THERMAL REGULATING BEHAVIOR OF OUTLAST® LATENT HEAT SYSTEMS™ 89 (LHS-89) WITH COPPER HEAT SPREADERS

WHITE PAPER | Joe Kelly - Materials Scientist, Outlast Technologies LLC

Testing of copper heat spreaders coated with Outlast's LHS-89 phase change material (PCM), was performed at Outlast's R&D laboratory to obtain thermal benefit results.

TEST PARAMETERS

Testing parameters were as below:

Copper foil:	50mm X 50mm w/ 50μ thickness
Copper plate:	50mm X 50mm w/ 550μ thickness
Outlast LHS-89:	50mm X 50mm w/ 500μ and 950μ thickness
Acrylic control film:	50mm X 50mm w/ 500μ and 950μ thickness

A test apparatus thermal kit was designed using a 2W 4 ohm wirewound resistor (5mm X 10mm) attached to an isolated FR-4 PCB (7.2cm X 9.5cm) placed in a controlled-environment container at a volume of 3465cm^3. A small 10mm x 10mm copper plate of 550μ thickness was attached to the resistor using a thermally conductive epoxy adhesive. A thin thermocouple was attached to the side of this small plate. A regulated DC power supply operating at 3.0V and 0.78A was used to keep a constant power output of 2.4W. A Bare and modified copper heat spreader was attached to the heating element using a small amount of Artic Silver 5 thermal compound.

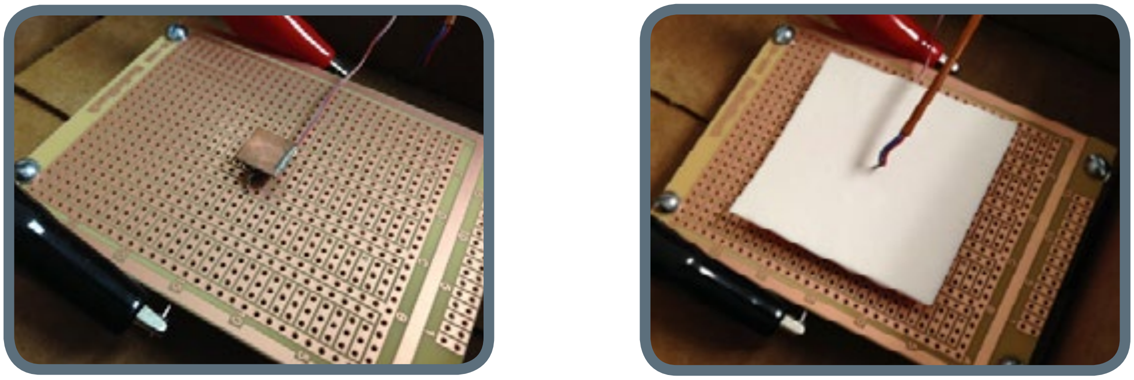

FIGURE 1: OUTLAST'S TEST APPARATUS WITHOUT HEAT SPREADER (LEFT) AND WITH HEAT SPREADER (RIGHT).

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RESULTS

As per test design, 2.4W was applied to copper heat spreaders with top surfaces modified using films of Outlast's LHS-89 and an acrylic control, both at thickness of 520μ and 960μ, which corresponds to loadings of 0.049 g/cm² and 0.093 g/cm², respectively.

As seen in figure 2, the LHS-89 and acrylic film-modified heat spreaders show an overall decrease in total temperature of the simulated chip element in comparison to an unmodified copper heat spreader. This is expected due to the increase in overall thermal mass of the spreader. However, a striking difference can be seen between the LHS-89 and acrylic control spreaders in their heat dissipation effect on the chip simulator. The element attached with the LHS-89/copper heat spreader clearly shows a slower ascent in its temperature profile during the heating phase. This behavior corresponds to a noticeable phase change plateau that was not exhibited by the acrylic controls. The 0.049 g/cm² LHS-89 modified spreader was able to keep the heated element at lower temperatures five minutes longer than the acrylic control whereas, at a loading of 0.093 g/cm², the LHS-89 modified heat spreader was able double the time duration of this low temperature behavior to roughly the entire 10 minutes of applied heat. While increasing the thermal mass of copper by using a plate with 550μ thickness did display enhanced dissipation characteristics in comparison to the foil, its thermal performance was comparable to the acrylic control at similar thickness. Excluding variability from surrounding environmental factors, surface thermocouple data express similar performance to the embedded probes.

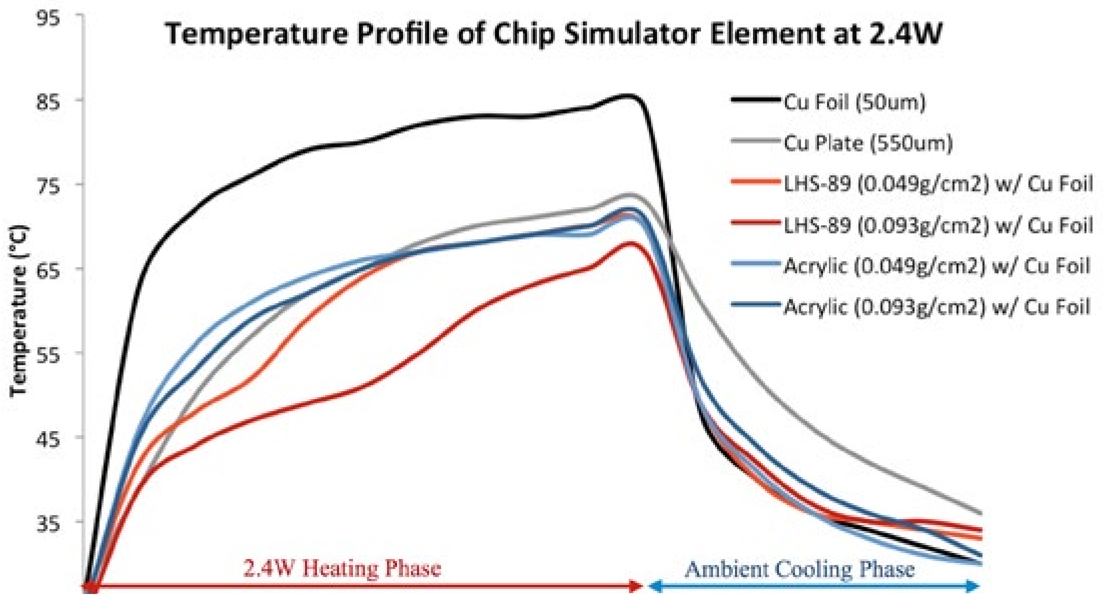

FIGURE 2: GRAPH OF TEMPERATURE OF CHIP SIMULATOR ELEMENT CONTAINING EMBEDDED THERMOCOUPLE WITH COPPER HEAT SPREADER MODIFIED USING LHS-89 AND ACRYLIC CONTROL FILMS AT 0.049G/CM² AND 0.093G/CM² LOADING.

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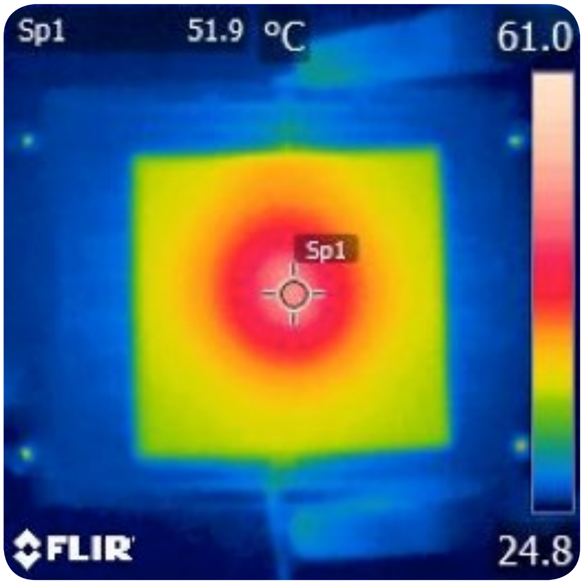
CONCLUSION

Outlast LHS-89 modified copper heat spreaders were effective in regulating temperatures of a simulated chip element at 2.4W, keeping the element at or below 50°C for a greater part of the heating phase. Because of the latent heat storage ability of the LHS-89 material, these modified heat spreaders are able to noticeably outperform current state of the art copper foil heat spreaders. The ability to tailor the amount of latent heat through applied mass gives the Outlast's heat spreaders the capability to meet a variety of application-specific thermal management criteria. Overall, Outlast LHS-modified heat spreaders give a competitive edge over traditional copper foils in the ability to effective dissipate heat generated from electronic components.



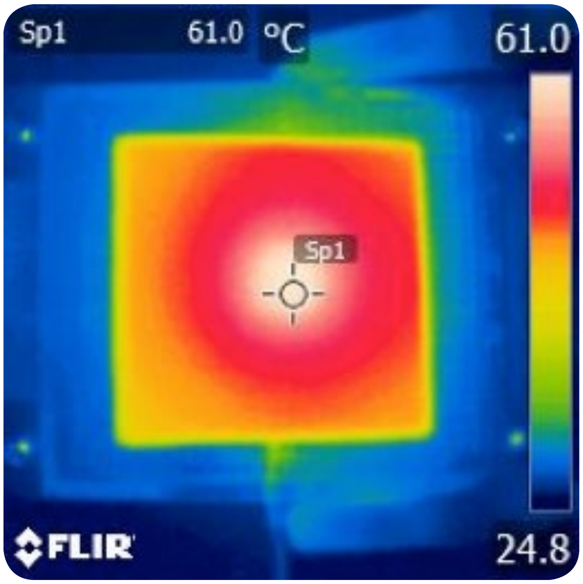


FIGURE 3: IR IMAGES OF A CU HEAT SPREADER COATED WITH LHS-89 (LEFT) AND ACRYLIC (RIGHT) FILMS AT A 0.049G/CM^2 LOADING WITH A 2.4W HEAT LOAD AFTER 3 MINUTES.

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