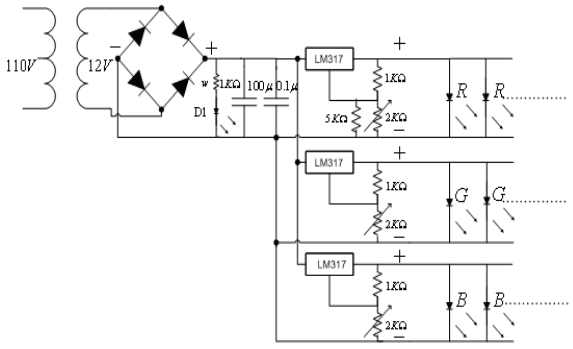

Figure 3: Circuit diagram

In this paper, we designed the 110V under the general household power supply (mains), which can be rectified from Figure 3 to 12V pulsating DC, D1 light-emitting diode for power indicator, 1kΩ for

protection circuit, 100μF for filtering, and 0.1μF for noise filtering. 1kΩ and 2kΩ role for voltage division [1-8].

3. ACTUAL MEASUREMENT DATA OF ELECTRIC CIRCUIT

3.1 LED arrangement combination

The light source part uses high brightness eagle-eye LED lights to make, and then try to mix the white light source with different arrangements. It is important to emphasize that it is not the combination of red LEDs, green LEDs, and blue LEDs with the same number of pieces that makes the module closest to the white light source. We use LED arrangement group a total of 20 kinds of arrangement combinations, the arrangement combination is described as follows.

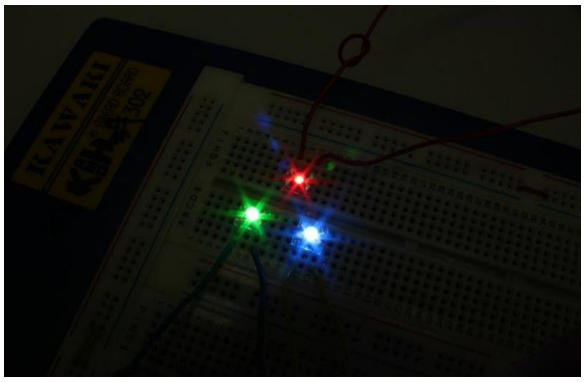

Figure 4: One red, one green and one blue arrangement

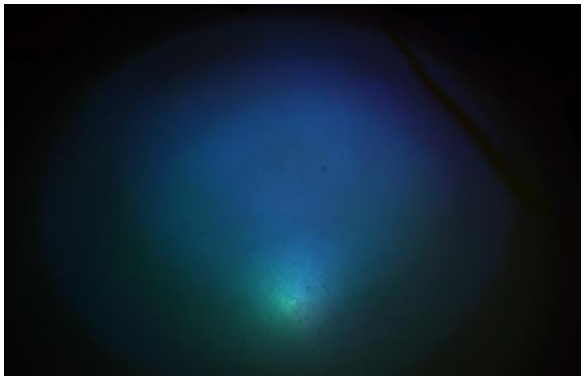

Figure 5: The result of mixing light - blue light with green aperture outside

(1) one red, one green and one blue combination, (2) one red, two green and one blue combination, (3) three red, four green and one blue combination, (4) two red, two green and two blue combinations, (5) one red, one green and one blue combination, (6) one red, one green and one blue combination, (5) Two red, two green, two blue combinations (different arrangement from (4)), (6) Four red, four green, two blue, (7) Four red, one green, one blue, (8) Four red, four green, four blue, (9) Four red, two green, four blue, (10) Two red, two green, two blue, (11) Two red, two green, two blue (different arrangement from (10)), (12) Two red, two green, two blue (different arrangement from (10), (11)), (13) Four red, six green two blue, (14) five red, eight green, three blue, (15) eight red, six green, three blue, (16) eight red, three green, six blue, (17) three red, six green, eight blue, (18) six red, three green, eight blue, (19) six red, eight green, three blue, and (20) three red, eight green, six blue. We only take the arrangement of (1), (4), (5), (18) and (19) as an example, and the situation after mixing light is shown in Fig. 4 to Fig. 13. The result of mixing light decided to use the arrangement module in Figure 12 as the light source part of the LED lamp.

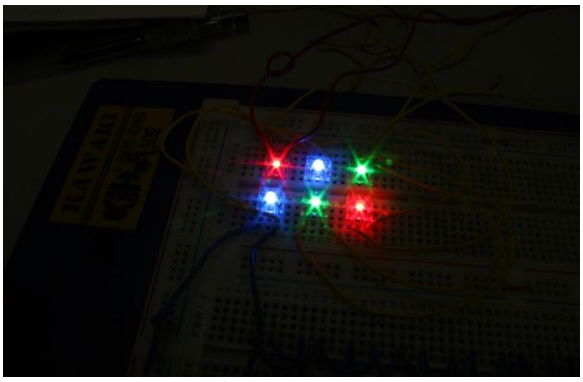

Figure 6: The result of mixing light - blue light with green aperture outside

Figure 7: The result after mixing light - blue with purple

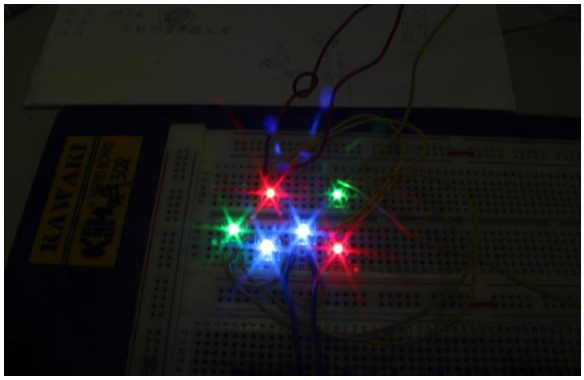

Figure 8: Two red, two green, two blue arrangement method

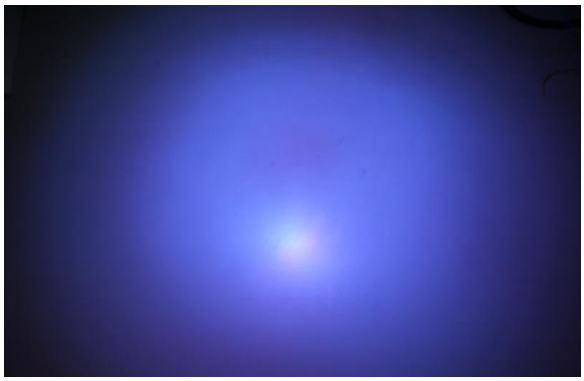

Figure 9: The result after mixing light - bluish

Figure 10: Six red, three green, eight blue arrangement method

Figure 11: The result after mixing light - tend to white light bluish

Figure 12: Six red, eight green, three blue arrangement method

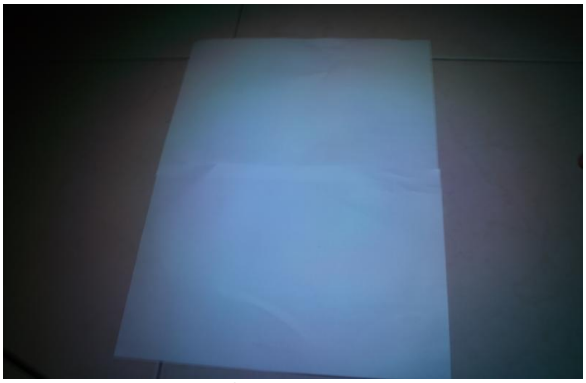

Figure 13: The result after mixing light - tend to white light

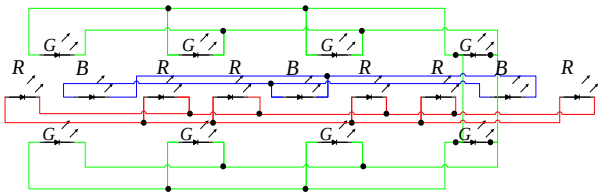

Figure 14: Color differentiated LED arrangement single module circuit

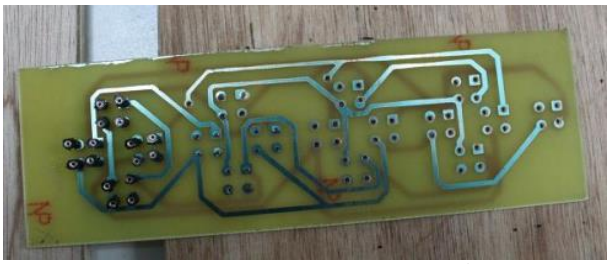

Figure 15: Printed circuit board parts surface

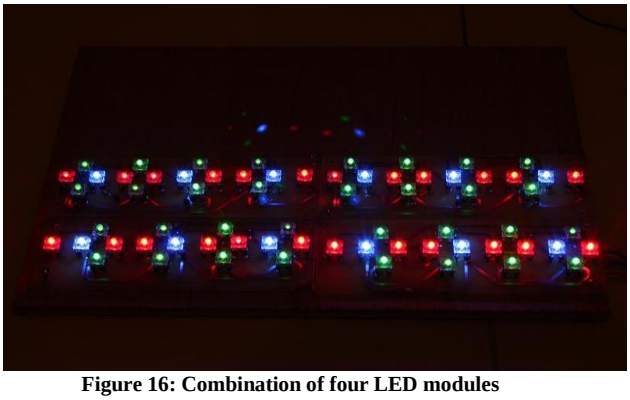

Figure 16: Combination of four LED modules

A single module circuit with color-separated LEDs is created as shown in Figure 14. It is etched to make the printed circuit board in the desk lamp mounting part, as shown in Figure 15. The LEDs will not be overheated and can be easily replaced by using the pin header(PH) connectors to raise the LEDs. The brightness of one LED module for the desk lamp is not enough, as shown in Figure 16. The lamp shade made by expanding one lamp source module into four groups on the board, plus the circuitry, is shown in Figure 17. The finished product is shown in Figure 18, and can be completed using the finger switches in the figure can achieve red, green, blue, yellow, purple, cyan blue, white color lighting.

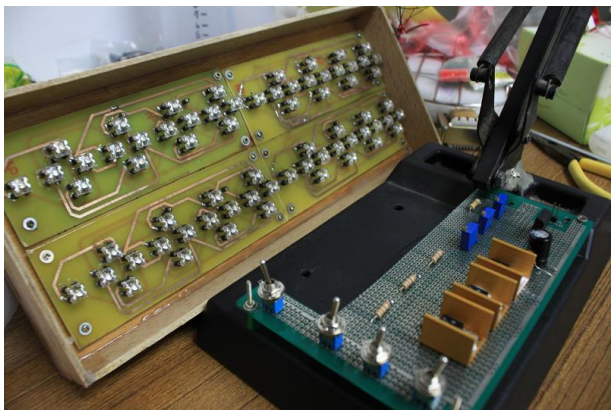

Figure 17: The finished product

Figure 18: Lampshade and circuit part

3.2 Actual measured illuminance and measured power consumption data

The finished LED desk lamp illuminance measurements are shown in Table 2. In order to meet the operation of the necessary vision and reduce the phenomenon of eye fatigue to set the value of illumination, known as the illumination requirements. The illumination value of the reading place should be 750~1000lux according to the standard illumination. As can be seen from Table 2, the illumination value of the distance between 25cm and 35cm is almost between 700 and 1200, so the middle distance can be used as a general desk lamp. The actual measured power consumption data are shown in Table 3 and Table 4.

Table 2: LED Illuminance

Colors	White light (tri-color mixed light)	Red Light	Green Light	Blue Light
Illumination Distance cm	lux	lux	lux	lux
25	1208	227.7	760	35.83
30	924	192.0	608	30.11
35	706	155.5	462	23.27
40	617	139.1	406	21.98
45	490	111.1	326.8	17.58

Table 3: LM317 driver circuit plus LED power consumption

Circuit	Voltage(V)	Current(A)	Power(W)
Red light part	4.92	0.29	1.4268
Green light part	4.92	0.45	2.214
Blue light part	4.92	0.22	1.0824
Driver circuit with all LEDs	4.92	0.96	4.7232

Table 4: LED actual power consumption

LED	Voltage (V)	Current (A)	Power (W)
Red light	2.08	0.28	0.5824
Green light	3.15	0.41	1.2915
Blue light	3.07	0.21	0.6447
Total power consumption			2.7886

3.3 Actual measurement of spectral data

In this paper, the spectral measurements were performed using the EPP2000 spectrometer from Chuanshu Optoelectronics, and the measurement schematic is shown in Figure 19. For color analysis of light-emitting diodes, an Integrating Sphere or Cosine Receptor is

used to receive light and enter the spectrometer host through the optical fiber for color analysis.

From the white light waveform can be seen, although R, G, B mixed light, the visual presentation of white light, but the actual measurement of the instrument, is produced by the R, G, B three colors stacked on top of each other.

It can also be proved that in the process of stacking, light will not change the original wavelength, but in the process of stacking can increase the intensity of light, resulting in the naked eye to see white light, but in the instrument is still R, G, B respective wavelengths. Its mixed white light spectrum is shown in Figure 22 to Figure 24, and its wavelengths are described in Table 4.

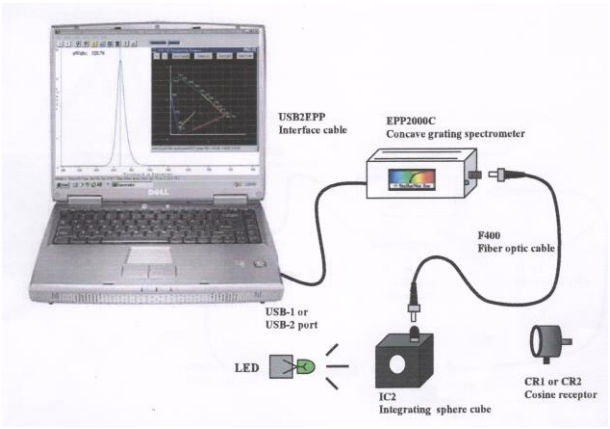

Figure 19: Schematic diagram of the spectrometer measurement

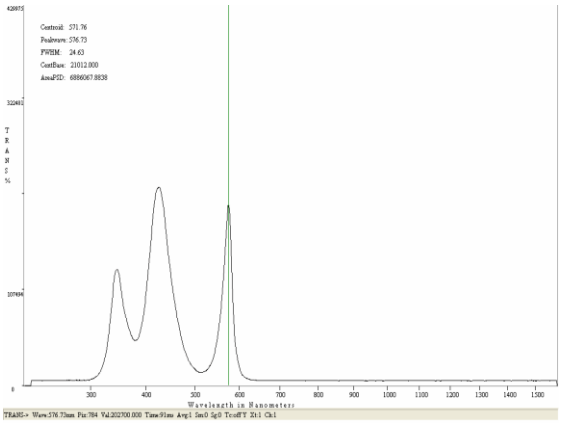

Figure 20: Spectrum of mixed white light - red light part

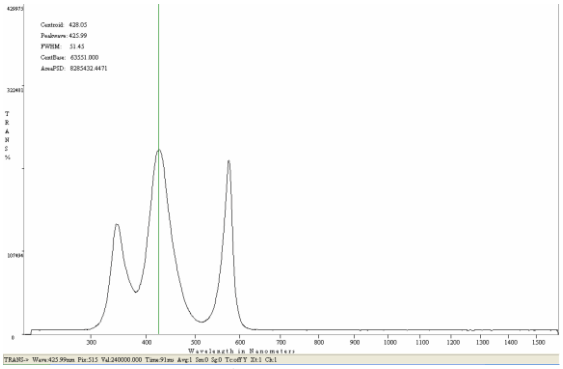

Figure 21: Spectrum of mixed white light - green light part

Table 4 White light spectrum of mixed light

	White light (unit: nanometer)		
	Figure 20	Figure 21	Figure 22
Wavelength	576.73	425.99	347.92
Half-wavelength	24.63	51.45	35.86

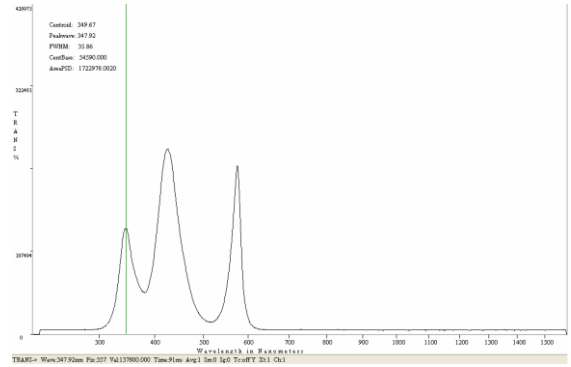

Figure 22: Spectrum of mixed white light - blue light part

4.CONCLUSION

Within the scheduled time, we have completed the LED desk lamp that can achieve seven different color light changes, such as red, green, blue, yellow, purple, cyan blue and white, and the mixed light effect of RGB three color LEDs is also very obvious. Especially the white light effect is also similar to the market deske lamps. The part that is more unfortunate is that the RGB primary colors are used to arrange and mix the light, so when an object passes under the light source, the object will change the effect of the original three primary colors mixed with the light projected down. This leads to the visual overlap of colors, which affects the white light mixing effect projected by the desk lamp at the beginning. This is the goal of the future improvement of this paper.

ACKNOWLEDGMENTS

The authors would like to acknowledge Mr. M.C. Chure, and Mr. Jin-Kun Wu who constructed much of the hardware for the experimental system.

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How to cite this article: Wen-Bin Lin, Kao-Feng Yarn. The manufacturing of tri-chromatic white LED for LED desk lamp. *International Journal of Research and Review*. 2022; 9(4): 435-440. DOI: *https://doi.org/10.52403/ijrr.20220454*

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