Graphene-Aluminum Nitride Nano Plate Resonators

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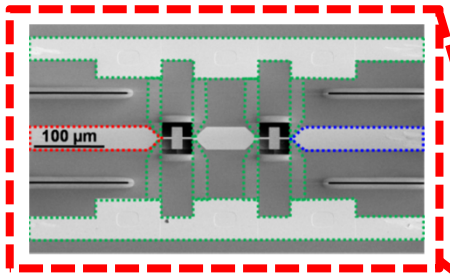
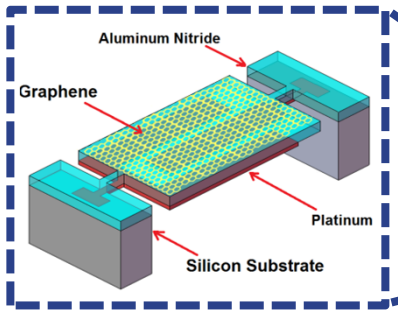
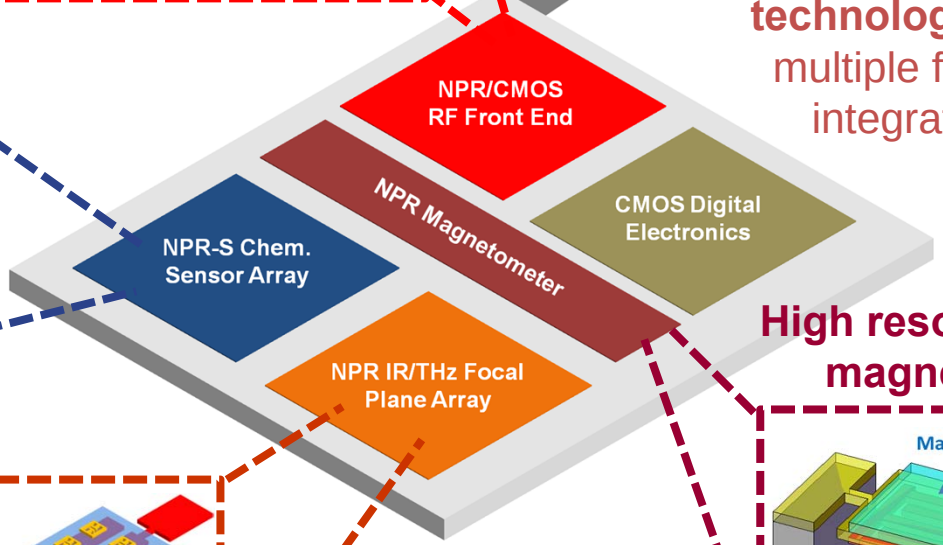
Multi-function Piezo NEMS Resonators

RF MEMS devices for wireless communications



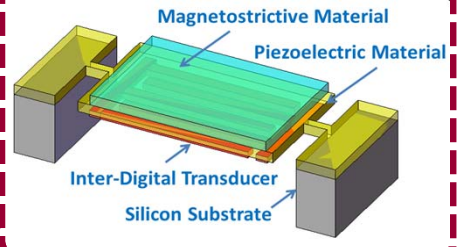
Ultra-sensitive NEMS gravimetric sensors

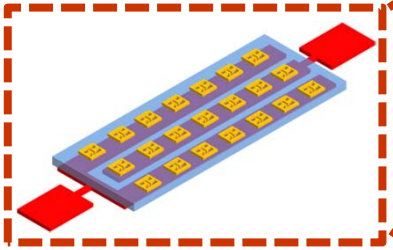




The same **NEMS core technology** provides for multiple functionalities integrated on chip

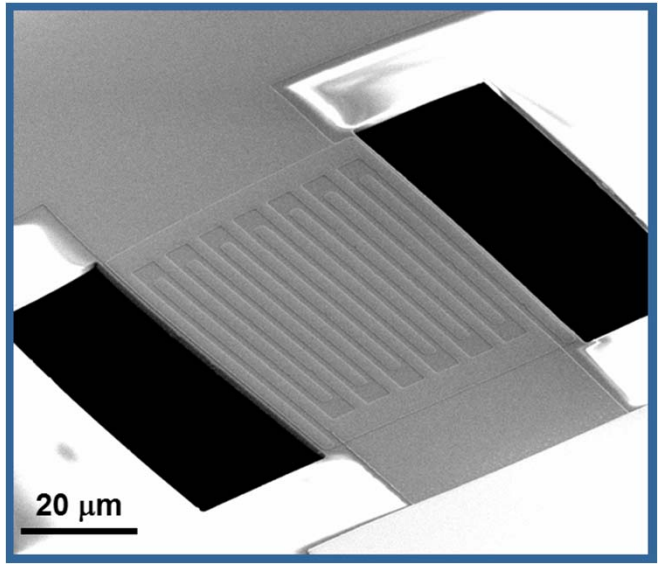
High resolution NEMS magnetometers

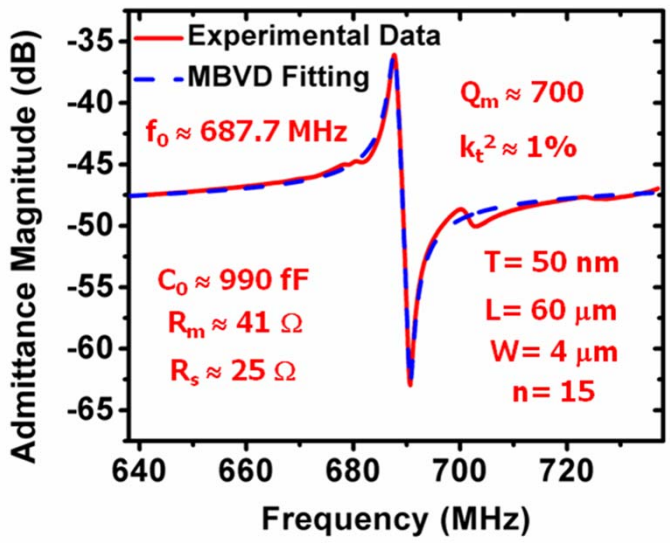


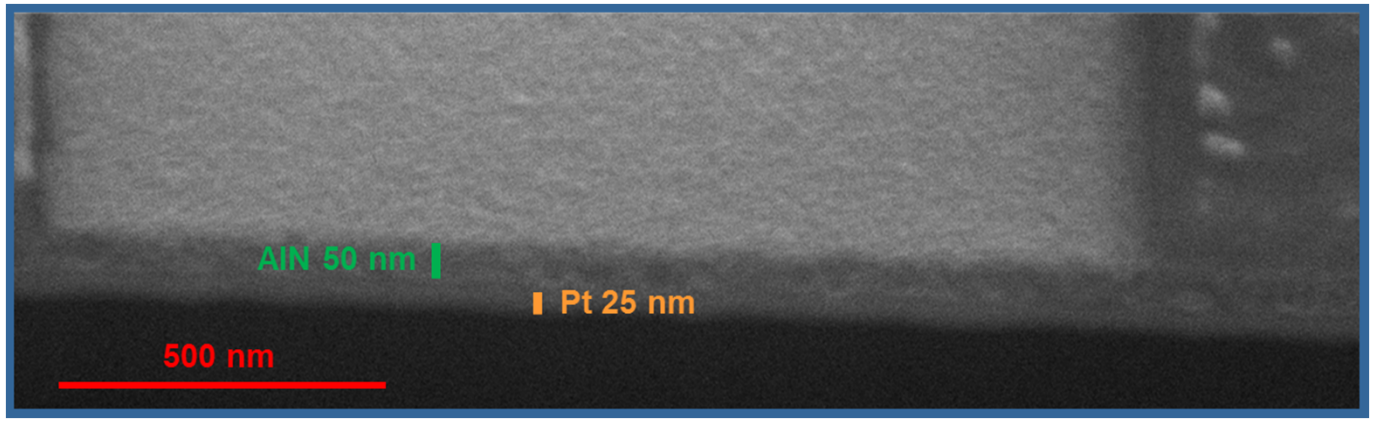


Uncooled, high resolution and ultra-fast NEMS IR/THz detectors for chip-scale IR/THz spectroscopy

Scaling of Piezo NEMS Resonators







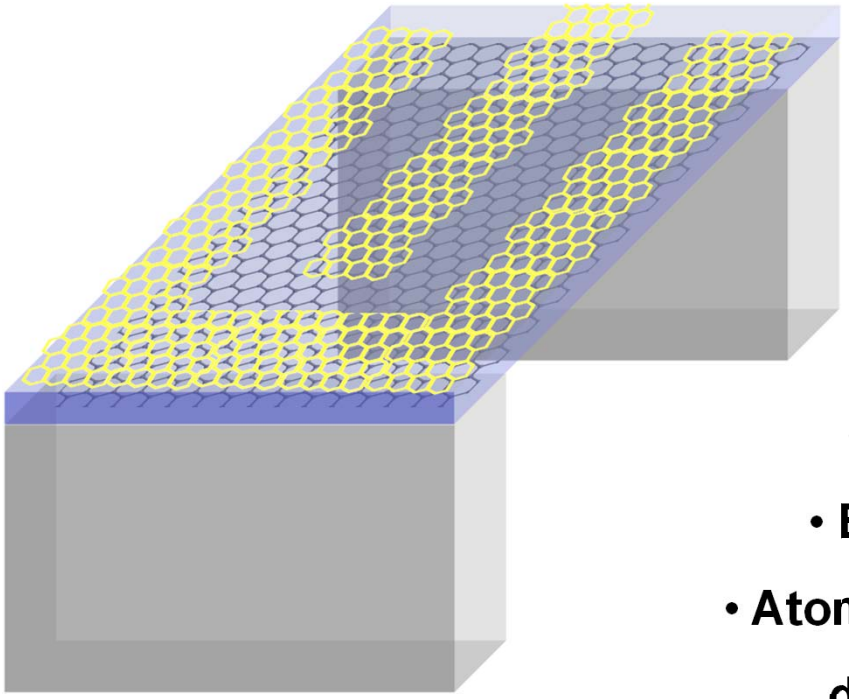
Au 25nm

AlN 50nm

Pt 25nm

83% mass come from metal electrodes!

Graphene-AlN Nano Plate Resonator



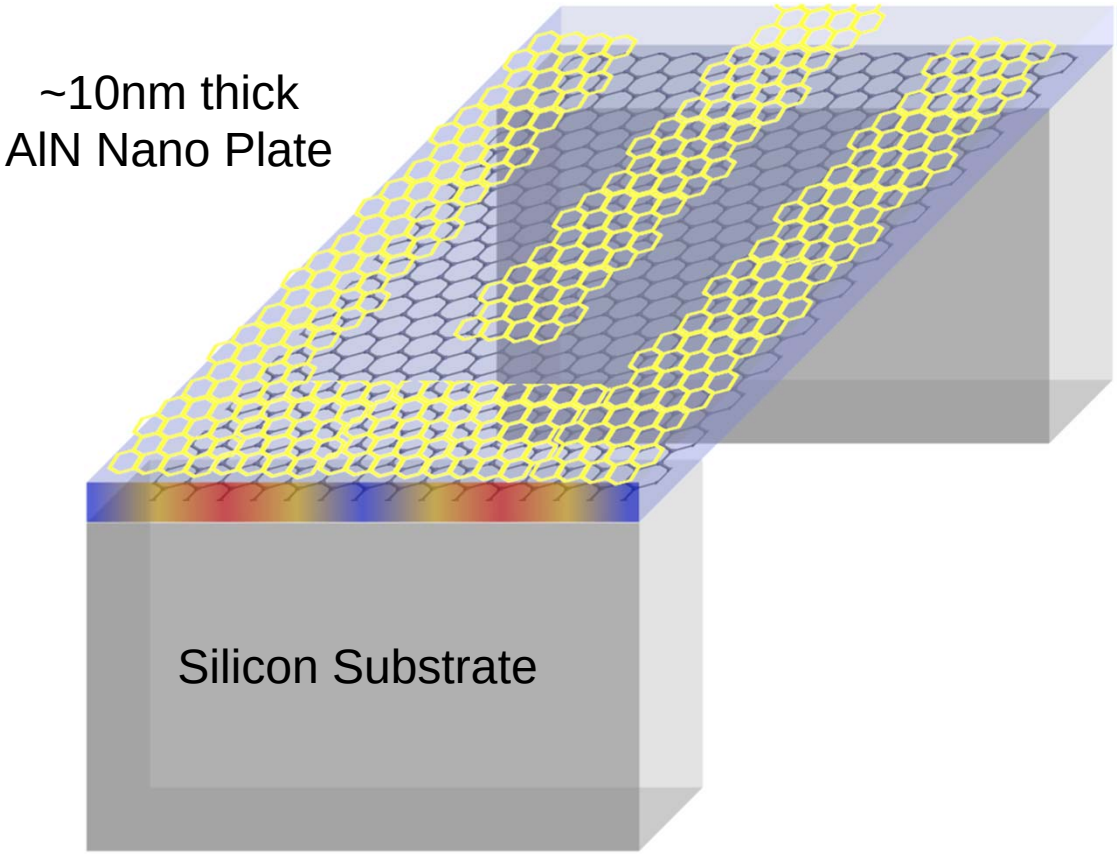
Advantages of Graphene electrode:

(Comparison between a graphene monolayer and 1nm ALD Platinum)

- **Very high electrical conductivity**
  (Rs 60Ω/sq :150Ω/sq)
- **Extremely low mass (1:10)**
- **Ultra-thin (one atomic layer 0.6nm)**
- **Effective chemical interactive material**
- **Atomic monolayer introduce lowest electrode damping and interface strain (High Q)**

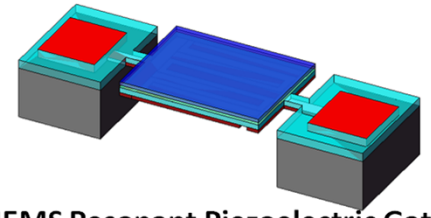
Graphene-AlN Nano Plate Resonator

Graphene electrodes to solve **fundamental scaling issue** associated to metal loading in piezoelectric NEMS resonators

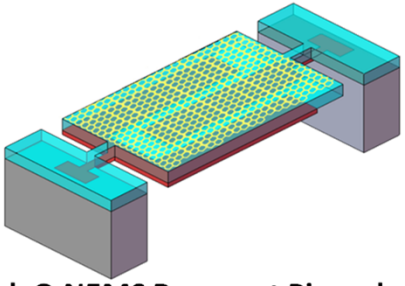


Graphene-AlN nano plate excited to vibrate at high frequency in its contour-extensional mode

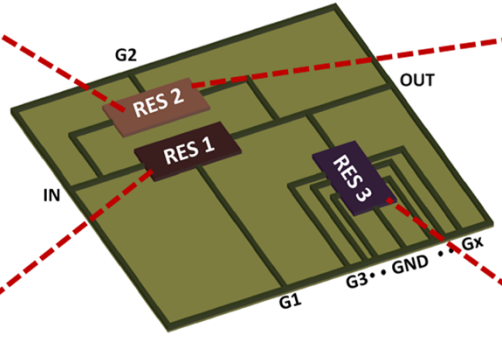
Reconfigurable Low Power Radio Architectures



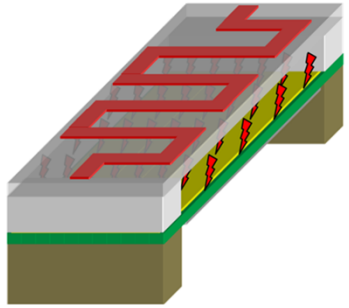
MEMS Resonant Piezoelectric Gate Thin Film Transistor



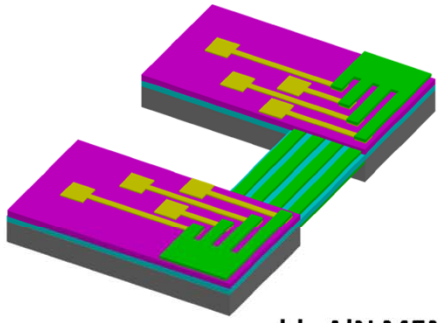
High Q NEMS Resonant Piezoelectric Gate Graphene Transistor



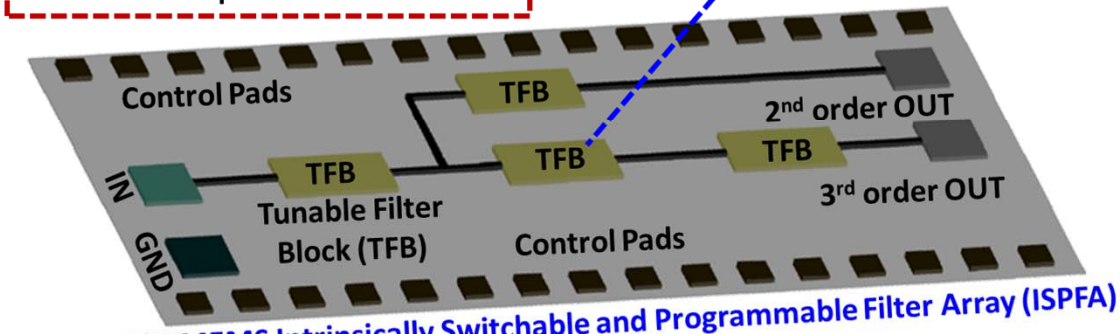
Tunable filter block based on Intrinsically switchable and frequency programmable AlN MEMS acoustic devices



Intrinsically switchable AlN/PC micro-ovenized MEMS resonator

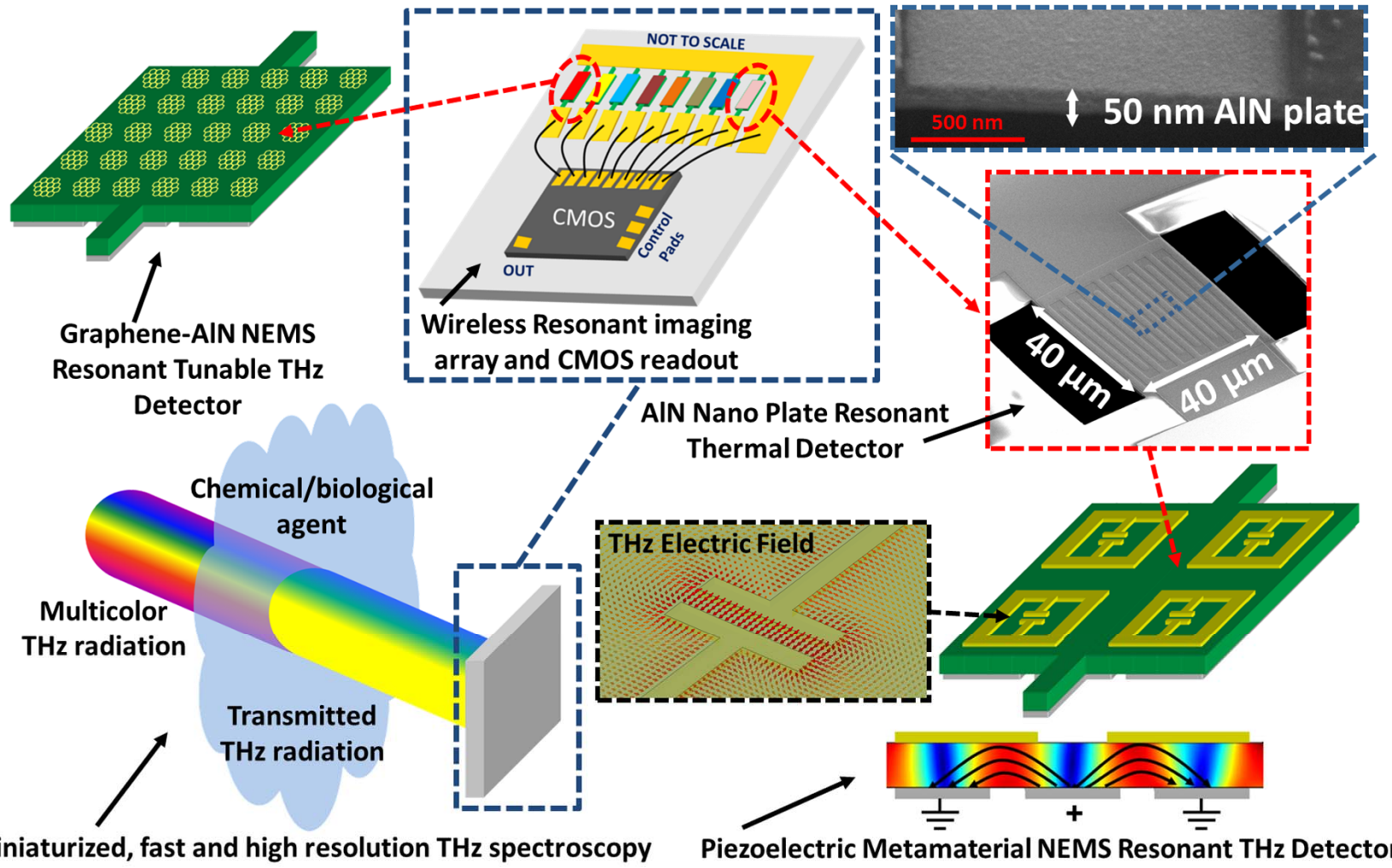


Frequency programmable AlN MEMS Resonator



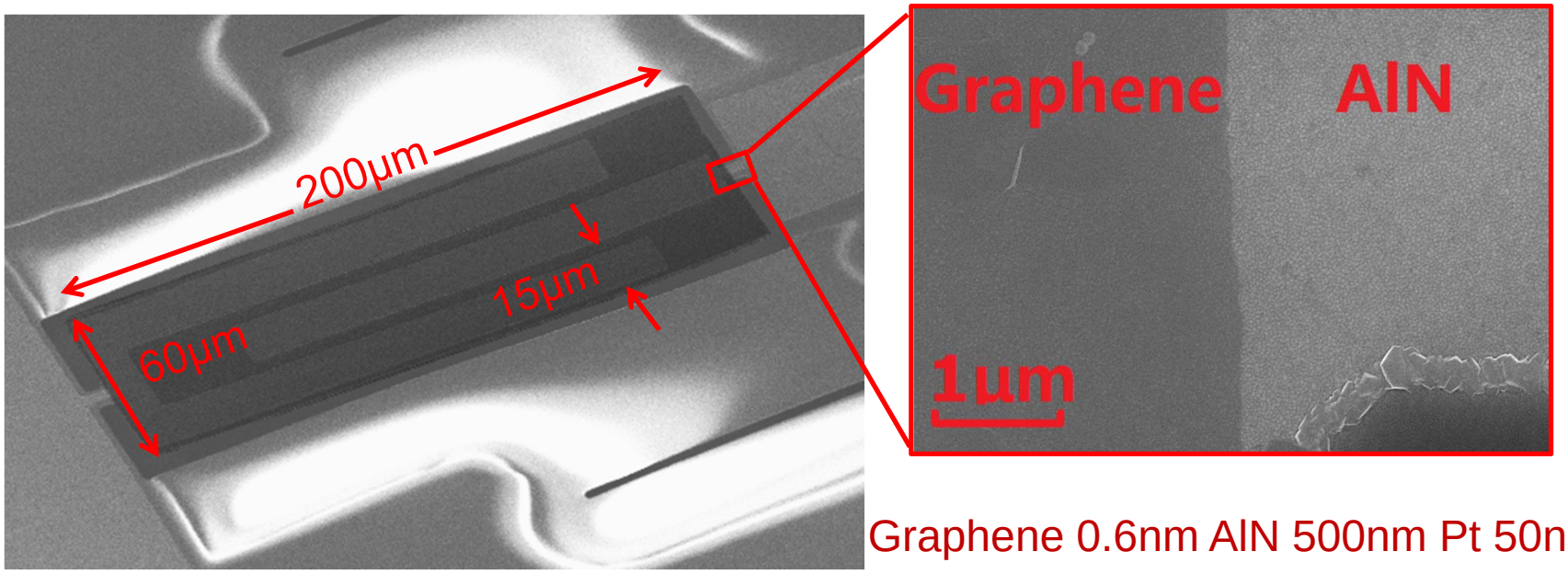
AlN MEMS Intrinsically Switchable and Programmable Filter Array (ISPFA)

Un-cooled NEMS Resonant THz Detectors



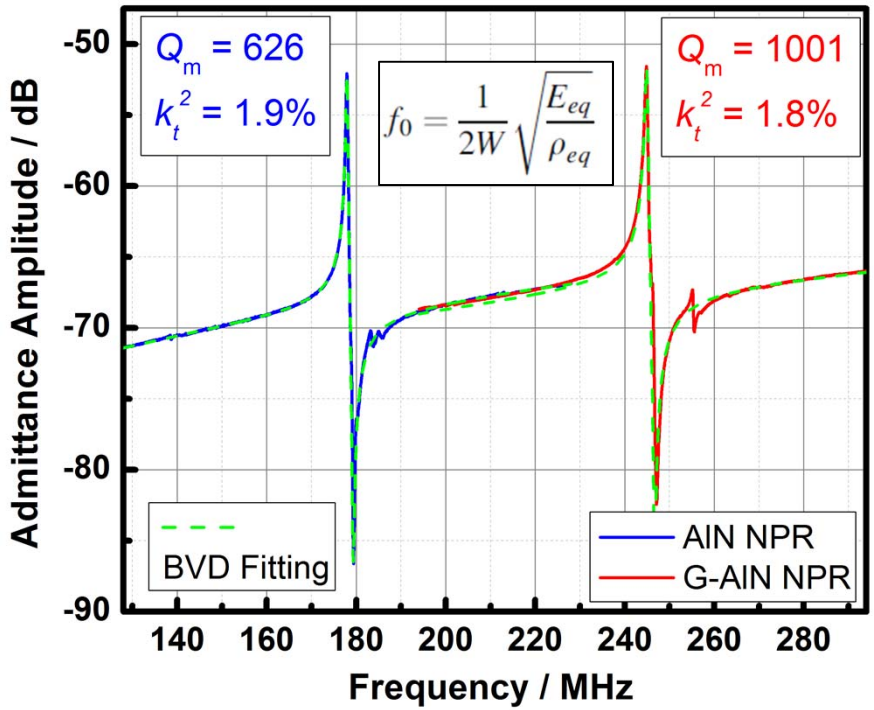
Northeastern

Experimental Results



Graphene 0.6nm AlN 500nm Pt 50nm

Experimental Results



	f_0	Q_m	k_t^2	C_0	R_m	R_s
AlN	178MHz	626	1.90%	324fF	285Ω	128Ω
G-AlN	245MHz	1001	1.81%	282fF	157Ω	228Ω

Higher operating frequency and *comparable* kt^2*Q_{load} in a reduced volume was achieved with the G-AlN NPR!

Experimental Results

As proof of concept of the switching mechanism the electrical conductivity of the graphene layer was changed by doping

Over 6 order of magnitude increase in resistivity for fluorinated graphene has been reported in literature.

The graphene electrode was fluorinated with xenon difluoride (XeF2) gas fully demonstrating the effectiveness of the proposed switching mechanism.