MITEC GROUP

Microtechnology and Instrumentation for Thermal and Electromagnetic Characterization

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"gather research collaborators with common approaches for actions around shared goals"

The objectives of the group are to carry out both basic and applied research in the fields of microwave characterization and thermoelectric microsensors and microgenerators

CORE ACTIVITIES

• INSTRUMENTATION DEVELOPMENT

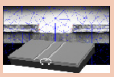
RF to High frequency circuit & System

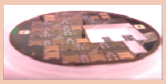
- Analog passive and active circuit design, high value added technology for broadband applications Microwave and millimeter-wave system design for a wide range of applications (network analysis, telecommunications, radar,…)
- Microfabrication of Monolithic Hybrid Microwave & Millimeter-wave Integrated systems and sensors
- Development of test and probing structures and calibration standards at the micro-to-nanoscale

Thermoelectric (TE) microgenerators and microsensors

- Fabrication and development of TE microsensors (IR and heat-flow) to be integrated in µ-systems dedicated to the energy management ('energy efficiency', intelligent building etc…)
- Development of a new family of planar TE microgenerators for general purpose appliances

• CHARACTERIZATION TECHNIQUES





Characterization using centimetric & millimetric wavelengths

- Development of original instruments & Tools for Non-Destructive Testing & Evaluation applications, dielectric characterization, RF impedance measurement
- Development of Modeling & Calibration techniques to extract the physical properties of materials
- Sub-wavelength characterization by means of near-field microwave microscopy

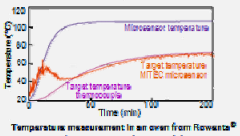
Development of new TE thin films

- Elaboration of nanostructured materials (superlattices)
- Optimization of thermoelectric nanostructured structures for energy harvesting and management

CONTACTLESS TEMPERATURE MICROSENSORS AND THERMOELECTRIC MICROGENERATORS

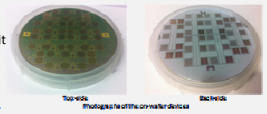
Contactless temperature sensors for harsh environnemental conditions : In the framework of the PSPC contract "**Open Food System**" a new family of robust and high-temperature silicon microsensors dedicated to infrared imaging for consumer and industrial ovens is developed.

Such sensors are very innovative and the concept is protected by an European patent. OFS is a large structuring project for the agri-food and digital sectors bringing together 25 public and private partners on 5 competitiveness clusters.



A first set of microsensors was fabricated in 2013. Results are in good agreement with theoretical model. Two new «fabrication runs » are planned in 2014.

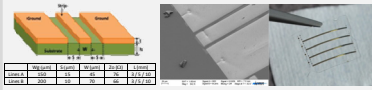
Planar Thermoelectric Microgenerators :
Original low-cost silicon and eco-friendly microgenerators based on Seebeck effect are developed as part of CPER-MEYSA project. These devices benefit from the MITEC in- house expertise in planar Silicon technology. The first prototypes realized have shown very promising results in terms of reliability and performance. New developments including materials and technology aspects are ongoing to propose the next generation of thermoelectric micro-generators.



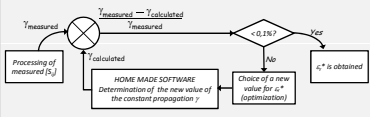
FLEXIBLE SUBSTRATES CHARACTERIZATION

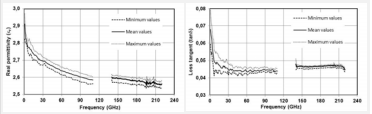
Complex permittivity measurement

Experimental measurements on polydimethylsiloxane (PDMS) substrate (up to 220 GHz)



- CPW lines, different lengths, different dimensions.
- On-wafer probing system.
- Extraction of the complex propagation constant with an appropriate de-embedding home made software.
- Determination of complex dielectric permittivity for each frequency.

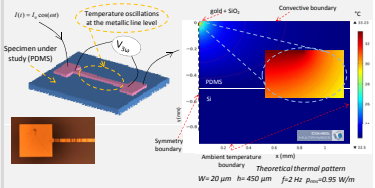


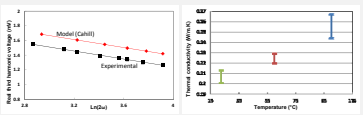


Thermal conductivity measurement

Experimental measurements on polydimethylsiloxane (PDMS) substrate for different temperatures

Three Omega Method:
- Due to joule's heating, temperature oscillations are produced at 2ω.
- Consequently fluctuations in the line heater resistance are produced.
- This leads to a third harmonic voltage $V_{3\omega}$.
- The slope of the curve $V_{3\omega}=f(\ln(2\omega))$ enables to determine the thermal conductivity



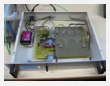


MICROWAVE & MM-WAVE SENSING APPLICATIONS

Innovative solutions based on Six-port Technology

Compact measuring instruments

1-10 GHz forward network analyzer

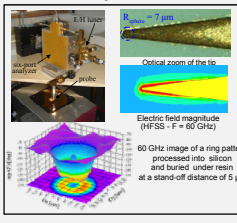


Low-cost PCB
Fully automated
Embedded Calibration
Friendly operation

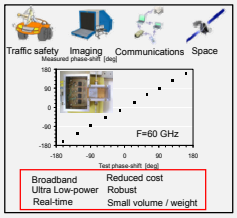
Six-Port V-band forward network analyzer

Thin ceramic technology
Diodes Schottky zero-bias

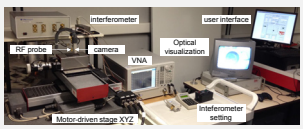
60 GHz 3D imager with sub-λ resolution



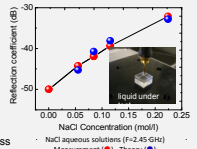
Compact V-band Radars



Interferometric Scanning Microwave Microscopy



Freq : 1-20 GHz
Resolution : < 1aF
Course : 25 × 25 cm²
Resolution : 0.1 µm
Mode : Probing – Contactless



Liquid near-field sensing application

MAIN COLLABORATIONS

Within IEMN

Involvement in three IEMN Flagships

"Nano-characterization"
"Flexible Electronics"
"Smart Energy Autonomous Microsystems"

National level

Univ. Artois - LAMH
ESTIT - HEI
Lille Hospital (CHRU)
Univ. du Mans
Univ. Reims - DTI
Ecole des Mines de Douai
CEA-LITEN
CRHEA (Sophia Antipolis)
FOTON (Insa Rennes)

International level

EMPA (Switzerland)
Univ. Tlemcen (Algeria)
Univ. Meknes, Univ. Tanger (Morroco)
CINTRA Singapour
Univ. ECNU, SICCAS (China)
Georgia Tech (USA)
Univ. California - Irvine (USA)

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