**High power thermal transient testing: challenges and chances**

The hardware products of T3Ster line at Mentor Graphics Mechanical Analysis Division are designed for the thermal transient characterization of packaged semiconductor devices, assemblies and systems. Our technology enables in-situ, non-destructive junction-temperature measurement of power semiconductors, LED-s, and even VLSI IC-s.

As a response on market needs our technology allows the identification of standard thermal metrics in a way compliant with major JEDEC and MIL standards, combined radiometric/ photometric and thermal characterization of LEDs and also the identification of failure mechanisms after reliability tests.

The reliability testing of high power electronics such as different MOSFET or IGBT modules in automotive/aerospace and defense environments require testing at elevated power. The latest generation of MicReD high current instruments helps you meet these requirements.

This presentation covers the following topics:

* Standards and methods for testing transistors (BJT-s, MOSFET-s and IGBT-s)
* Measurement of advanced devices (HEMT, MESFET, etc.)
* The new high current (200A/7V) booster family for the reliability testing and high power thermal characterization of power devices
* In situ thermal interface material testing
* New designs for thermal and radiometric/photometric measurement of solitary high power LEDs, complete LED chains and single LEDs in a powered chain

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| Measurement of high current semiconductor devices |  |
|  | We have a long history in measuring different transistor devices.  —BJTs, MOSFETs, IGBTs, HEMTs can be tested  Tests may have different purposes:  — Junction temperature measurement  —Structural analysis  —Reliability analysis  —Thermal model generation  —Measurement of standard datasheet values  Our test methodology follows the  JEDEC 51-1 and the MIL-STD-750E series of standards |
|  | New power supplies help testing diodes, transistors with different powering, IGBTs also in saturation with high constant VGE |
|  | Structure functions help identifying structural details in a qualitative and quantitative manner |
| Related measurement standards |  |
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Rearranging the sources we need only ONE high current source, while the circuit behaves in the same way

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|  | This simple fixture acts as independent VCB source. It realizes the rearranged Method 3131. |
|  | - VG opens the power MOS transistor and high current used for heating on RDSon  - In measurement phase VG switched to 0 and reverse diode opened for sensing  - The negative sense current is taken from T3Ster.  Vdiode≈– 0.5V |
|  | **Other features:**  - Switching takes place physically next to the DUT to avoid disturbing electric effects  - Switching box contains an additional 0.5A/10V sensor source and a 15V voltage source for gate driving  - The system can help to perform reliability studies by making power cycles on the tested devices  - Implicitly a reliability tester for high power semiconductor packages and assemblies |
| Measurement of TIM2 materials |  |
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|  | C:\Users\vvandras\Documents\Saját cikkek\MEJ2010\MEJ_Final_article\7.TIF  Zth curves already show well the dependence of thermal resistance on bond line thickness. Still hard to get numeric values. |
|  | C:\Users\vvandras\Documents\Saját cikkek\MEJ2010\MEJ_Final_article\7.TIFReading thermal resistance at high thermal capacitance in the cumulative structure functions gives a single number for total Rth. All portions of the structure all stable except the TIM. |
|  | The slope of the Rth values read out at a given bond line thickness shows the thermal conductivity of the TIM material. |
|  | Measurements are highly repeatable on low viscosity materials. Viscous materials also show acceptable results, but obviously repeated tests scatter a bit. |
|  | Surface quality of TIM testers is not standardized. This leads to constant difference in the measured curves. |
|  | Two testers of very different principle at Mentor Graphics MicReD show consistent results. Vendors often give unreliable material data, sometimes much better than reality. |
| Measurement of HEMT and MESFET devices |  |
|  | A textbook scheme for measuring them is basically the shown. |
|  | The test can be decomposed on heating and cooling.  During heating the FET conducts and the channel heats.  During cooling the Schottky gate is forward biased and used as temperature sensor.  More details are shown in the oral presentation. |
| Measurement of high voltage device strings |  |
|  | T3Ster Measurement Channel can accept signals ± 5V differential, ±12V common mode. For LEDs or other devices at a higher voltage position an instrument is needed which gets rid of common mode voltage. This is LED string tapper. |
|  | The new LED string tapper device enables the test of individual junction temperatures in an LED chain |
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| Enhancements of the TERALED system |  |
|  | **New system with**  ∅50cm sphere  ∅120mm temperature stabilized DUT holder  LEDs up to 50W can be measured with water cooling  Filter based detector system with array spectrometer option  **Previous system** characterized by ∅30cm sphere, ∅60mm temperature stabilized DUT holder, 8..10W heat sinking capability, filter based detector system |
| Case study: complex testing of LED assemblies |  |
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|  | Structure functions of 3 samples, power corrected with Popt |
|  | Structure functions of sample AL-2, power corrected with Popt |
|  | LM80 test chamber with all the LEDs assembled  All measurements are done in-situ to eliminate any  Rth change which is NOT due to ageing  In-situ thermal transient measurement  In-situ light output measurement |
|  | 8 different kinds of LEDs from 4 vendors, so far 4000h burning time |
|  | Light output drop likely due to increased Rth caused by TIM degradation, not by LED degradation |