FAME: Failure Analysis of RF MEMS Devices

Journées Nationales en Nanosciences et en Nanotechnologies (J3N)

Coordinator: LAAS-CNRS (Dr. Fabio COCCETTI)
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Project webpage: www.laas.fr/fame

LAAS-CNRS · ThalesAlenia Space · Leti · novamems · Ecole Nationale Supérieure des Mines Saint-Etienne

Background & Organization

Motivations

- The RF MEMS devices were introduced 15 years ago and rapidly demonstrated highly attractive capabilities in term of insertion loss, isolation, power consumption and linearity.
- They are ideal candidates to create innovative reconfigurable front end architecture for RF and millimeterwave communication in different industrial segments such as mobile communications, aeronautic and space communications, radar applications and RF instrumentation.
- However, their industrialization has faced a very important issue concerning the reliability of these devices (sticking effect and material degradation)

Partners and Project Organization

- **Thales Alenia Space** as end user (qualification procedures for MEMS devices)
- **NovaMEMS** (SME) failure analysis for developing some standardization procedure and advanced knowledge on the Physic of Failure (PoF)
- **CEA-LETI** acts RF-MEMS technology provider and it is interested inassessing the potentialities for space application
- **ARMINES** (École Nationale Supérieure des Mines de St-Étienne et le Centre de Microélectronique de Gardanne) has experience in material charcaterization and analysis
- **LAAS-CNRS** has expertise in the field of RF MEMS failure analysis and modelling.

Objectives

Understand the fundamentals of these failure mechanisms in order to:

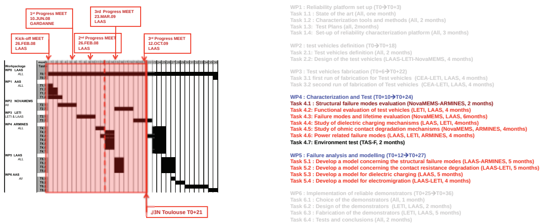
- Get a standard in the methodology to assess the RF MEMS reliability propose technological issues to minimize and/or overcome these effects
- Develop models that will be implemented in the design to predict their life time

The FAME project will focus on these three objectives and two types of RF MEMS devices :

- Ohmic switches
- Binary state capacitances/switch

Failure analysis results will be exploited to design, fabricate and characterize RF MEMS demonstrators featuring enhanced predictable reliability behaviour.

Work breakdown and Timeline

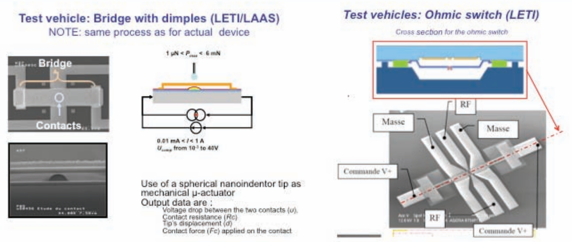


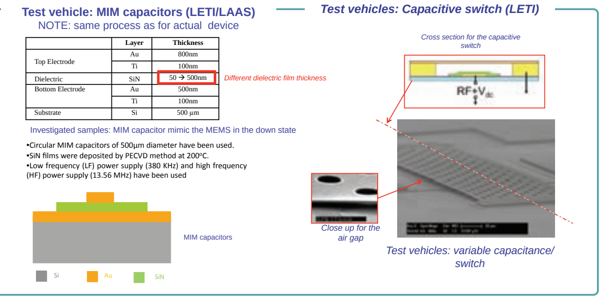
Scientific and Technological Achievements

Two major failure mechanisms in RF-MEMS switches occur both at the mechanical contact

- Ohmic Switches --> Metal-to-Metal --> Microcontact degradation
- Capacitive Switches --> Metal-to-Dielectric --> dielectric charging

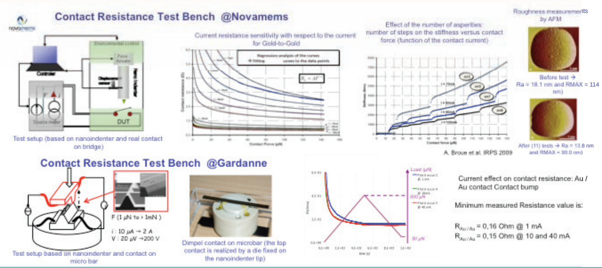
Technology

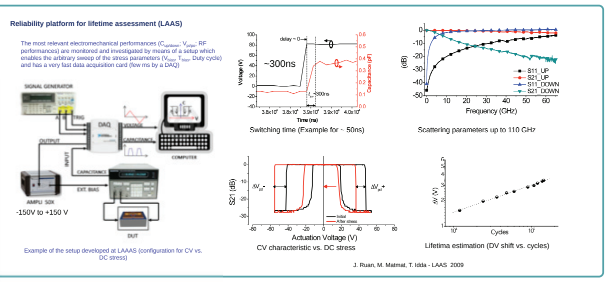




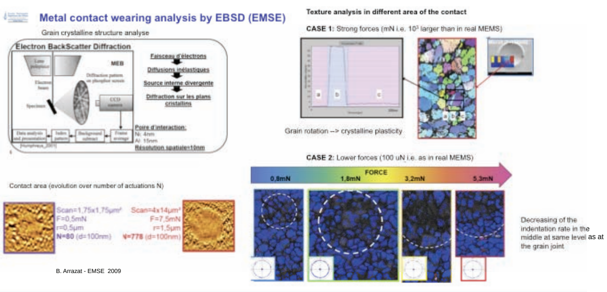
	Layer	Thickness
Top Electrode	Au	800nm
	Ti	100nm
Dielectric	SiN	50 → 500nm
Bottom Electrode	Au	500nm
	Ti	100nm
Substrate	Si	500 µm

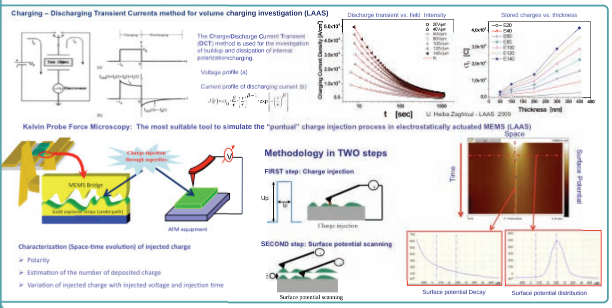
Physics of Failure – Component Level





Physics of Failure – Material Level





Conclusions and Perspectives

- PoF associated to failure mechanisms have been studied at material and device level --> NEXT: Acceleration techniques implementation based on space application specifications (by TAS-F)
- Demonstrator (system level) based on the acceleration techniques will be developed in order to validate FAME methodology and approach

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