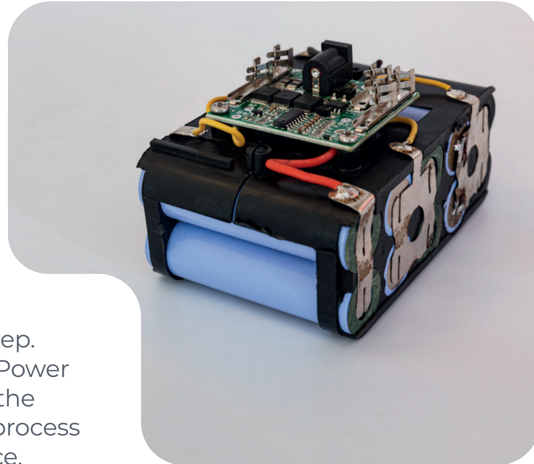
Case Study

Overmolding of Battery Management System (BMS) with KERAMOLD® 20

The power density in electronic devices is continuously increasing. This high level of generated heat and temperature requires a smart thermal transfer from the electronics to the heat sink (e.g. cooling plate or alumina housing). Next to the thermal parameters, the voltage level in many applications is also continuously increasing which means, a reliable electrical isolation between electronics and housing is crucial.



With the current solution, the BMS of a cordless screwdriver is covered by a conformal coating to protect the electronic components from dust, vibrations and ensure the electrical isolation. That solution has two main disadvantages. The first one is the thermal management, as the conformal coating is not able to transfer or at least spread the heat. The result can be "hot spots" on critical components which may lead to a failure of the whole device or at least to a forced downgrade in the power. The second topic that must be optimized is the cycling time for applying the material. The conformal coating is often a manual and time consuming production step. Together with one of the leading manufacturers of BMSs for Power Tools, KERAFOL® was working on a new solution to combine the usage of a material that can be applied by a fast automated process and being able to increase the thermal efficiency of the device.

The new developed material KERAMOLD® 20 has a thermal conductivity of 2,0 W/mK and even if the filling level is very high, the material can be processed by a low-pressure overmolding process. With that kind of injection molding process, the cycling time will be much lower in comparison to conformal coating or potting. To demonstrate the effectiveness of using the KERAMOLD® material, a thermal analysis of four different printed circuit boards (PCBs) has been done.

The test setup, test results, and PCB overmolding where provided by X2F ("Extrude to Fill"). The X2F innovative process leverages low pressure and a patented pulse-packing method to mold parts that throw away the constraints of traditional injection molding. X2F technology combines patented hardware, sensors, and software and is available for prototyping and full scale production scale. For more information visit www.X2F.com.

Test Setup

PCBs were setup as follows:

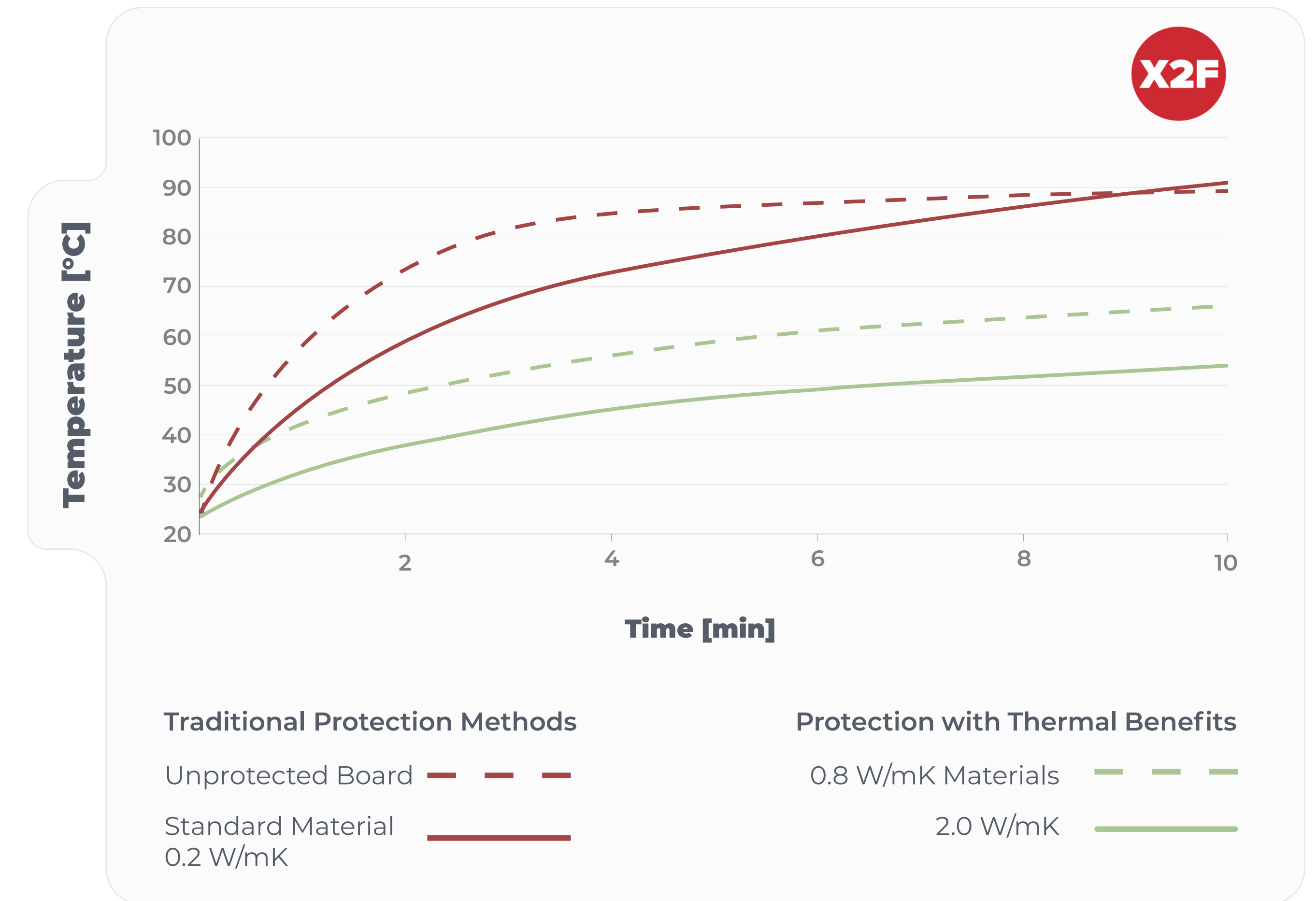
- **PCB 1** This "baseline" board had no overmolding material and no thermal management solution is applied
- **PCB 2** This board was overmolded by a conventional injection molding granulate without focus on thermal management by having a thermal conductivity of only 0.2 W/mK
- **PCB 3** This board was overmolded with a thermally conductive polymer composite with filles and a thermal conductivity of 0.8 W/mK
- **PCB 4** This board was overmolded by the KERAMOLD® 20 that has a thermal conductivity of 2.0 W/mK

Thermocouples were soldered to the back of each board, on the bottom-middle pad, and plugged into thermometer. A power supply was attached to each board to control current. 270mA of current was applied to each board for 10 minutes. Temperature readings were taken every 10 seconds over the 10-minute period. The temperature values were recorded graphically for each PCB tested.

Test Results

The test results shown in Graph 1 clearly demonstrate the correlation between thermal conductivity of the injection molding material and the thermal performance for PCBs.

The KERAMOLD® 20 excelled in this study, reducing PCB temperature to 45°C compared to the PCB temperature with no thermal management solutions (90°C).



Conclusion

The KERAMOLD® 20 is able to set new standards for Thermal Management in the field of injection molding materials.

- Improved thermal performance
- Protection against dust & humidity
- Compensation of vibrations
- Highly electrically isolating
- Saving production time in comparison to conformal coating or even potting materials
- Cost effective solution