Antonio Pio Catalano

Tutor: Prof. Vincenzo d'Alessandro

XXXII Cycle - I year presentation

Thermal analyses of electronic devices for RF and Power applications

Background

M.Sc.	Ph.D.
Electronic Engineering – October 27th 2016 Subject : **Microelectronics**, Prof. *Vincenzo d'Alessandro* Title: *Numerical Optimization of GaAs HBT Thermal Ruggedness with Design Of Experiments*	Electronic Group – **Ing-Inf/01** Prof. **d'Alessandro**, Prof. **Rinaldi** **Athenaeum** fellowship **RF devices characterization laboratory**, building 2, Via Claudio. Tel. +39 081 73 **86145**

Cooperations

Politecnico di Milano

Prof. *Lorenzo Codecasa*

Qorvo Inc.

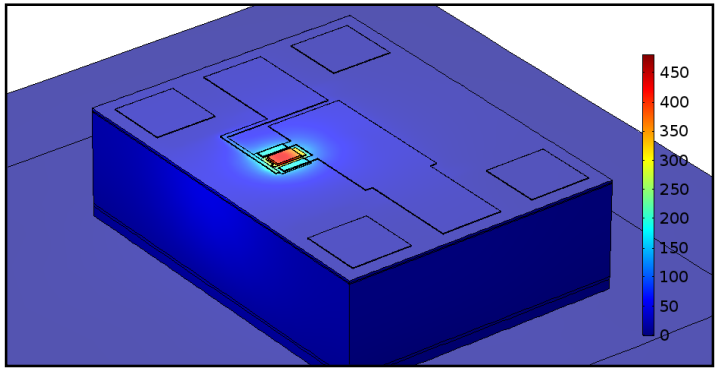
Peter J. Zampardi (Newbury Park, CA, USA)

Brian Moser (Thorndike Rd. Greensboro, NC, USA)

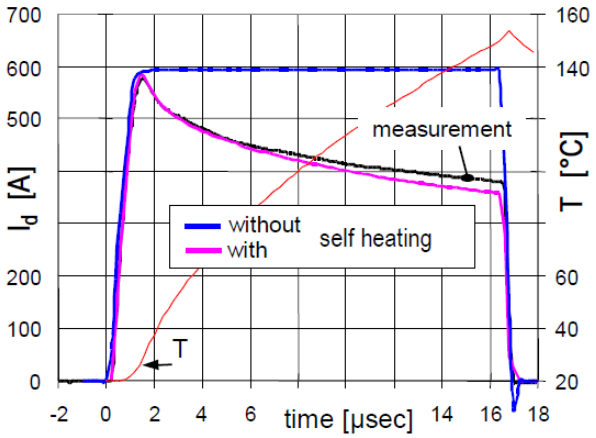
High-accurate thermal analyses

Study **thermal performance:**

- Impact on **SOA**
- Technology, layout and package **design**

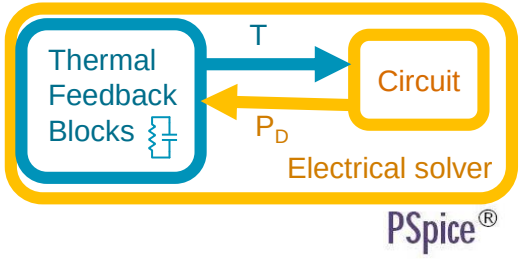


Electrothermal simulations:



By ET analyses is possible:

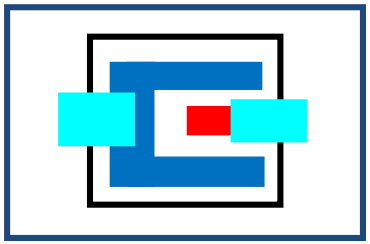
- to include the **self-heating effects**
- to evaluate the **real performance**
- to study **breakdown** effects



FEM purely-thermal simulation tool

Layouts

State-of-the-art devices



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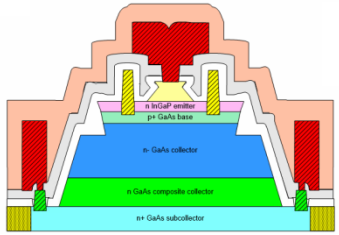


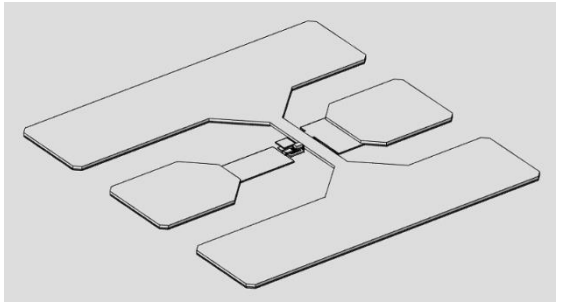
Technology process

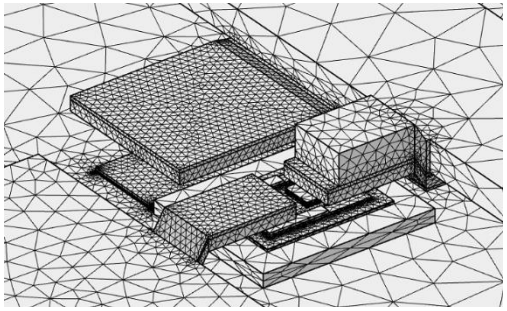
MATLAB

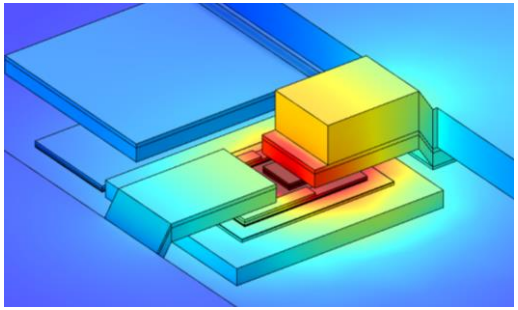
Automatically

COMSOL MULTIPHYSICS

Geometry + **Meshing** + **Solution**





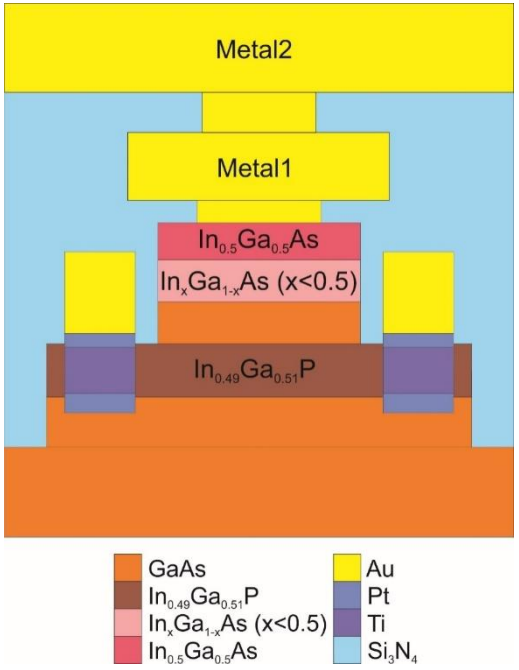


Extremely detailed structures for highly accurate simulations

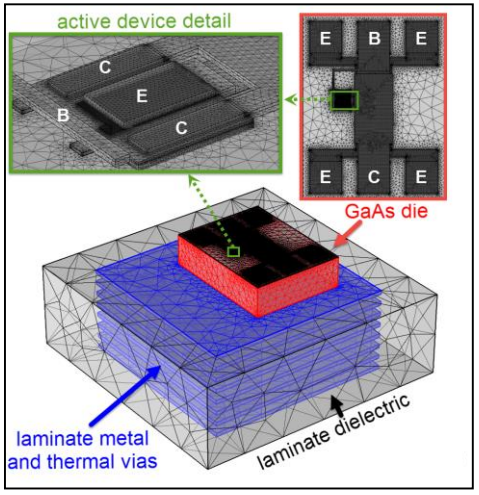
Devices for RF applications

GaAs-based Heterojunction Bipolar Transistors (**HBTs**)

Impact of semiconductor and metal layers on R_{th}

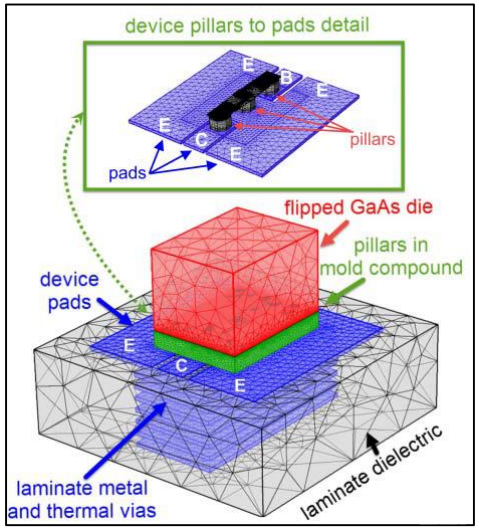


Impact of packaging styles on R_{th}



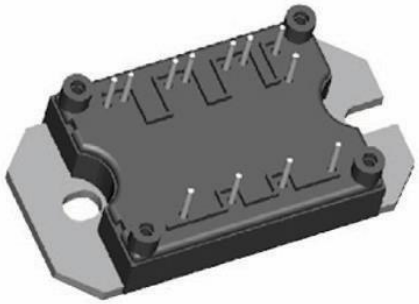
⇦ wire bonding

flip-chip ⇨

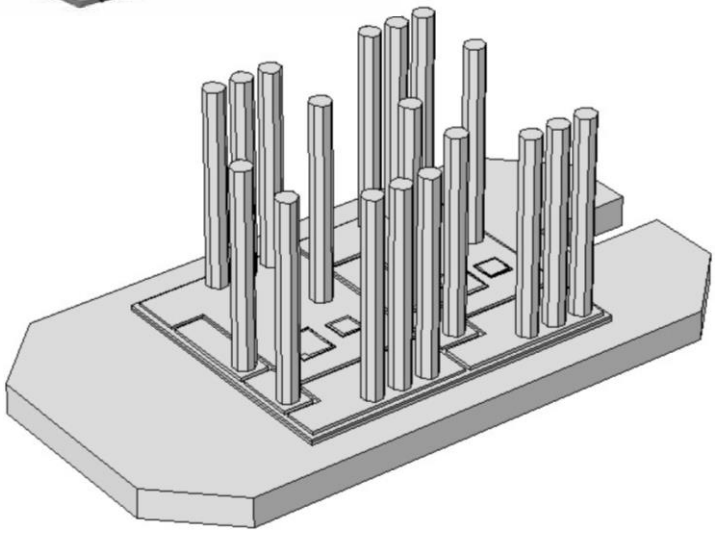


Devices for Power applications

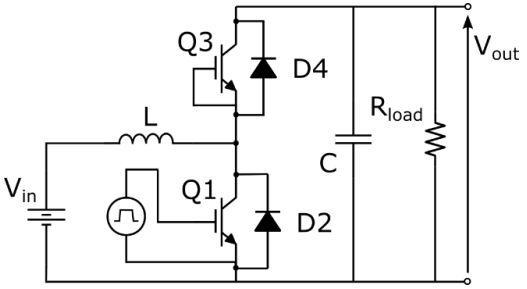
IGBT module in MTP package – thermal feedback block extraction

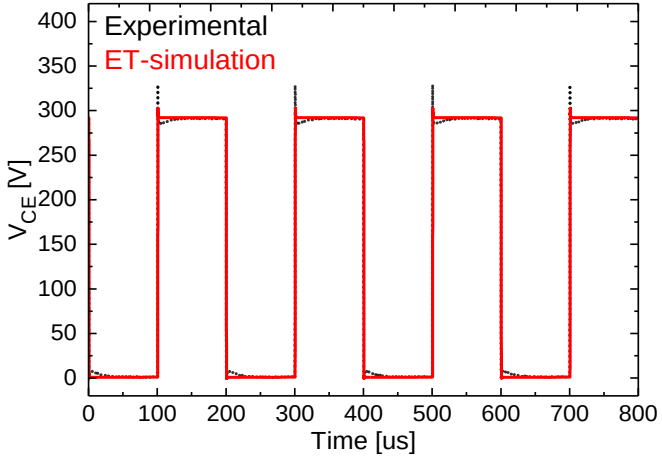


3D model
TFB extraction



Circuit-level
ET simulations
(Buck converter)





Agreement with **experimental** results

1st year production

Journal Papers	V. d'Alessandro *et al.*, "Simulation comparison of InGaP/GaAs HBT thermal performance in wire-bonding and flip-chip technologies," *Microelectronics Reliability*, vol. 78, pp. 233-242, 2017.
Conference Papers	A. P. Catalano *et al.*, "Influence of layout and technology parameters on the thermal behavior of InGaP/GaAs HBTs," *in Proc. IEEE 13th Ph. D. Research in Microelectronics and Electronics (PRIME), Jun. 2017.* A. P. Catalano *et al.*, "Numerical analysis of the thermal behavior sensitivity to technology parameters and operating conditions in InGaP/GaAs HBTs," *in Proc. IEEE Compound Semiconductor Integrated Circuit Symposium (CSICS), Oct. 2017.* A. P. Catalano *et al.*, "Model-Order Reduction Procedure for Fast Dynamic Electrothermal Simulation of Power Converters," *in Proc. Applications in Electronics Pervading Industry, Environment and Society (APPLEPIES), Sep. 2017.* A. P. Catalano *et al.*, "Effect of heat source modeling in DC circuit-level electrothermal simulation of power MOSFETs," *in Proc. 49th SIE conference,* 2017. V. d'Alessandro *et al.*, "Combined SPICE-FEM Analysis of Electrothermal Effects in InGaP/GaAs HBT Arrays for Handset Applications," *in Proc. IEEE 19th Thermal, Mechanical and Multi-Physics Simulation and Experiments in Microelectronics and Microsystems (EuroSimE), Apr. 2018.* (accepted as Keynote presentation)

Next years…

Research activity:

- Extend the purely-thermal simulations for **ET stationary analyses** of **GaAs HBTs**
- **ET analyses** for **photovoltaic** fields
- Thermal evaluation of **packaging techniques** for **Power modules**

Conferences and **PhD schools**:

- **EuroSimE** conference, Toulouse, France, April 15th-18th 2018
- **Società Italiana Elettronica**, Conference and PhD school, Napoli, Italy, June 18th-22th 2018

Credits summary :

Student: Antonio Pio Catalano antoniopio.catalano@unina.it **Tutor: Prof. Vincenzo d'Alessandro** vindales@unina.it **Cycle XXXII**

	Credits year 1								Credits year 2								Credits year 3									
	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Estimated	1 bimonth	2 bimonth	3 bimonth	4 bimonth	5 bimonth	6 bimonth	Summary	Total	Check
Modules	20	3	0	0	0	3	9	15	10							0	0							0	15	30-70
Seminars	5	1,9	0	0	3	0,8	0,3	6	5							0	0							0	5,7	10-30
Research	35	5,1	10	10	5	5,2	3,7	39	45							0	60							0	39	80-140
	60	10	10	10	8	9	13	60	60	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	60	180

Thank you for your kind attention