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Thermal Simulation Of Chemical-Synthesized Thick Film As Thermal Interface Material In Downlight LED

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Abstract

Light emitting diode (LED) has been used to replace the conventional compact fluorescent bulbs (CFL) in the recent market with outstanding advantages that makes it an important light source for the next generation. With the increasing usage of LED in the lighting application, heat dissipation of the LED in a package has caused much problem to the lighting device itself. As the light output of the LED is strongly dependent on the thermal performance, thermal interface material (TIM) has become an area of interest that can be used to sink more heat out to the ambient. This TIM is fabricated from the screen printing method, by mixing Zinc Oxide powder (ZnO) with optimized ratio of binder and polymer. From the synthesis, different TIMs are produced. The thickness of each TIM is measured. The material properties of the different synthesized TIM are characterized by using Thermal conductivity machine, supplied by Perkin Elmer. By combining thickness, different material properties from the synthesized TIM, and the applied current to the LED, the downlight LED was developed into application mode for end-user to study these phenomenon. In COMSOL Multiphysics, modules like joule heating, heat transfer in solid and laminar flow are used to simulate the thermal dissipation with the specific material properties and thickness of synthesized TIM. Geometry of downlight LED package is created and live-linked with Solidworks, as shown in Figure 1. The TIM is indicated by a red layer in figure 2. The material properties, for instance density, specific heat capacity at constant pressure, and thermal conductivity, are created of different synthesized TIM and used to do comparison in the simulation modules. All the studies are computed at stationary stage. Interactive web app is built from the application builder to show the effect of thickness, different material properties, and applied current to the leds. In this simulation, the LEDs are considered as heat source with the maximum current of 1 ampere (A). The force convection is applied at the air velocity of 5 m/s from the left to the right. The insulated boundary conditions are implied to the model. Next, the thickness of the TIM is studied and varied in the application builder with the maximum of 100 micron. The maximum temperature is obtained and compared with different simulated variables, ranging from 88.58°C to 92.93°C at 0.5A. Furthermore, the velocity, current and heat distribution are studied in order to optimize the TIM performance of the whole package. This studies shows the importance of the thickness of the TIM and applied heat power to the geometry created based on the specific material used in the simulation. The heat distribution of the whole downlight is important to be identified via simulation as it will improve the development of the prototype.

Figures used in the abstract

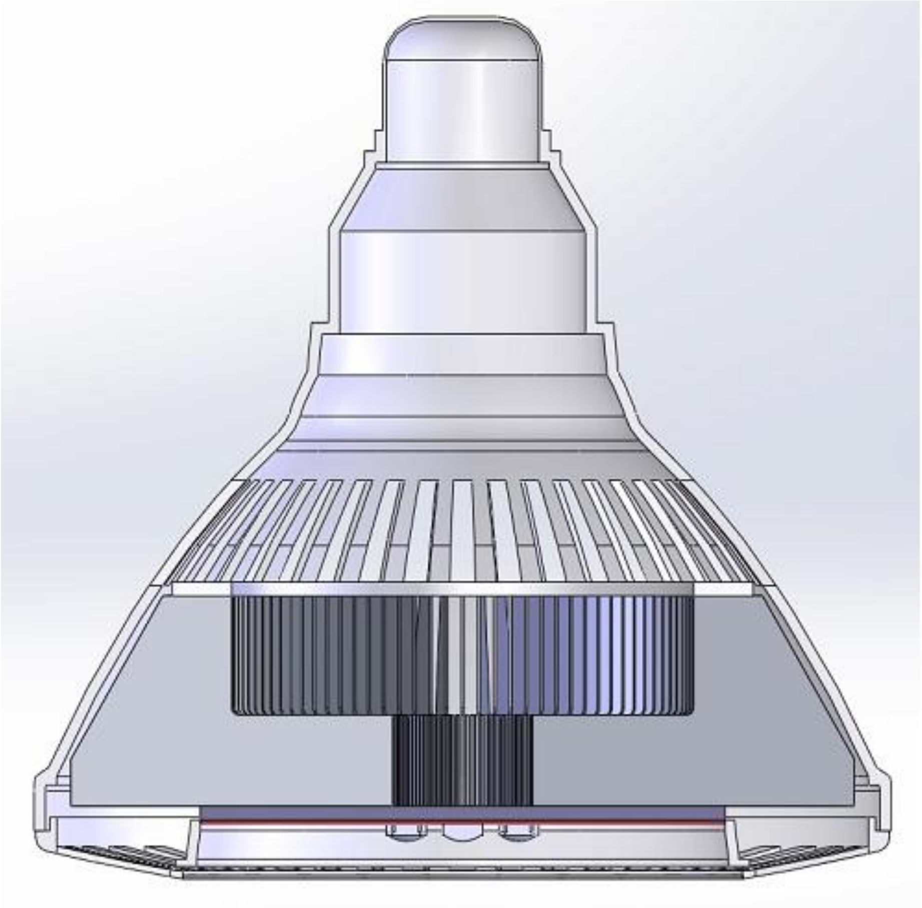

Figure 1: Cross-section of downlight MR16

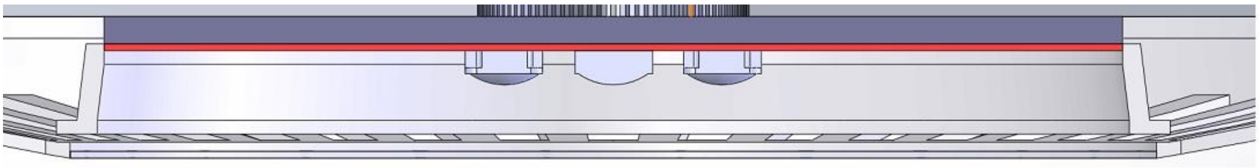

Figure 2: Structural diagram of LED mounted on red TIM on aluminium substrate