VISIBLE LIGHT COMMUNICATION ANALYSIS OF LIGHT EMITTING DIODE SOURCES

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INTRODUCTION

Visible Light Communication (VLC) is gaining an extensive interest in academia and industry. By occupying almost 384 THz bandwidth of electromagnetic spectrum, it can be a complementary telecommunication technology for the current radio networks [1]. The rapid development in Light Emitting Diodes (LEDs) fabrication makes them a good candidate for high-speed data rates transmission. This project examined different types of conventional LEDs available commercially and Micro-LEDs fabricated laboratory. Measurement of electrical modulation bandwidth had been taken for each set of LEDs followed by an analysis of their electrical and optical characteristics. Carrier’s recombination lifetime is the main factor that affects the modulation bandwidth and its related to the LEDs resistivity and configuration.

HISTORY

Visible Light used in communication since 1148 BC by ancient Greeks. Henry J. Round discovered the electroluminescence in 1907 on Carborundum. Since 1960s high bright LEDs being developed followed by invention of white LEDs. Recently, micro-LEDs are being fabricated with the attention to used LEDs in data transmission purpose.

LIGHT EMITTING DIODES

- Set of radial 5mm and 3mm LEDs
- High Power LEDs
  - Blue and White Surface Mount LEDs
- Micro-LEDs
  - 16 x 16 array of 450nm Micro-LEDs range from 5μm to 60μm.

EXPERIMENTAL SETUP

- Modulation bandwidth measurements
  - LED light focused by a lens and aligned to the photodetector.
  - Electrical currents applied by a bias-T coupled with RF signal form a calibrated network analyzer.
  - Frequencies responses recorded from the network analyzer to measure the 6dB modulation bandwidth.
  - Radial LEDs currents range from 10 – 60 mA, High power Blue from 10 – 400 mA, High power white from 10 – 150 mA, micro-LEDs from 10 – 60 mA.
- I-V-L measurements
  - Measure the LED’s voltages and light intensity.
- Electrical currents applied directly to the LED.
- Resistance values derived from I-V slope.
- Spectrum Measurements of White LEDs
  - Spectra of white LEDs measured by spectrometer.
- LED light focused by a lens and aligned to the spectrometer input.

RESULTS

- The relation observed between the injected current, LED surface area, and the frequency response reflects the modulation bandwidth dependency on the current density.
- Radial 3mm LEDs recorded higher bandwidths than the 3mm LEDs of the same set. I-V measurements show that 3mm LEDs have higher resistance values and affect the recombination lifetime. Blue LEDs performed a higher bandwidth up to 34 MHz, while white LEDs recorded the lowest bandwidth that didn’t exceed 1MHz.
- The electrical modulation bandwidth of high power White LED shows a higher value more than 5MHz.
- Micro-LEDs achieved a noticeable high electrical modulation bandwidth that reached values more than 100MHz.

CONCLUSION

Light Emitting Diodes are promising devices to be utilized in VLC. The experience showed the effect of LED’s resistances on their modulation bandwidth. Commercial LEDs with larger areas will have larger capacitance and lower resistance values. Therefore, they have higher modulation bandwidths because of the lower carrier recombination lifetime. Micro-LEDs are fabricated to have lower resistance and area and they reach a very high bandwidth of 100MHz.

The attention of future VLC is to use White LEDs for dual purpose of communication and illumination. However, Phosphor layers on the single-chip white LEDs limits its operations. Therefore, future study on RGB White LEDs in VLC is recommended.

References: