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Overview of Light Decay Due to Environmental Effects for Light Emitting Diode

Debashis Raul[1*], Payel Bhattacharya[2] and Kamalika Ghosh[3]

[1]*School of Illumination Science, Engineering and Design, Jadavpur University, India*
[2] *School of Illumination Science, Engineering and Design, Jadavpur University, India*
[3]*School of Illumination Science, Engineering and Design, Jadavpur University, India*

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***Abstract*—** Now a day's LEDS have also been used in outdoor illumination due to their low power consumption and high life as compared with conventional lighting solutions. These LEDs may be operated in an environment with high humidity and high temperature. All these environmental effects may lead to increase the light decay and end of the result leads to lamps failure. In this paper, Surface Mounted (SMD) and Chip on board (COB) type LEDs were studied by high humidity and high temperature in the environment test chamber to find their light decaying behavior. Another aging test would be established by using rapid life cycle switching mechanisms. It is found that environmental effects as well as rapid switching are the serious causes for lumen decay of these LEDs.

***Keywords*—**Aging; Illuminance; Life cycle; Optical decay; Relative humidity

I. INTRODUCTION

Light is a very much essential components of civilized society. The present era of lamps are usually based on Gas Discharge Technology [1]. In future Light Emitting Diode (LED) is expected to be replaced these lamps as well as Incandescent Lamps [2]. A LED is a p–n junction diode, which emits light when a suitable voltage is applied to the leads, electrons are able to recombine with electron holes within the device, releasing energy in the form of photons [3]. This effect is called electroluminescence, and the color of the light (corresponding to the energy of the photon) is determined by the energy band gap of the semiconductor [4]. A LED is often small in area and integrated optical components may be used to shape its radiation pattern. With the development of high-efficiency and high-power LEDs, it has become possible to use LEDs as commercial light source for general illumination purpose. Now, LEDs have wide application in aviation lighting, projectors, Backlight LED television, Laptop display, mobile etc. Modern LEDs are available across the visible, ultraviolet, and infrared wavelengths, with very high brightness. LEDs are very often used for street lighting, as well as architectural lighting purpose. Henceforth the expectation of High efficacy as well as high life, the LED lights are penetrating all over world even Indian market in a very fast pace. At present LEDs are available in different technologies which may be need for various applications. As per technology goes LED has several option depending upon age, its expected light output as well as place of application, such as DIP(Dual In Package), SMD(Surface Mounted Device), COB(Chip On Board) etc. Due to its high initial cost comparing to conventional lamps with Gas discharge technology to LED light has one of the drawback of its high initial investment. Even then there is report of failure of LEDs [5]. But considering its high cost with environmental and thermal constraints reframing the customer from its future investment [6]. Thus viability of implementation of LED is at stake. Thus through this study the objective is to find out the causes of failure of this high potential technology in lighting field. By performing different types of experiments with various types of LED of same make, it is expected to draw an idea about the behavior of those similar kinds of LEDs available in the market.

II. EXPERIMENTS OF COB AND SMD TYPE LEDS

A. Experiment setup

The experiment has performed with five types of LED lamps of same make. One Chromameter has used in the experiment for observing light output, CCT (Co-related color temperature) and Chromaticity co-ordinates at a time. An Environment test chamber to different lamps and luminaries have used during study for observing light output decay by environmental effect, this chamber is able to create artificially different atmospheric condition by increasing temperature and humidity inside it. A special type of Lamp Life cycle test system has used in the experiment for life test of different LEDs. Two SMD types 6W both cool and warm white LEDs, two COB types 3W of both cool and warm white LEDs and one 11W warm white LED has used to perform the experiments.

B. Test conditions

First the light outputs are measured by varying its input (AC) voltage when each lamp connected with driver. Light output also taken from the lamps by connecting DC power supply without driver circuit, and data has recorded. Now two groups of different aging test have been performed to the two kinds of LED samples. First both types of SMD and COB type (Cool and warm white) LED were put in the Environment Test chamber and observed their light output change by increasing ambient temperature and relative humidity. Continuous switching of each lamp was performed by lamp life cycle test switching system. Then output of each lamp was observed during 15 hours with a fixed time interval of 1 hour for analyzing the age of a lamp. The measurements were accomplished with lamps in vertical base-up position and kept away 1 meter distance from the Chromameter.

III. RESULT ANALYSIS

A. LED Performance with and without Driver

Both COB 3W warm and cool white LED lamp with constant current drivers, desired illuminance values of lamps were shown almost constant up to 100V, then slowly decay the light output which is shown in Fig. 1. Similarly according to measured data from Table 1, two SMD type lamp ware illuminated almost constant desired rated values up to 80V and after that decaying nature is observed in Fig. 2.

COB and SMD types LEDs also used in experiment for studying its nature while giving direct DC supply without using Driver circuit. By changing 1V input DC voltage the light output of lamps decreased very rapidly which are shown in Fig. 3, Fig. 4 & Fig.5. It can be concluding from this measurement that without driver circuit, desired light output would not give. Since, light output is directly proportional to forward current of LED.

B. Temperature and Relative Humidity effect on LED Performance

It is observed that the light output is slowly decaying by increasing temperature above the ambient temperature. So it can be said from Fig. 6 that COB type LED will be affected in highly summer region. Performance analysis of COB type LED in Environment Test Chamber by varying relative humidity. It is observed that by increasing humidity, light output is slowly decaying in nature which is shown in Fig. 7.

C. Rapid switching decay the LED light output

The illuminance value of each lamp was observed by providing continuous switching to the lamps. The light output decaying is seen very rapidly for COB type LED lamp in shown in Fig. 8. It can be assumed from the experimental data of providing continuous switching of a COB type warm white LED, lumen output decay is shown earlier. The light output is quite varying in nature for both SMD type cool and warm white LED Lamp. The optical decay of SMD type are quite slowly which is shown in Fig. 9.

Table 1: Test results of various types of LEDs with driver.

AC input (volt)	Illuminance (Lux)			
	6W SMD Cool	6W SMD Warm	3W COB Cool	3W COB warm
230	174.7	170.5	896	939
220	172.6	168	890.7	933
210	172.1	167.8	886	929
200	172.2	168	882.9	925
190	172.3	168.1	877.4	922
180	172.5	167.9	875	919
170	172.5	167.6	874.6	919
160	172.5	167.2	872.5	919
150	172.6	167.3	872.5	920
140	172.2	167.2	872.5	920
130	171.4	167	873	920
120	171.1	166.7	875	925
110	170.7	166.4	877.2	927
100	177.1	166.1	873.8	923
90	176.7	165.4	866.9	915
80	169.8	158.8	863.3	911
70	156.3	146	842.8	889
60	137.3	128	775.2	816
50	120.8	113.3	0	0

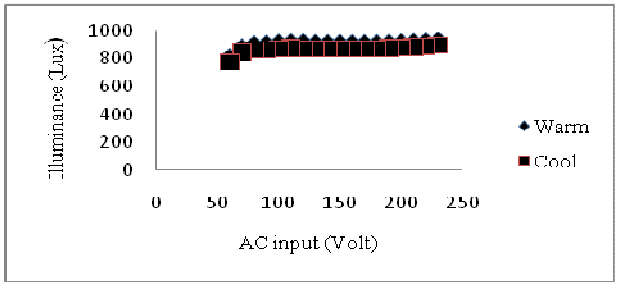

Fig. 1: performance characteristics of 3W COB type LED with Driver

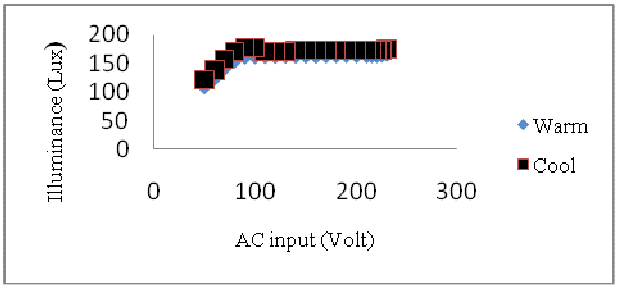

Fig. 2: performance characteristics of 6W SMD type LED with Driver

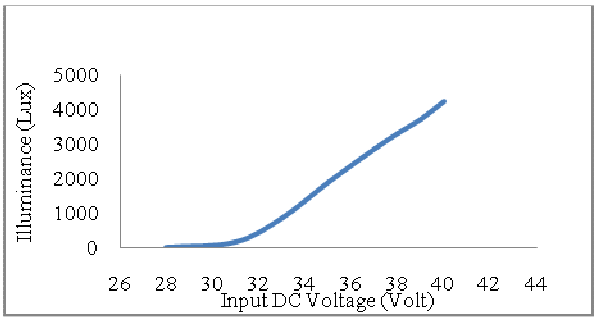

Fig. 3: performance characteristics of 3W COB type warm white LED without Driver

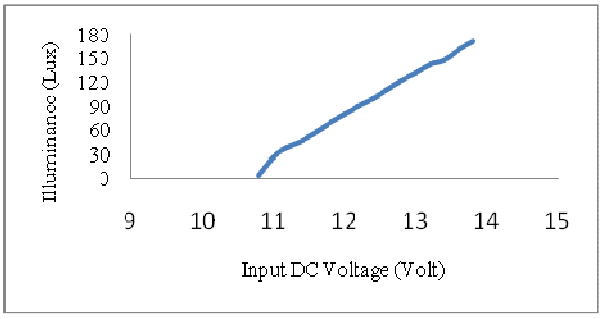

Fig.4: performance characteristics of 6W SMD type cool white LED without Driver

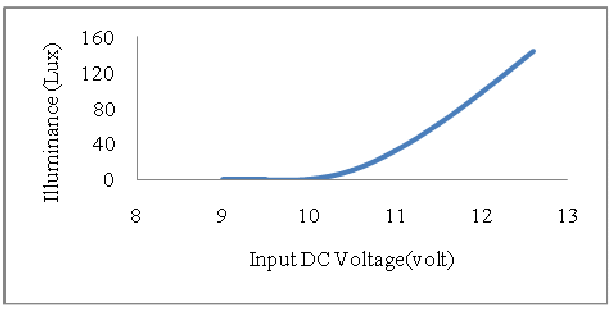

Fig. 5: performance characteristics of 6W SMD type warm white LED without Driver

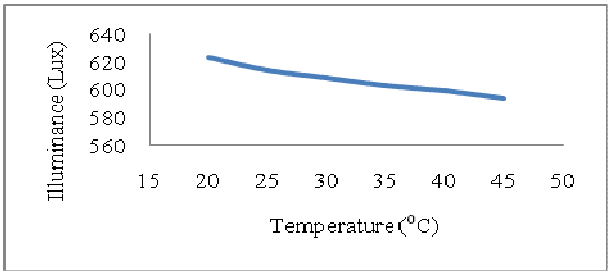

Fig. 6: performance characteristics with Temperature variation for COB type warm white LED

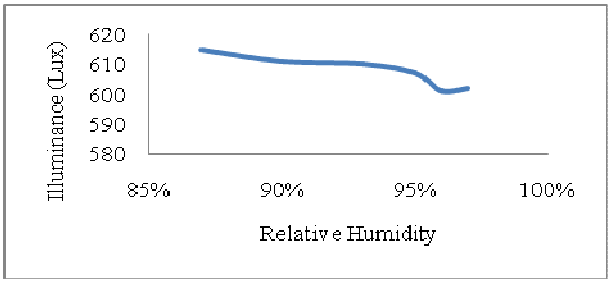

Fig. 7: performance characteristics with Temperature variation for COB type warm white LED

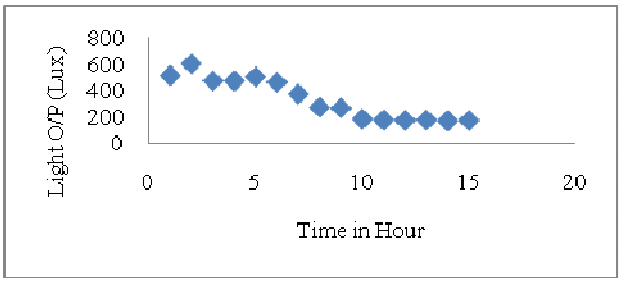

Fig. 8: Life cycle test of COB warm white LED

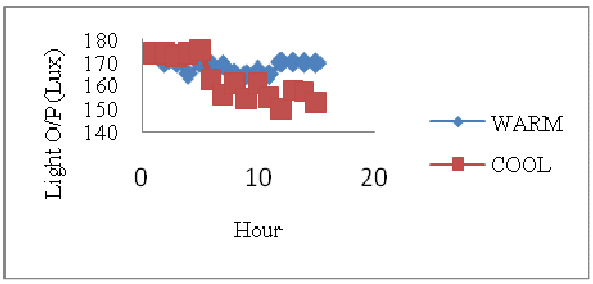

Fig. 9: Life cycle test of SMD cool and warm white LED

IV. CONCLUSION

Several experiments have performed for analyzing nature of light output through same make of SMD and COB type LED. Now a day SMD and COB type LEDs have a number of applications in lighting field. So, it must take a consideration for observing these types of LEDs in various conditions. Since, this is a matter of customer's satisfaction

in a commercial aspect so light output nature in several conditions should be known to all, especially for a manufacturing designer. From this analysis a designer can modify the product based on need of application. Therefore the performance of COB type LED has been observed by providing different environmental effects like increased temperature, increased humidity etc. The LED optical performances have been observed degraded at high temperature. Therefore, in high ambient temperature difference between high latitudes, the designers should be designed a LED lamp with a proper shape, compact structure and a waterproof surface and to ensure the reliability.

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AUTHORS PROFILE

Debashis Raul did his B.Tech. in Electronics & Communication Engineering from Birbhum Institute of Engineering & Technology, Suri. He passed M.E from Jadavpur University in Electrical Engineering (Illumination Engg.). He has four years teaching experiencs as an Assistant Professor at Camellia Institute of Engg. & Technology. At present he is Guest Faculty and Senior Research Fellow (SRF) at School of Illumination Science, Engineering & Design (SISED), Jadavpur University, Kolkata,India.

Payel Bhattacharya did her B.Tech. from Hooghly Engineering and Technology College in Electrical Engineering Department. She is pursuing (Final Year) in M.TECH in Illumination Technology and Design of Jadavpur University. She has 5 years of Teaching Experience as a Lecturer in several Diploma Engineering Colleges. Now she is engaged with The New Horizons Institute of Technology, Durgapur. She has 2 nos. of papers related to lighting technology. She is Associate Member of ISLE (Indian Society of Lighting Engineers).

Dr. Kamalika Ghosh did her B.E., M.E. and Ph.D. from Jadavpur University, Kolkata. She has 20 years Industrial Experiences. .At present she is a Teaching Faculty as well as Director of School of Illumination, Science, Engineering and Design, Jadavpur University She has about 30 nos. published papers. She is a Life Fellow of Institution of Engineers India and Indian Society of Lighting Engineers.

