Research Paper

International Journal of Aerospace System Engineering
Vol.1, No.1, pp.44-47 (2014)

ISSN 2383-4986

A Study on Adhesive for High Efficiency LED Light Using Nano Silver

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Abstract : This study proposes a development for the nano silver adhesive, which is applicable to high efficiency LED(light-emitting diode) light. The important issue of LED light is heat exhaust from LED. Generally, the middle area of LED light is increased up to 380K. Therefore, the bottleneck between LED chip and heat sink are caused by high temperature. In this work, the adhesive material between LED Chip and heat sink was newly developed for improvement of bottleneck. The nano silver was adopted to solve heat problem of chip on board package for LED light. In order to evaluate the performance of the nano silver adhesive, the thermal analysis was performed. Moreover both adhesive performance and heat exhaust were verified through the prototype test. From the experimental test results, it is found that the developed nano silver adhesive has the high performance.

Key Words : Nano Silver, LED Light, Heat Sink, Adhesive

1. Introduction

Currently, the important issue to be solved in the high efficiency LED light is to effective heat exhaust from LED. Based on the heat emission, the amount of light and reliability of the LED lightening are decided. In general, in the LED light, the temperature of the heat sink adjacent to the chip goes up to 380 K (107 ℃) with the minimum temperature of 319 K (46 ℃). Most of the heat occurs from the LED chip area, but they tend to not dissipated away through the heat sink, and the bottleneck occurs at this point. For this reason, as the temperature increase by time, so does the intensity of radiation.

In this study, it was developed the new adhesive between the LED chip and the heat sink, which is expected to solve the bottleneck effect occurs in the LED chip. With the use of nano silver, we connected the LED and heat sink in the low temperature to develop the adhesive with higher radiation efficiency than the existing LED lights.

Received: March 27, 2014 Revised: June 19, 2014 Accepted: June 26, 2014
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2. Review on previous studies

Among the previous studies, Rita Faddoul et al. performed the study on inkjet printing of silver nano-suspensions on ceramic substrates-sintering temperature effect on electrical properties [1].

Xin Li et al. performed the study on creep properties of low-temperature sintered nano-silver lap shear joints [2].

Feifei Chen et al. studied investigation on Formation and third-order optical nonlinearities of silver nano-crystals embedded bismuthate glasses [3].

Yipu Kang et al. conducted the study on Surface-enhanced Raman scattering (SERS) spectra of hemoglobin of mouse and rabbit with

self-assembled nano-silver film [4].

M. Hosseinkhani et al. performed the study on simultaneous in situ synthesis of nano silver and wool fiber fineness enhancement using sulphur based reducing agents [5].

Hamid Reza Taghiyari performed the study on Effects of nano-silver and nano-zycosil on mechanical strength of heat, vapor, and dry-ice-treated biscuit and dovetail medium-density fiberboard miter joints [6].

Many studies of nano silver application were performed in an early stage of research. However, little research work has been carried out to apply nano silver for LED light. This study proposes a development for the nano silver adhesive, which is applicable to high efficiency LED light.

3. Development of nano silver adhesive

High efficiency LED structure utilizes the material with low heat conductivity between the LED chip and the heat sink. Fig. 1 shows the existing LED structure. Metal with heat conductive quality has the conductivity of 200 ~ 400 w/m-k, but the adhesive which connects the middle metal and LED chip has the maximum conductivity of 3w/m-k, which is the 1/100 of that. In this study, it was used nano silver to improve the existing adhesive, and connect the LED, conductor, AL PCB and heat sink at the low temperature to develop the product with high radiation efficiency and durability than the existing LED products. The minimum temperature that the chip of the high efficiency LED light endures is 300℃ or under. Therefore, the nano silver which is adhesive under 300℃ was developed Fig. 2 shows the developed LED structure using nano silver.

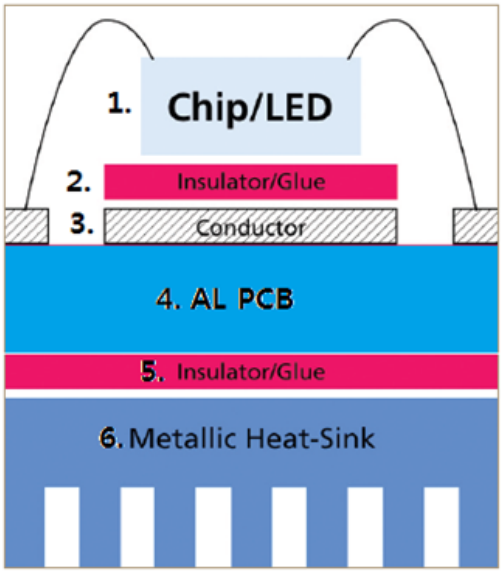

Fig. 1 The existing LED structure

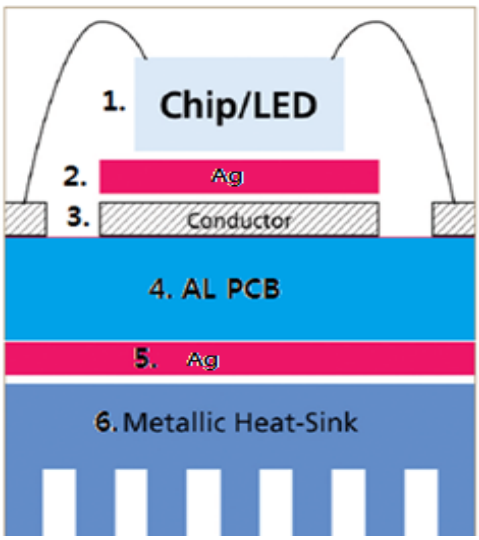

Fig. 2 The developed LED structure

4. Manufacturing method of nano silver adhesive

Currently, silver paste is manufactured by mixing nano silver into the epoxy resin and curing a the 240~270℃. The role of silver is to improve heat conductivity between the resin. The most recently developed silver paste enables

10w/mk or higher heat conduction, but resin separates when used for a long time. The epoxy resin remains after the hardening and causes the limitations in reliability and heat conductivity. In existing manufacturing process, the silver covers the resin. In this study, the existing manufacturing process was improved. Fig. 3 shows the configuration of silver covered with resin.

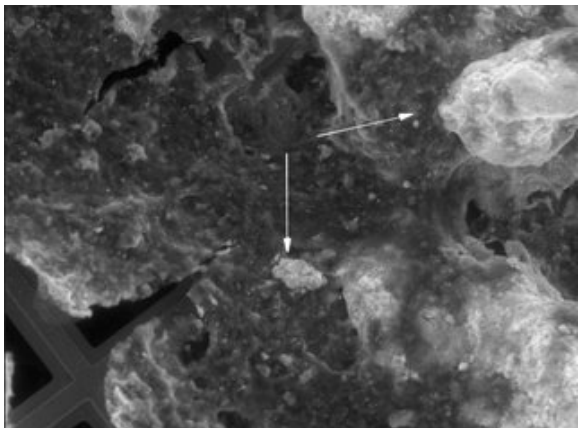

Fig. 3 Configuration of silver covered with resin

In this study, we suggest to use special solvent during the hardening process so that only remaining silver is combined while the solvent is dissipated in the drying process. Therefore, in the final adhesive plain, the only the pure silver remains, which results in high reliability and vibration and heat resistant. Fig. 4 shows the configuration of pure silver adhesive.

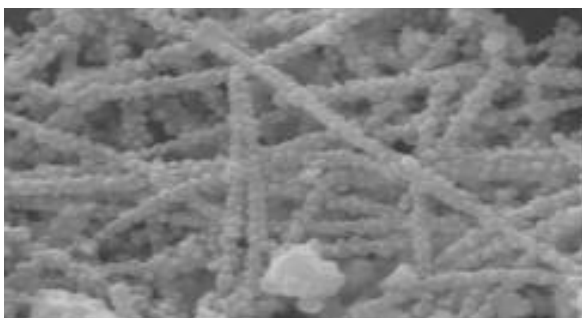

Fig. 4 Configuration of pure silver adhesive

5. Conclusion

As it was tested the heat resistant characteristic of the LED light with the nano silver adhesive developed through this study applied, it has been improved to 1.7k/W. The heat resistance of the existing product is 3k/W. Therefore, the result is the 56% improvement from that. Also, the adhesive power of our nano silver adhesive is 2kgf, which is 40% improved than the 0.8kgf of existing adhesive.

In this study, it was solved the heat issue of the high efficiency light market, and to reduce the heat sink. Using the nano sized silver, adhesive with improved heat conductivity under the 300℃. Utilizing the results, it was tested that the adhesive can be applied in the specialty lights up to 100W in the future. The saving of the manufacturing cost is also expected.

Acknowledgement

This work (Grants No. C0115396) was supported by Business for Cooperative R&D between Industry, Academy, and Research Institute funded Korea Small and Medium Business Administration in 2013.

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