MERCURE - *"*Micro and Nano Technologies based on wide band gap materials for future transmitting receiving and sensing systems"

ENIAC2009-1

Contract No: 120220, 2010 – 2014, Coordinator: Thales Research and Technology, France, 9 European partners

http://www.project-mercure.com/

The target of MERCURE project is to develop the design methodologies and technological steps necessary to achieve the integration of WBG RF devices such as GaN based MMICs with III-Nitrides (GaN, AlN) sensors for the realization of subsystems required for future smart systems. The potential of WBG based micro and nano devices as sensors and their integration with WBG RF electronics will be demonstrated. The implementation of the objective mentioned above, coupled with a thorough assessment of the market and the needs of end-user/industrial partner of the consortium (TSA), will lead to the production of four demonstrators in order to prove the feasibility of the various technologies and their integration.

The MERCURE consortium (made up of 9 partners from 6 countries including 1 major industrial player, 3 SMEs, 4 universities and 1 research centre – **IMT Bucharest,** all with significant experience in EU funded projects) is confident that the realization of its ambitious objectives will assist Europe to achieve technological leadership in domains that are targeted by ENIAC.

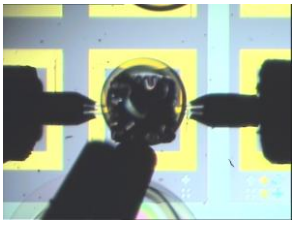
The IMT team is involved in the **fabrication and characterization of humidity sensors, based on film bulk acoustic resonator (FBAR) structures and surface acoustic resonator (SAW) structures working in the GHz frequency range.**

The work is done in cooperation by IMT Bucharest Romania, FORTH Heraklion Greece, University of Science and Technology Krakow Poland, Via Electronics Jena Germany.

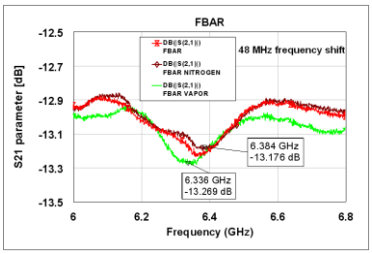
The FBAR and SAW structures have been manufactured using micromachining and nano-processing of GaN/Si. The resonance frequencies of 6.3 GHz for the FBAR structures and 5.7 GHz for the SAW structures represent the state of the art in GaN acoustic devices. Microwave characterization was performed by measuring the S-parameters with vector network analyzer Anritsu 37397D equipped with PM5 on wafer set-up from SUSS Microtec, using the measuring pads of the structure.

A special polymer coating was developed for the humidity sensor structures and the shift ofthe resonance frequency for SAW and FBAR test structures when they are exposed to water vapors was analyzed. The coating for selective water vapors absorption, has been manufactured by Univ. Krakow. They have manufactured also the experimental setup to locally spray with water vapors the acoustic device.

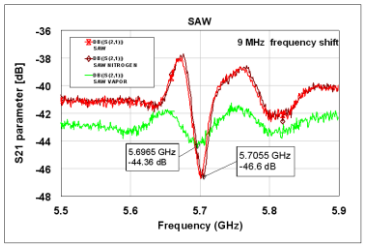
Qualitative experiments to determine the resonance frequency shift of the SAW and FBAR structures in a humid atmosphere have been done in IMT together by Krakow Univ. and IMT scientists.



A coated FBAR structure under test as humidity sensor



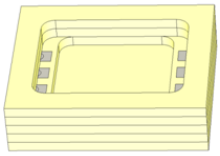
A FBAR structure coated with polymer (red in surrounding humidity, brown dry nitrogen flow, green after water spray)



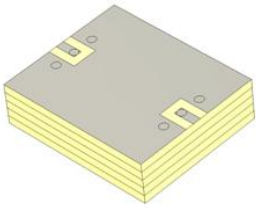
A SAW structure coated with polymer (red in surrounding humidity, brown dry nitrogen flow, green after water spray)

The best results have been obtained using the FBAR structure with only the polymer coating. Here we have obtained about 50 MHz frequency shift. For the other structures the frequency shift was lower then 10 MHz. The mechanism in frequency shift is different in FBARs and SAWs. In the FBAR structure, the membrane changes its properties due to the increasing mass while in the SAW it is a change in the propagation properties of the surface waves.

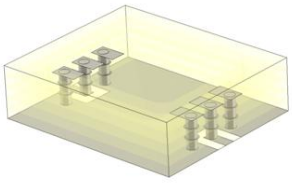
The devices will be packaged in a special LTCC package designed by IMT and manufactured by Via Electronics Jena. Two LTCC package models were mechanical designed and modelled in IMT for this purpose, both using the same stack structure (six layers), with specific differences only in dimensions and pad arrangement.

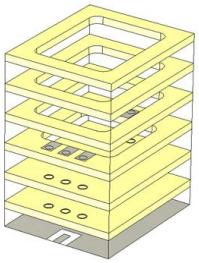


Top and bottom views (CPW modell)



Metallic connection





Exploded view

The final demonstrator is in progress and it will be finalized in January 2014. The result is very promising.

The design of the SAW and FBAR structures, the mask manufacturing, the design of the LTCC structure, the characterization of the structures were performed using the IMT infrastructure. On wafer microwave equipment was used in characterization. SAW and FBAR have been manufactured in cooperation by IMT and FORTH.

Five conference papers were presented at 5th International Conference on Micro-Nanoelectronics, Nanotechnology and MEMS, Oct 2012, Heraklion, *Greece, (Invited paper),* International Symposium on RF MEMS and RF Microsystems, Memswave 2012, Antalia, EMRS Spring 2013, Strasbourg, and Romanian national Seminar on Nanoscience and Nanotechnologies, Bucharest, May 2013.