

Multi-functional and Reconfigurable Piezoelectric MEMS/NEMS Resonators for Advanced Sensing and Wireless Communications

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Sensors are nowadays found in a wide variety of applications, such as smart mobile devices, automotive, healthcare and environmental monitoring. The recent advancements in terms of sensor miniaturization, low power consumption and low cost allow envisioning a new era for sensing in which the data collected from multiple individual smart sensor systems are combined to get information about the environment that is more accurate and reliable than the individual sensor data. By leveraging such sensor fusion it will be possible to acquire complete and accurate information about the context in which human beings live, which has huge potential for the development of the Internet of Things (IoT) in which physical and virtual objects are linked through the exploitation of sensing and communication capabilities with the intent of making life simpler and more efficient for human beings.

This trend towards sensor fusion has dramatically increased the demand of new technology platforms, capable of delivering multiple sensing and wireless communication functionalities in a small foot print. In this context, Micro- and Nanoelectromechanical systems (MEMS/NEMS) technologies can have a tremendous impact since they can be used for the implementation of high performance sensors and wireless communication devices with reduced form factor and Integrated Circuit (IC) integration capability.

This work presents a new class of Aluminum Nitride (AlN) piezoelectric nano-plate NEMS resonant devices that can address some of the most important challenges in the areas of physical, chemical and biological detection and can be simultaneously used to synthesize high-Q reconfigurable and adaptive radio frequency (RF) resonant devices. By taking advantage of the extraordinary transduction properties of AlN combined with the unique physical, optical and electrical properties of advanced materials such as graphene, phase change materials and magnetic materials, multiple and advanced sensing and RF communication functionalities are implemented in a small footprint. Particular attention is dedicated to the key attributes of such piezoelectric MEMS/NEMS devices in realizing intrinsically switchable and reconfigurable RF MEMS components, high performance gravimetric chemical sensors, ultra-fast and high resolution un-cooled IR/THz detectors and ultra-miniaturized and low power magnetoelectric sensors.

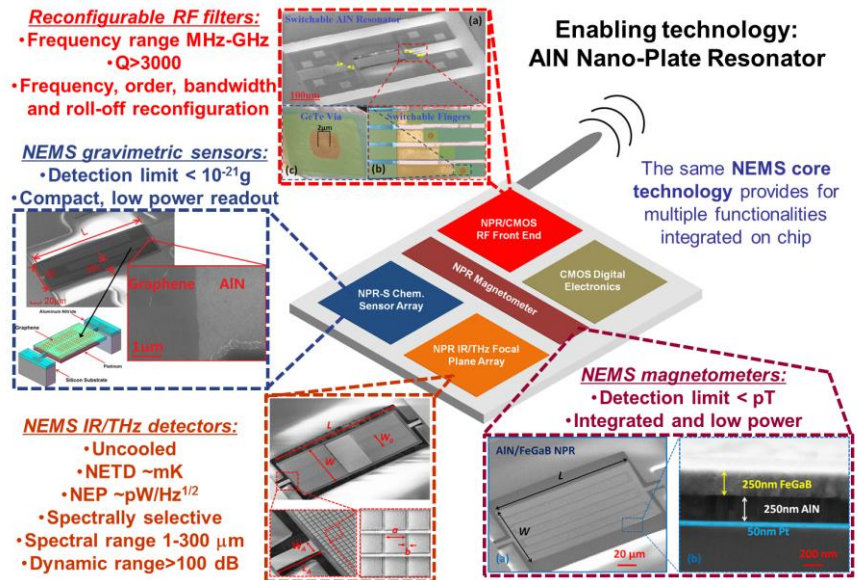


Fig. 1: Schematic representation of multiple sensing and wireless communication functionalities implemented by the core AlN Nano-Plate Resonator technology.