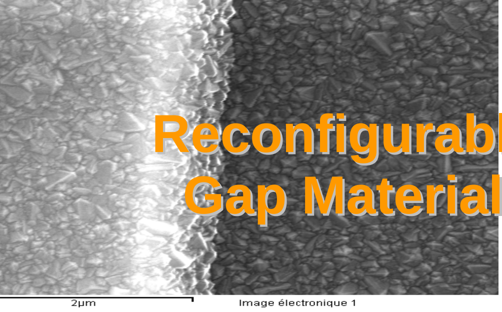

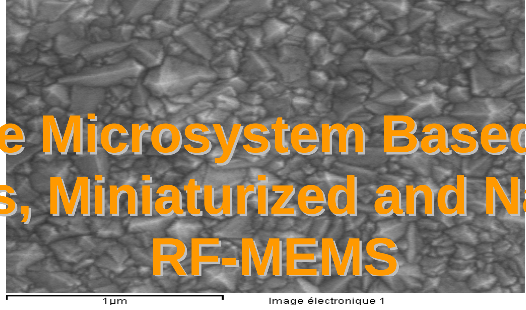

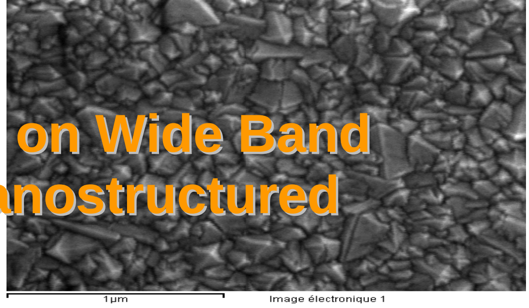

Reconfigurable Microsystem Based on Wide Band Gap Materials, Miniaturized and Nanostructured RF-MEMS

nanocom

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Nanocom is an European ENIAC project aiming at the development of a new approach for future generation of smart systems by introducing nanostructured materials capacitive MEMS to improve the reliability by one order of magnitude.

NANOCOM addresses the dielectric charging effect which limits the lifetime and enhances the thermal performances of the device, increasing the power handling capability.

The implementation of Intelligent Micro Systems (IMS) will require the achievement of new components that are reliable and able to manage simultaneously high RF powers and re-configurability properties (such as changing output power and bandwidth requirements). A successful integration of nanostructured materials and novel sensors and actuators in RF Micro Electro Mechanical Systems (RF-MEMS) switches will enable miniaturized reconfigurable microwave components and systems with very high power handling and reliability capabilities (e.g. adaptive transmitters and frequency-agile robust receivers).

Focus : Nanocom missions

The main objectives of NANOCOM are:

- ✓ Explore new nanostructured materials to be used as dielectrics in RF-MEMS devices to achieve higher reliable devices by minimizing charging effects and improving thermal dissipation under high power.
- ✓ develop the design methodologies and technological process to achieve the integration of these MEMS switches in phase shifters and SPDT devices;
- ✓ develop gas and pressure sensors and actuators of unprecedented performance that can be integrated with RF components of the same type to perform complex functions such as sensing/actuating combined with wireless transmission of data.

Components of this type can improve the energy efficiency of systems by leading to efficient power supplies with intelligent energy control while allowing at the same time an increase of safety and functionality. 4 demonstrators will be fabricated by implementing them in a reconfigurable T/R module, a tunable filter and a reflect array antenna and a nitride-based sensor and actuator.

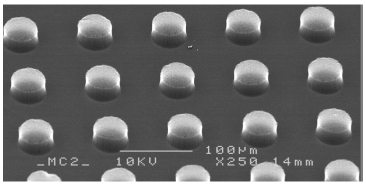
Presentation of the project activities

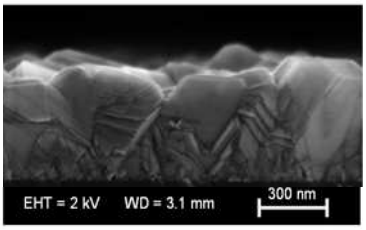
❑ Nanostructured materials integration

The aim of nanostructured dielectric development is to reduce the major failure mode of stiction due to dielectric charging in RF-MEMS capacitive switches. In NANOCOM different new nanostructured dielectric will be developed, such as:

- Integration of nanostructured PZT
- Development and integration of oriented carbon nanotubes in silicon nitride dielectric
- Development and first integration of diamond thin layers

These materials will be characterized in term of electrical and thermal properties.

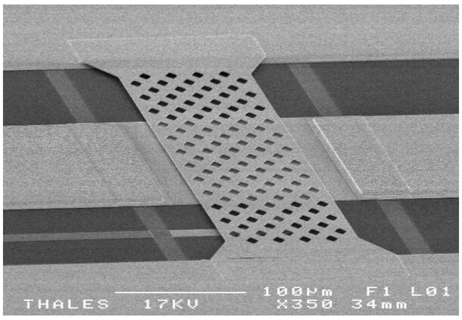




❑ WBG devices for microwave mm-wave circuit

In spite of the recent remarkable progress in microwave and millimeter-wave applications of WBG devices, no results have been reported so far on MEMS switches on GaN/SiC substrates. In scientific literature there is, to this date, no mentioning of any attempt to combine different active and passive RF functions (such Power Amplifier PA, Low Noise Amplifier LNA and switching networks) using GaN MMICs and RF-MEMS based technologies. In Nanocom we aim at combining :

- GaN technology
- High power, High efficiency, 1-40 GHz transistors
- RF-MEMS integration :
- High Integration density
- RF performance
- Thermal management
- Reliability
- RF-MEMS process flow compatibility



Demonstrator

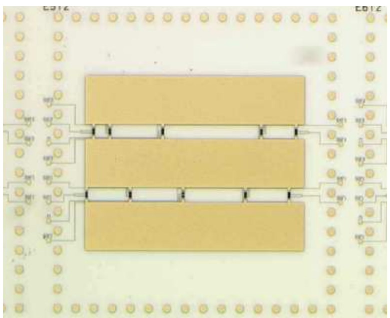
Four demonstrators will be developed in the Nanocom project.

Demonstrator 1 : Reconfigurable smart active antennas with RF-MEMS switches (Agile RF transceiver)

The application of smart antennas for next-generation communication systems is particularly attractive since in the near future there will be a huge expansion of such infrastructures, and since wireless LAN's will be employed not only in metropolitan networks for wide-band mobile communications, but also in indoor entertainment and UWB communication devices. The development of such enabling technologies will be therefore of great importance and will also create business opportunities in these fields.

Demonstrator 3 : RF-MEMS based Reconfigurable Reflect Array antenna

Reflect arrays can be said to combine some of the best features of the conventional printed phased array and parabolic reflector antennas. Reflect arrays are much less expensive than standard phased arrays and provide ample space for drivers and receiver electronics. They are space fed; therefore, they do not suffer from the high transmission-line (corporate feed) loss as the array size increases. The successful realization of the NANOCOM components and their corresponding fabrication process flows will have a strong leverage effect at the functional and system levels.



Phase shifting cell

Demonstrator 2 : RF-MEMS based Agile Radio (Tunable filter) for Air Traffic Management Radars. (Agile Radio)

The trend in radar architecture is to limit the analog signal processing to the front end of the radar. Thus, in future radar systems, the A/D converters will directly follow the receiver. This implies new constraints on receiver specifications in term of frequency agility. The tunable filter requirements are mainly driven by the required system capability of an airport radar sensor operating in a severe signal environment (air traffic management application). By using highly selective (narrow-band) RF front-end filters that are placed close to the antenna (i.e. in the radar receiver) it may be possible to reject interfering out-of-band signals that otherwise could jam the receiver.

Demonstrator 4 : A miniaturized piezo sensor and actuator based on III-Nitride materials (Energy Efficient systems through Piezo MEMS sensors and actuators)

The demand for solid state device gas sensors has been increasing due to the importance of low power consumption and circuit integration ability. Wide band-gap materials are considered as a promising new class of sensors for high temperature and harsh environment applications such as engine exhaust and combustor exhaust monitoring because of their chemical and thermal stability. Small Fermi level pining is considered to be an additional advantage. GaN and its heterostructures will be employed as sensors for different gas species, gas concentrations and operating temperatures with the aim of optimizing sensor performance.

Organization of the different steps of the project

The achievement of the Nanocom objectives can only be fulfilled through a well-coordinated effort. This undertaking involves tasks ranging from deposition and characterization of nanostructured materials to electromagnetic modeling of RF-MEMS, advanced WBG semiconductor technologies to antenna fabrication and component development to system integration. The work plan methodology is based on a top-down philosophy that employs efficiently both the broad expertise of the partners as well as their long-standing collaborative links. The goal is to devise novel technological "vehicles" in order to develop a new type of IMS based on WBG for harsh environment operation and high power handling applications.
In order to achieve the goals that we described previously, the scientific and technical program of NANOCOM will be developed on the main following tasks :

- Integration of new nanostructured materials (as new dielectrics) in the existing MEMS technology (WP2 –tasks 2.1 to 2.3):
  - PZT thin layers with improved performances in term of the electrical conductivity
  - Aligned carbon nanotubes within a Si3N4 dielectric matrix
  - Nanocrystalline diamond.
- Study and development of the technological process in order to reduce the size of the MEMS Switches. This activity will focus on the development of the technological process with the same material (PZT) than the standard one (WP2 task 2.4 & 2.5). Integration of the new nanostructured dielectrics with MiniMEMS technology.
- Design , fabrication and testing of GaN, Si and LCP based RF-MEMS and MiniMEMS circuits (SPDTand T/R modules) (WP3)
- Design, fabrication and testing of MEMS based switch capacitors and phase shifters on GaN, Si and LCP(WP4)
- Integration of GaN MMIC with RF-MEMS technology (WP5)
- Fabrication of 4 demonstrators : smart active antenna, miniaturized reconfigurable front-end and a reflect array antenna and also miniaturized piezo sensor and actuator based on III-Nitride materials (WP6)
- Development of measurement tools and lateral resolution enhancement techniques for the electro-thermo-mechanical characterization of small size RF MEMS. (WP2 task 2.5) (to be used in all technical WPs)