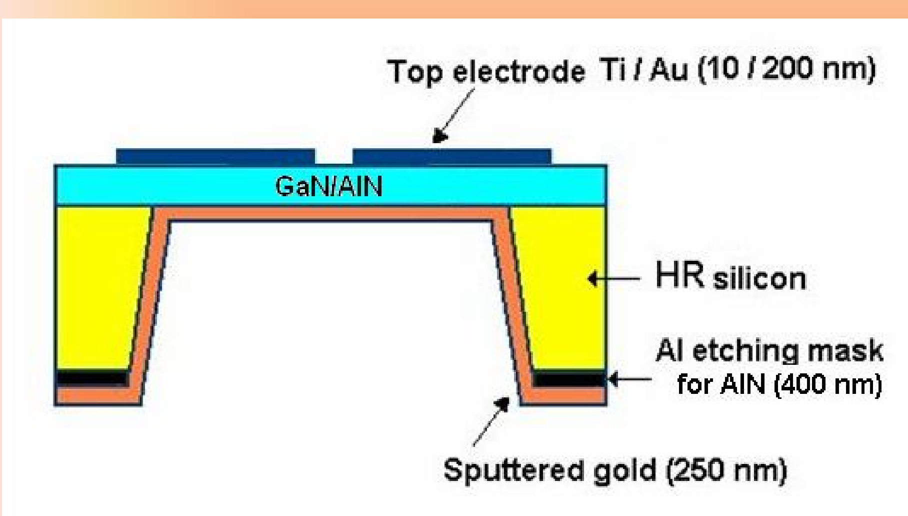
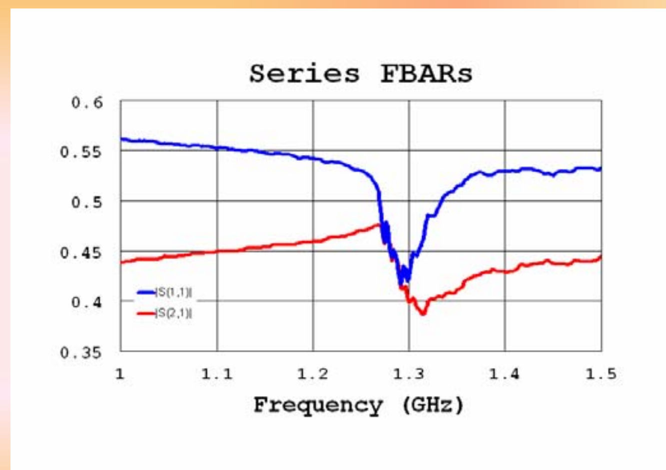
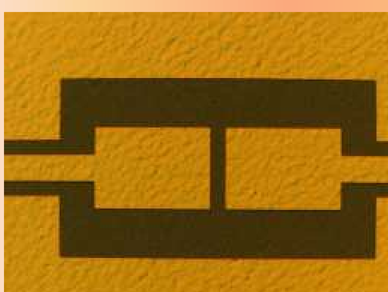
First GaN membrane FBAR structures

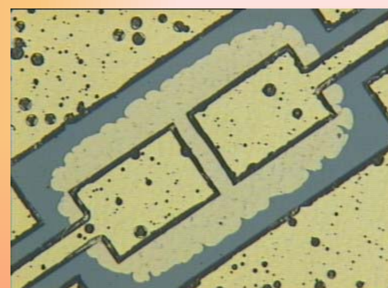
(series connection of 2 FBARs)



IMT-Bucharest and FORTH-Heraklion in the frame of the FP6 "AMICOM" NoE







GaN membrane supported series connection of two FBAR structures (test structures)

A. Muller, D. Neculoiu, D. Vasilache, D. Dascalu, G. Konstantinidis, A. Kosopoulos, A. Adikimenakis, A. Georgakilas, K. Mutamba, C. Sydlo, H.L. Hartnagel, A. Dadgar, "GaN micromachined FBAR structures for microwave applications", *Superlatices & Microstructures*, 40, 2006, pp426-431

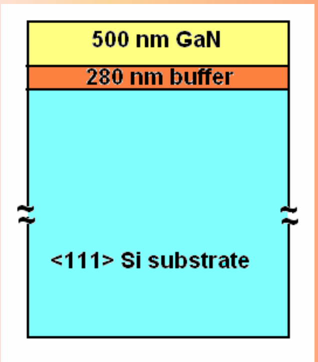
The thickness of the membrane was 2.2µm

GaN FBARs (1)

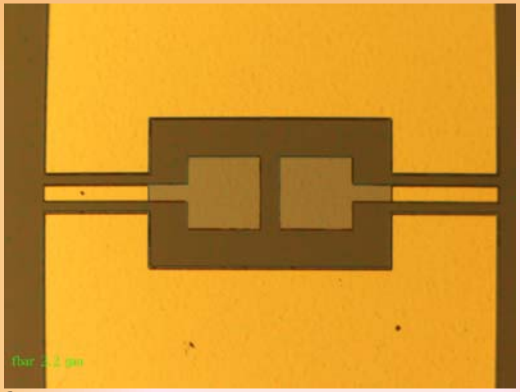
IMT and FORTH
March 2008

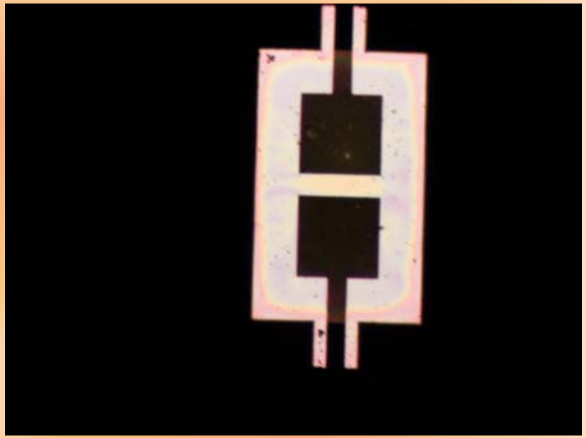
500 nm (GaN) +280nm (buffer) thin membrane supported FBAR structure based on GaN micromachining

- 50nm thin Mo metallization
- GaN/Si wafers from NTT AT Japan



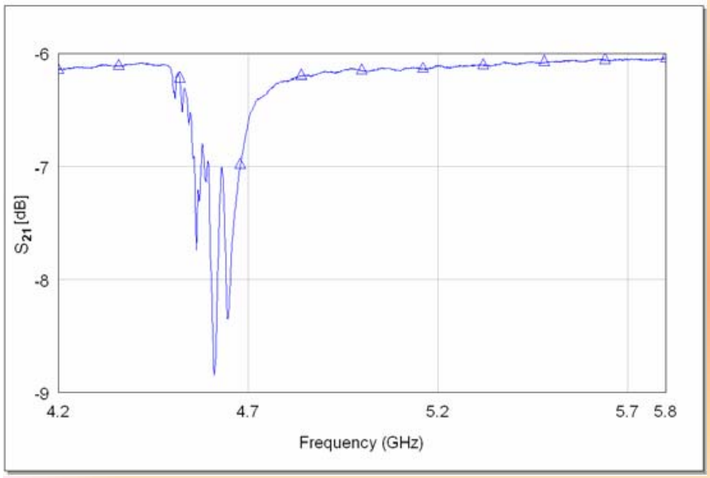
Before membrane manufacturing

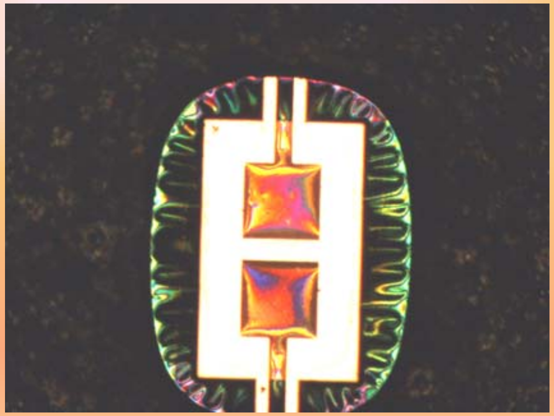


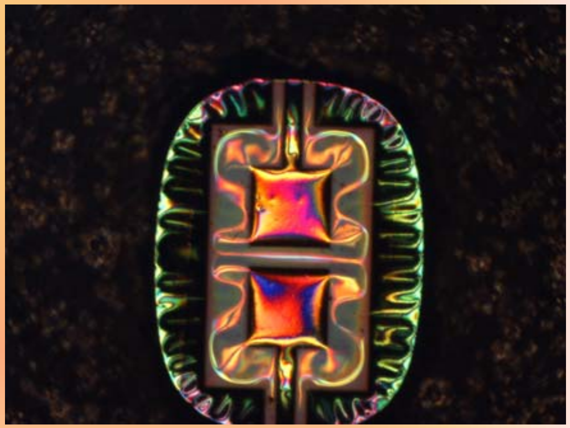


Top view; bottom illumination

Top view top illumination







Top view; top+ bottom illumination

Resonance at 4.6 GHz has been observed

GaN FBARs (2)

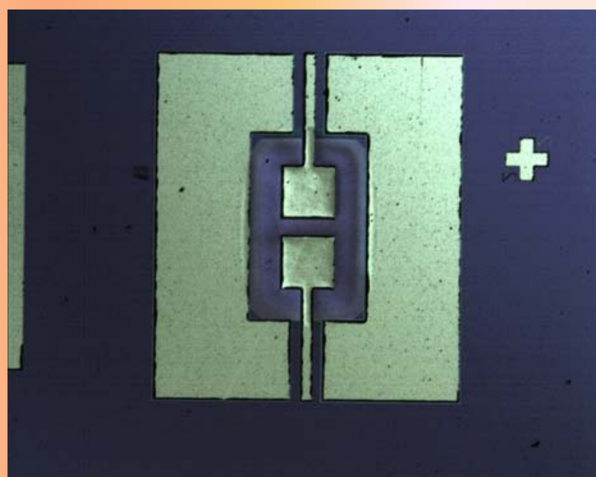
IMT and FORTH, July 2008

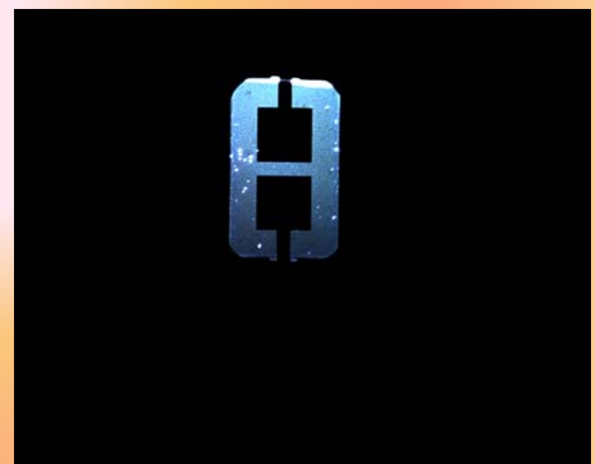
300 nm (GaN) +200nm (buffer) thin membrane supported FBAR structure based on GaN micromachining

50nm thin Mo metallization

GaN/Si wafers from NTT AT Japan

Mobility costs for common work in FORTH labs have been supported by MIMOMEMS Project





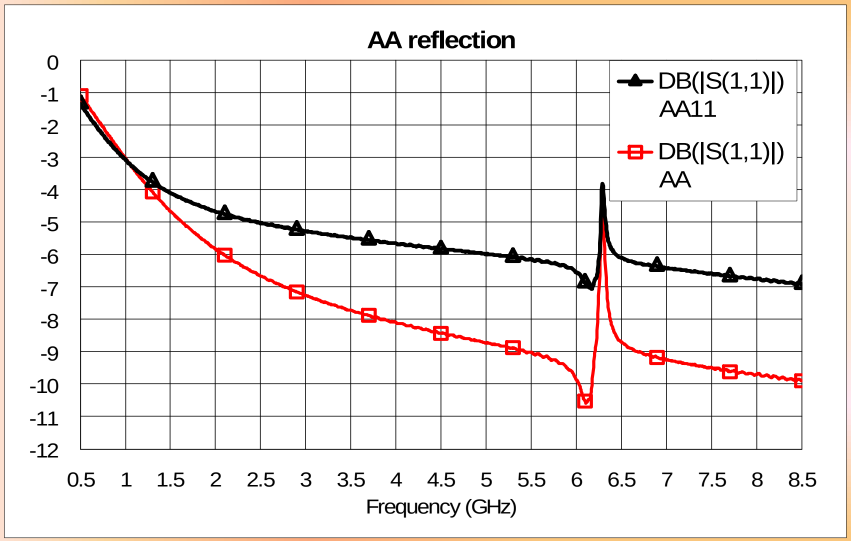
Final structure (top and bottom view)

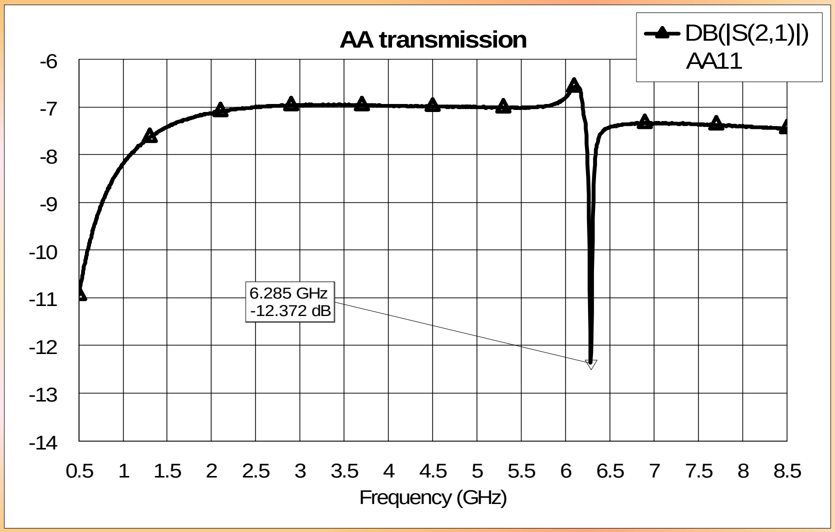
GaN FBARs (3)

IMT and FORTH, July 2008

Mobility costs for common work in FORTH labs have been supported by MIMOMEMS Project

S parameter measurements





Resonance at 6.3 GHz was observed ; values for Q>1000 have been extracted from experimental data.

Potential applications for GaN FBARs working in the GHz frequency range:

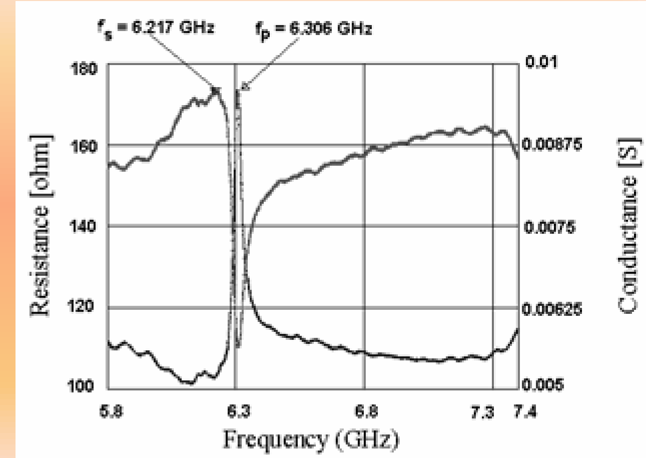
-high Q filters for 4 G mobile phone technology

-integrated gas sensors

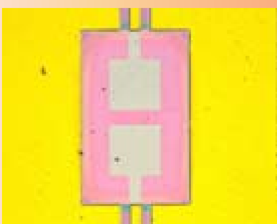
6.3 GHz resonance on a GaN FBAR obtained by micromachining of GaN/Si

IMT and FORTH

- 340 nm (GaN) +200nm (buffer) thin membrane supported FBAR structure based on GaN micromachining
- 50nm thin Mo metallization *GaN/Si wafers from NTT AT Japan*

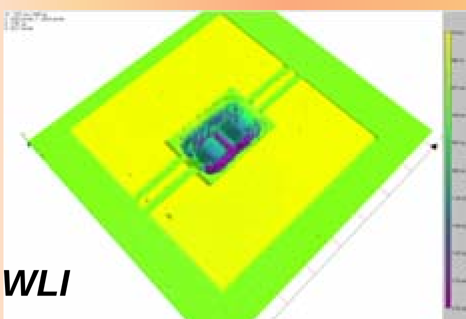


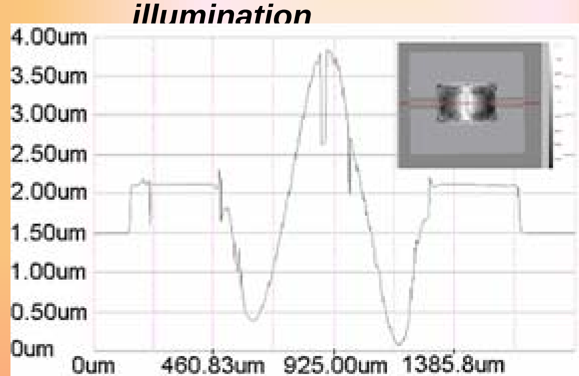
Q=1130



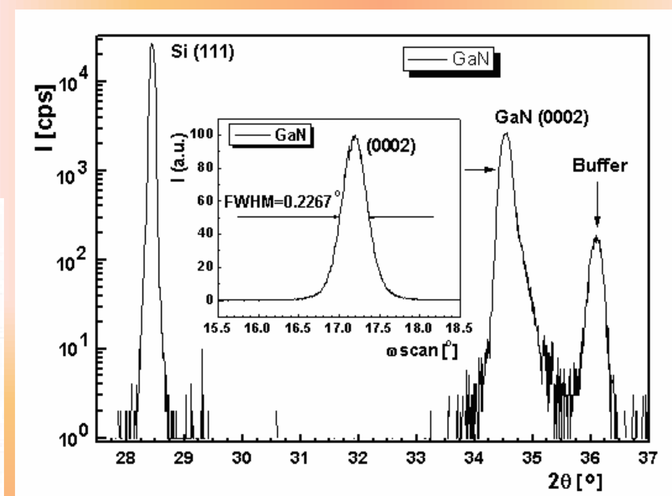
Top view with top illumination

Bottom view with top illumination





Maximum deflection 2.7μm



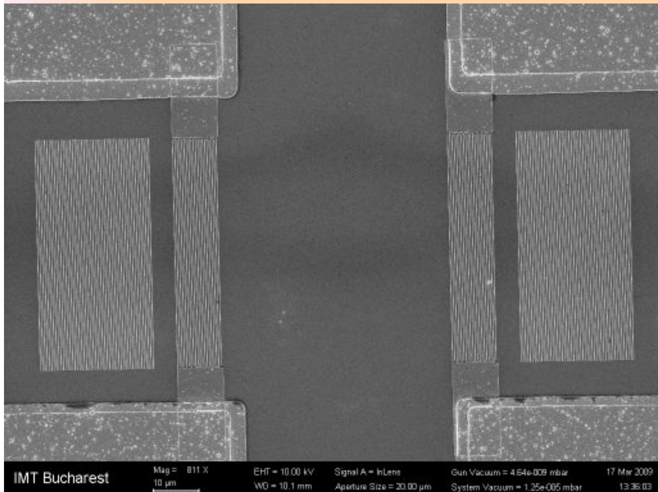
XRD

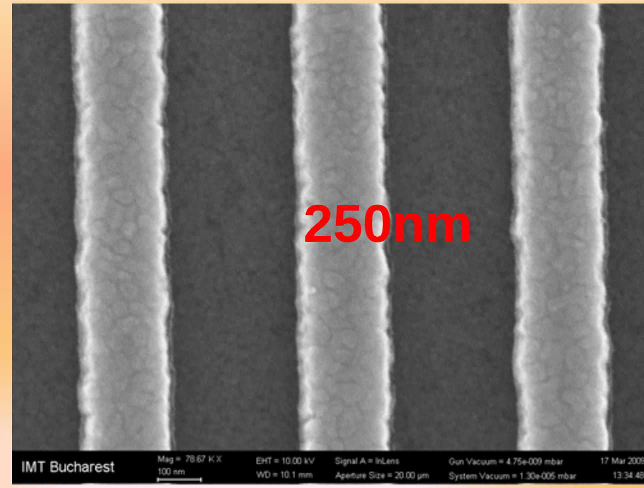
$$\varepsilon=\Delta c/c_o=1.9*10^{-3}$$

Microwave characterization, deflection measurements, stress and material analysis could be performed in IMT with the new purchased equipments

A. Müller, D. Neculoiu, G. Konstantinidis et al. "*6.3 GHz Film Bulk Acoustic Resonator Structures Based on a Gallium Nitride/Silicon Thin Membrane*" **Electron Devices Letters , August 2009, pp799-801**

GaN SAW structures manufactured using nanolithography

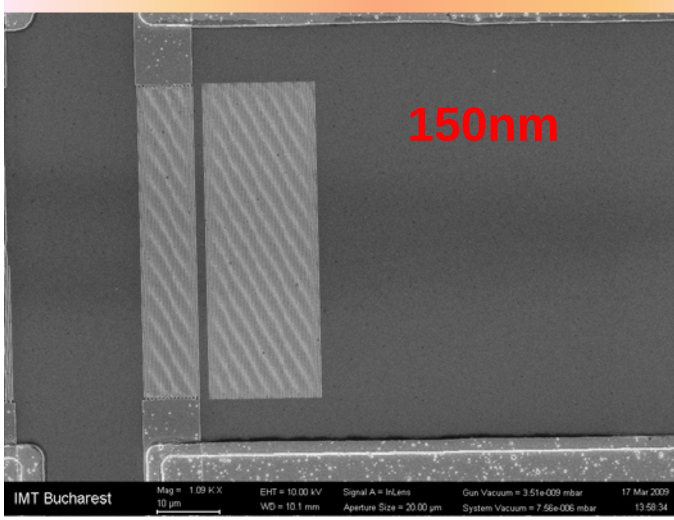


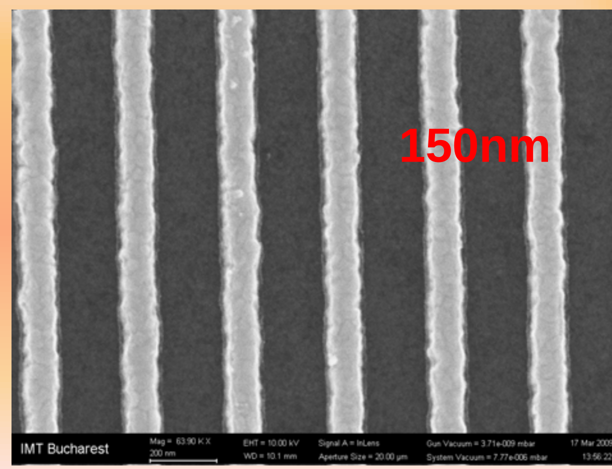


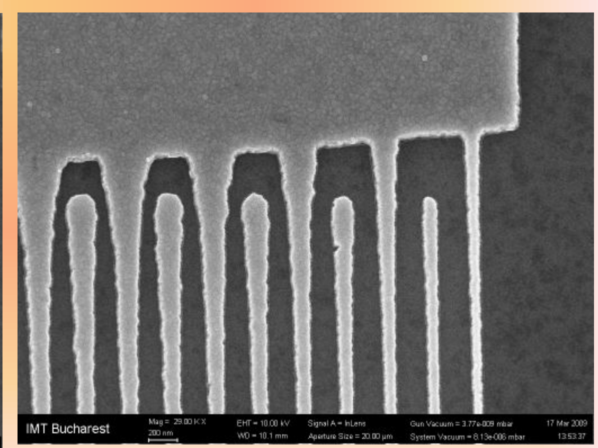
SAW resonators on GaN/Si with fingers and interdigits 250nm wide (up) and 150nm wide (down) ***patterned in IMT on the new "E-Line" equipment***

PMMA 200nm thick metaization Ti/Au 100nm thick

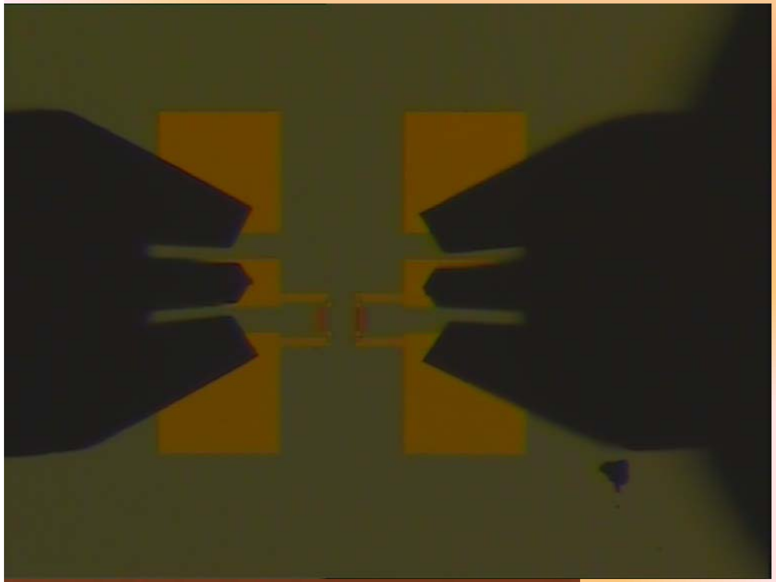
GaN/ Si from Azzuro Magdeburg (1μm thin GaN layer)

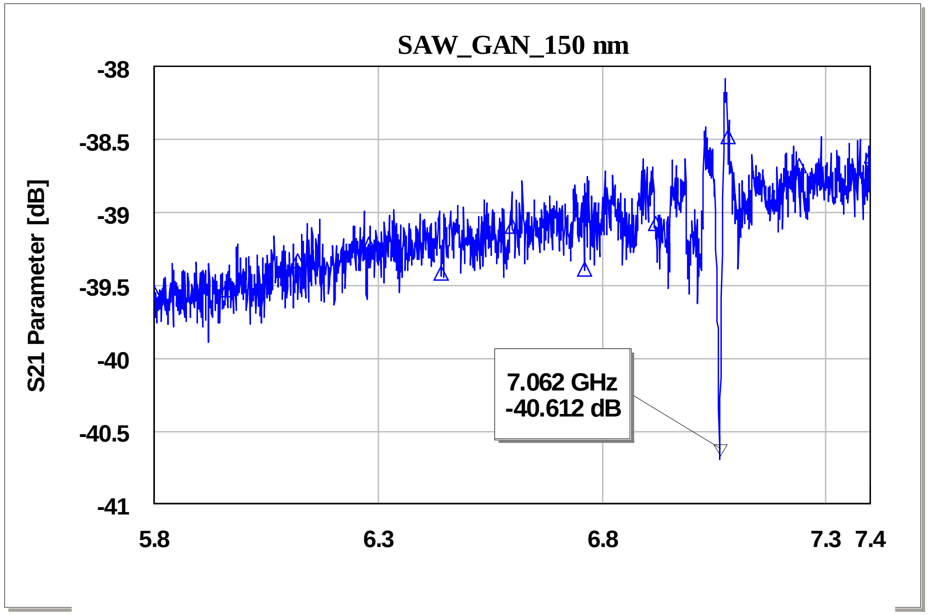


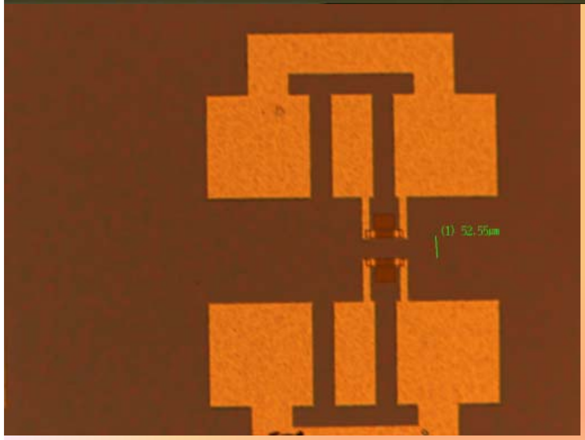


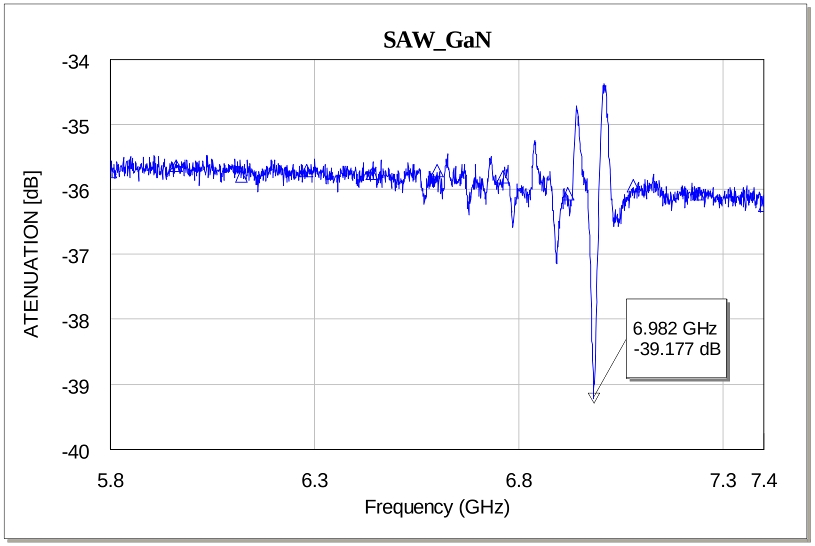


7 GHz rezonance on a SAW structure manufactured on GaN/Si







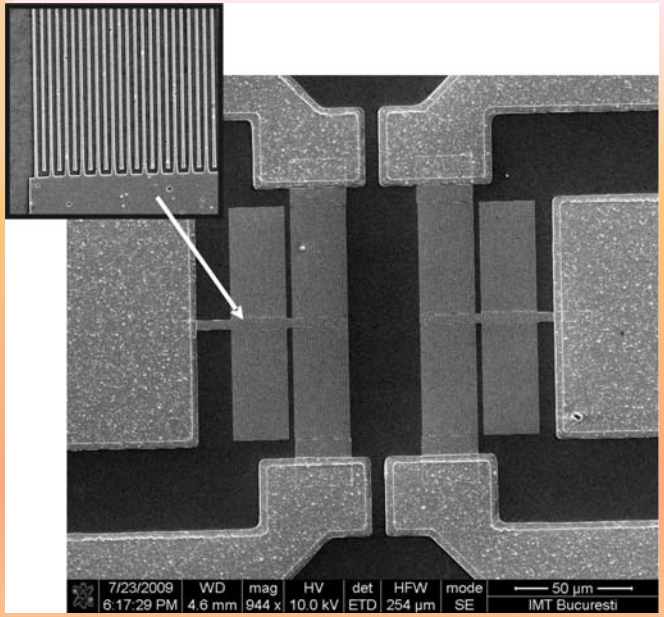


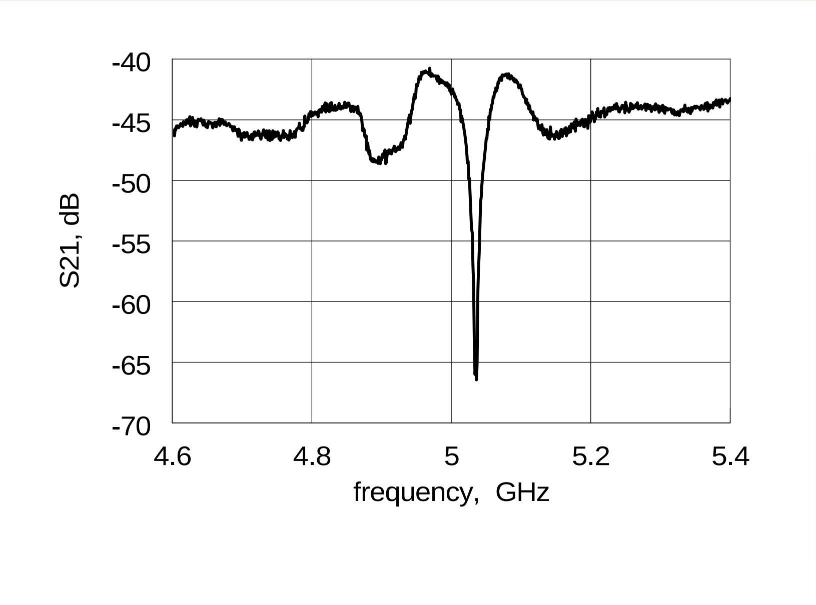
IMT- FORTH 2009

Best results reported up to now on GaN are at about 1 GHz

AlN/Si SAW structure resonating at 5.03 GHz

Fingers and interdigits 250nm wide processed at IMT





IMTBucharest-FORTH Heraklion 2009

D. Neculoiu, A. Müller, G. Deligeorgis, A. Dinescu, A. Stavrinidis, D. Vasilache, A. Cismaru, G. E. Stan and G. Konstantinidis. Submitted to publication Electronic Letters

AlN layer deposited at NIMP -Bucharest

Reconfigurable band-stop filter
IMT-LAAS

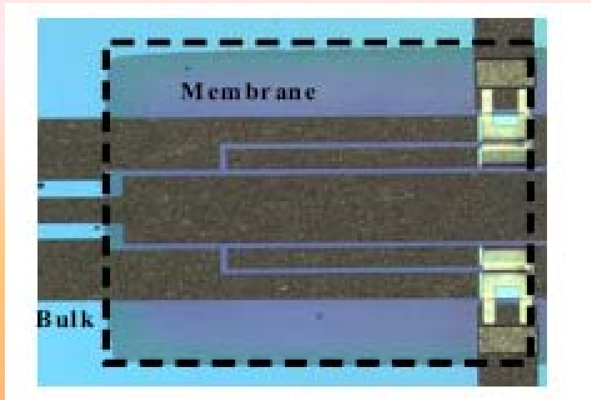
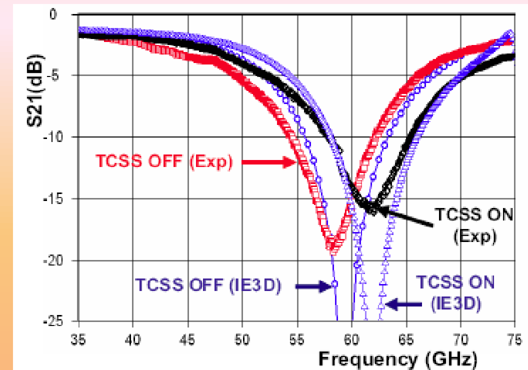


Photo of the manufactured reconfigurable band stop filter **for 60GHz**

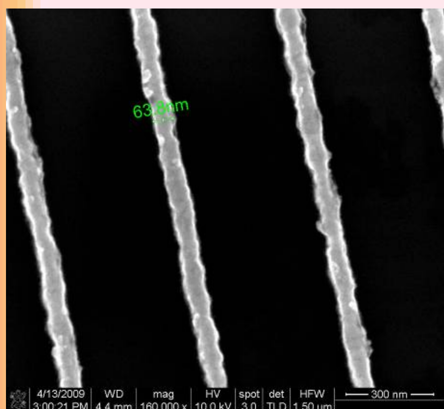


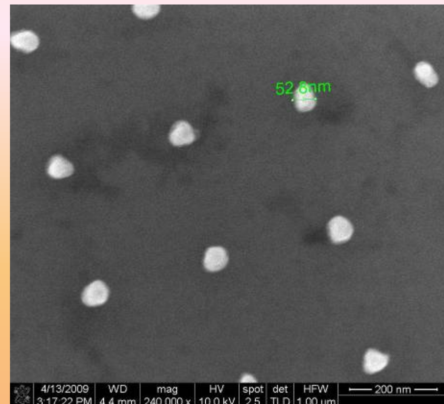
Experimental (Exp) and simulated (IE3D) results for the reconfigurable band stop filter

A Takacs, et al Proc MME 2009

Metallic nanostructures (process development)

The process combines : ***2D and 3 D Electon Beam Litography in a PMMA bi-layer, metal depozition and lift-off***





IMT-FORTH Heraklon Greece

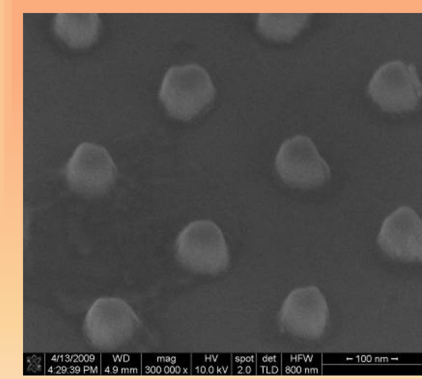
Applications:

-Plasmonics

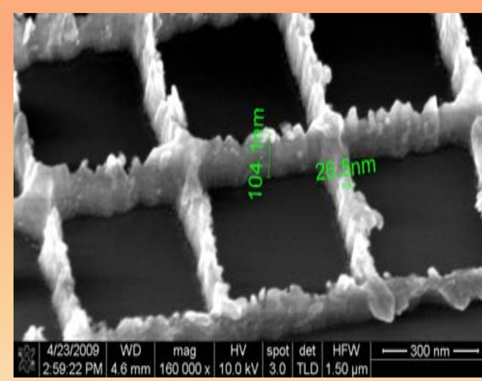
-Photonic crystals

-Master for replication of polymeric optical structures

Metalic nanostructures for plasmonics and for nanoelectrodes



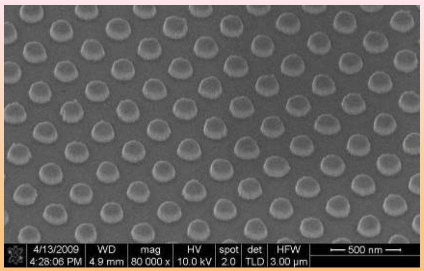
Metallic master for photonic crystals (ϕ << 100 nm)

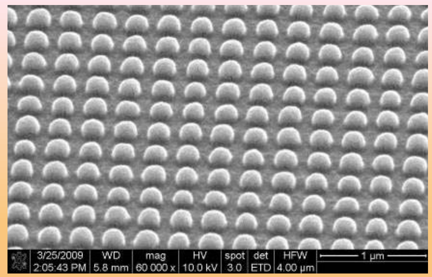


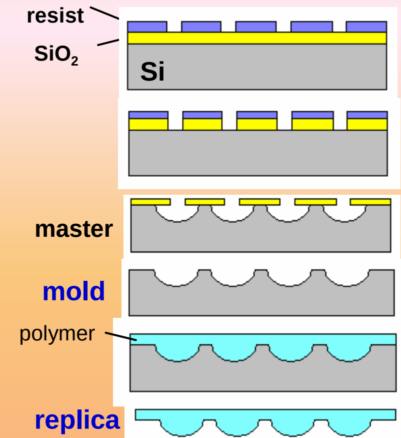
Metallic master for high aspect ratio grating obtained by EBL in PMMA by-layer, metal deposition and lift-off

Replication techniques for micro and nano-optical components

The techniques combine 2D and 3 D optical electon beam litography in a resist bi-layer, lift-off, and replication processes: cast molding, replica molding, nanoimprint.

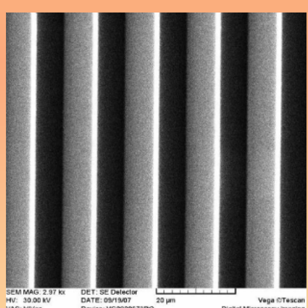




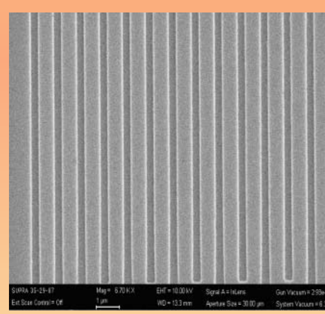


a) b)

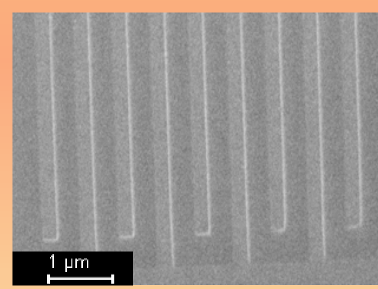
Lenses in epoxy resin obtained by replica molding with a master obtained by EBL in a) a thin layer of PMMA -950K layer; b) double PMMA layer (ϕ~150 nm, h ~200-300 nm).



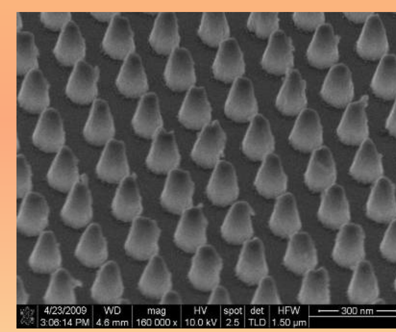
Difraction grating line 8 µm



Difraction grating line 8 µm



Microfluidic channels in PDMS width ~ 250 nm



Antireflective layer obtained by replication of a metallic master (ϕ < 100 nm , H ~250 nm)