IMPRESSION OF THE SPACE UNDER THE FLAT TYPE LIGHTING –COMPARISON BETWEEN OLED AND LED-

Ryoichi Yokoyama[1]*, Yuki Kawashima[1], Takehiro Nagai[1], Taiichiro Ishida[2], Yasuki Yamauchi[1]

[1] *Graduate School of Science and Engineering, Yamagata University, Japan.*
4-3-16 Jonan, Yonezawa, Yamagata, 992-8510 Japan

[2] *Graduate School of Engineering, Kyoto University, Japan.*
Kyotodaigaku-Katsura, Nishikyo-ku, Kyoto, 615-8540, Japan.

Ryoichi Yokoyama, (Phone/Fax) +81-238-26-3346, tky90178@st.yamagata-u.ac.jp

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ABSTRACT

Organic electroluminescent lighting (OLED) is expected to become one of the next generation lighting devices. In this research, we investigated the impression of a space illuminated by either flat-type LED lighting panels or OLED panels by changing the area of the illumination. The experiment was conducted with a small box in which miniature furniture was placed. Subjects rated the impression of the room for 20 adjective items in five steps while observing the model of the living room. From the results of the rated values, we found that the space illuminated by the surface-emitting type illumination will increase the impression of “brightness” and “uniformity” as the area of illumination increases. Moreover, OLED lighting was found superior in many items, such as "warm" and "soft". From the results of factor analysis, several factors were extracted, such as “amenity”, “activeness”, and “personality”.

INTRODUCTION

In recent years, Organic Electro-Luminescence (OLED) lighting has been attracting attention as a next-generation illuminant. This type of lighting has several important features including a wide range of illumination, thickness, and flexibility. The researches dealing with OLED in practical use, however, have just started and it is essential to explore various aspects of OLEDs before it enters the market. One of the biggest differences between OLED and other lighting devices is that OLED is a surface-emitting light source. When installed as a ceiling light, it is possible to place many OLED panels right next to each other to occupy a large area of a ceiling. Compared with conventional point or line light sources such as incandescent and fluorescent lamps, the setting of area light sources can cast shadows of the objects in a completely different way. As a result, OLED may mediate a different impression of the space. The purpose of this research is to find the effects of the relative ratio of the light source to the ceiling on the impression of the space under its illumination. Moreover, a flat-panel type LED lighting panel, which looks similar to an OLED panel, has recently entered the market. In order to find the differences in LED and OLED under a similar way of lighting, we repeated the same experiments for both light sources to find any potential effects of the light source on the impression of a space.

EXPERIMENT

The experiment was conducted with two small boxes, whose size was 300mm × 310mm × 110mm. One was illuminated with OLEDs while the other with flat-panel type LEDs which had the same chromaticities. In order to mimic a living room, we set several pieces of miniature model furniture inside them: a dining set composed of a table and chairs were placed in the center, a TV was placed to the left, and a sofa was placed to the right. Two different combinations of the panels (OLED manufactured by Lumiotec and a prototype custom-made RGBLED, and LED manufactured by Epoch and RGBOLED manufactured by Pioneer) were installed as a light source at the top of each booth. Chromaticities of the panels are shown in Figure 1. In all rooms, the area of the light was limited either by the number of panels or by a slit. The size of the slit was 40mm × 220mm, which allowed approximately 10% of the ceiling to be occupied. The experiment was also performed without a slit, where the room was illuminated with two panels (50%) or four panels (100%). Schematic locations of the light sources and the views of the room are shown in Figure 2. The illuminance of the center of the box was 480lx for all the slit conditions. The subjects were asked to evaluate the impression of the room for 20 Japanese adjectives, which are shown in Table 1, with a scale of 1 to 5 depending on their impression [1]. Subjects observed the room inside the box for 3 minutes to adapt to its illumination before starting a session. 9 subjects (6 male subjects and 3 female subjects) served in this experiment. 5 of them tested under all conditions, while the remaining 4 tested under only the 100% condition. All of the subjects were tested for either 2 or 3 sessions for each experimental condition.

Table 1: 20 adjectives

calm	cheerful	gentle
relaxing	bright	unique
natural	lively	spacious
warm	large	vivid
relief	interesting	showy
soft	uniform	dazzling
tasteful	premium	

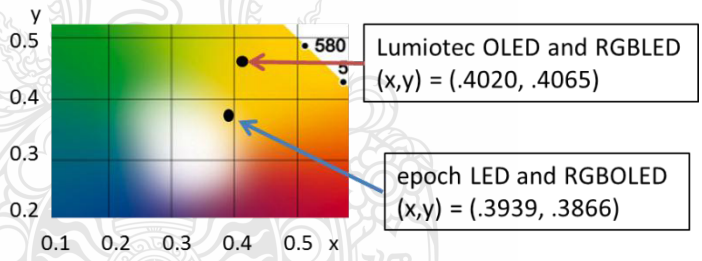

Figure 1. Chromaticities of each lighting source

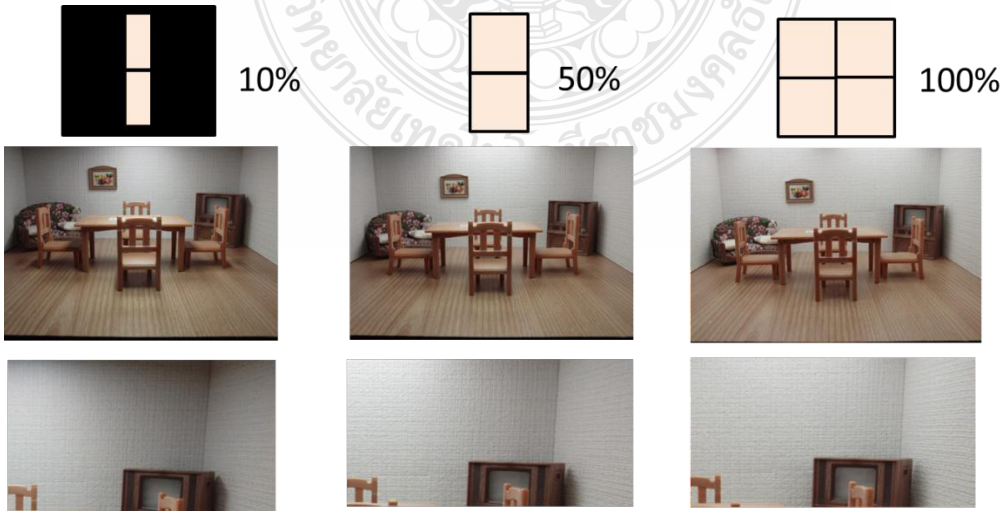

Figure 2. Light emission areas (10%, 50%, 100%)

RESULT & DISCUSSION

Figure 3 shows some typical results which showed significant differences between OLED and LED lights. Items whose evaluation values obtained with OLED were higher than those with RGBLED were: "warm", "soft" and “tasteful”. Items whose evaluation value obtained with RGBLED were higher than those with OLED were: "lively", “bright” and “cheerful”. Items whose evaluation value obtained with RGBOLED were higher than those with LED was "tasteful", “premium” and “vivid”. None of the items whose evaluation value obtained with LED were higher than those with RGBOLED.

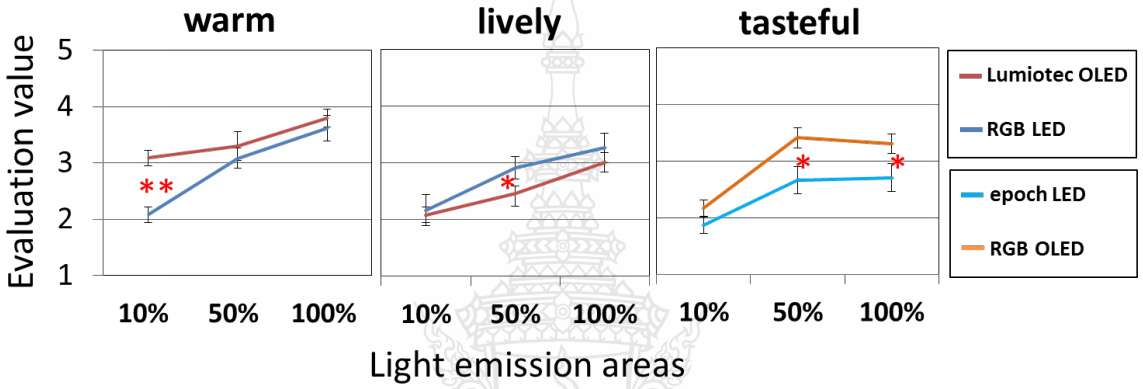

Figure 3. Evaluation items with different evaluation values between OLED and LED

In order to find if there is a correlation between the evaluation score and the light emission areas, linear fittings were conducted to all the estimated values. We averaged the evaluation values across all 9 subjects. The slopes of the fitted line and the R^2 were calculated. Figure 4 shows some typical examples which showed a good correlation between the evaluation value and the width of the slit. The items whose evaluation value increased with the width of the slit were "bright" and "uniform". In all light sources, their slope is greater than 0.7 with R^2 greater than 0.8, which means they can be well-fitted with a linear fitting. Items that showed no correlation with the width of the slit, with a slope of around 0, were “personalized", "interesting” and “calm”.

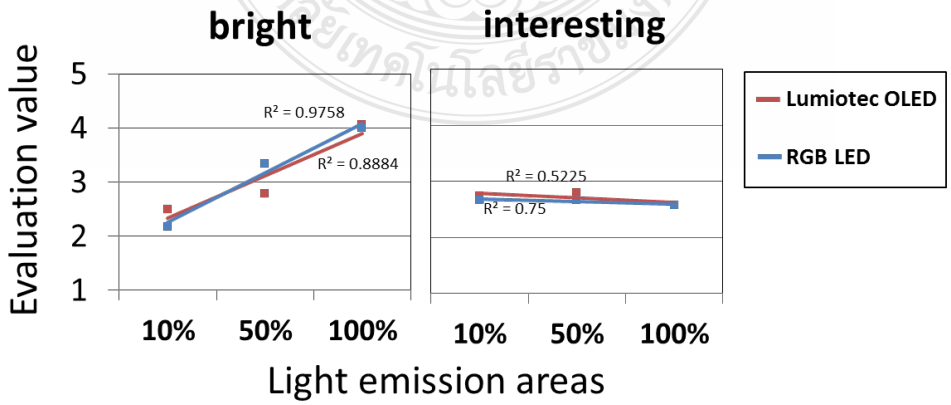

Figure 4. Evaluation values as functions of light emission areas

Factor analysis was performed using the factor extraction method of maximum-likelihood estimation. Factors for three high ranks were adopted. The rotation of factor axes using the Varimax method made it easier to extract factors. The cumulative contribution ratio of the first and second factors is 45.3%. We named the first factor as "**activeness**", derived from the amount of the factor loadings such as "lively" and "bright". The second factor was named as "**amenity**", derived from the factor loadings such as "warm", "gentle" and "relax". The third was named as "**personality**". Naming of these factors was derived from studies of a number of semantic differential scale methods. We derived a factor score by multiplying the evaluated values. We used this value to clarify the relationship of each factor and light emission areas, illustrated in Figure 5. The first factor (activeness) increases as the light emission area increases and is closely related to the lighted area of the ceiling. It is interesting that the values obtained from LED are higher than those of OLED for several emission area conditions. We need to clarify why this is the case, but it seems that the light from the LEDs gives the subjects a greater impression of "bright" and "lively", which is the opposite of the impression of OLEDs. The second factor (amenity) obtained from OLEDs is higher than that of LEDs for all emission area conditions. We think that these factors can be mediated from the characteristics of OLEDs themselves (its mild impression and lack of short wavelength).

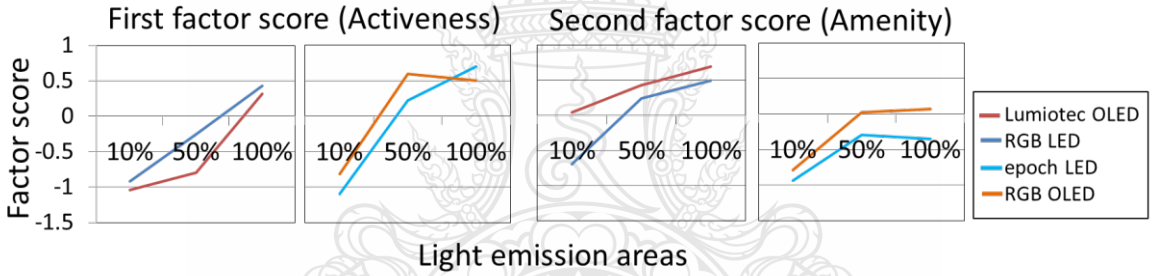

Figure 5. Factor scores

CONCLUSION

We have conducted an experiment to evaluate the impression of space illuminated by OLED lighting and by flat type LED lighting. From the results of the evaluation, we found that the impression of brightness and uniformity increased with the area of the illumination on the ceiling. Moreover, OLED lighting was observed to be superior in many impression items, such as "warm" and "gentle". From the results of factor analysis, we extracted three factors of "amenity", "activeness" and "personality". The amenity factor measured from OLEDs is higher than that of LED for all emission area conditions.

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