Roma Tor Vergata ET research unit presentation

Diana Lumaca for the Roma Tor Vergata group

Who we are?

(1) INFN ROMA TOR VERGATA

(2) TOR VERGATA UNIVERSITÀ DEGLI STUDI DI ROMA

(3) IMM Institute for Microelectronics and Microsystems National Research Council of Italy

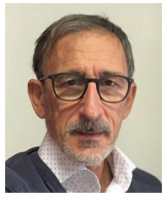
- Elisabetta Cesarini (1)
- Diana Lumaca (1)
- Valerio Scacco (2, 1)



- Fabrizio Arciprete (2)
- Paolo Prosposito (2)
- Fabio De Matteis (2)
- Thu Ha Dao (2)




- Matteo Cirillo (2)
- Zahid Ali (2)
- Fabio Di Pietrantonio (3)
- Raffaella Calarco (3)



Expertise

- Thermal noise issues
- Loss angle measurements and modelling (analytical/FEA)
- Thermal/surface treatments
- Optical characterization
- Morphological characterization
- Structural characterization, crystal kinetics
- Crystal growth
- Thin film deposition
- Photoemission spectroscopy, chemical composition

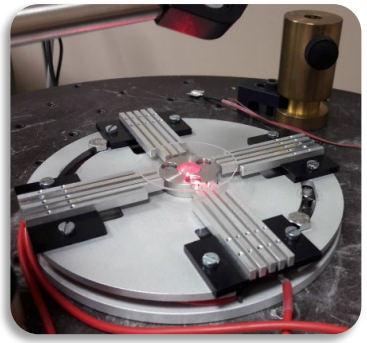
Deposition facilities

- RF sputtering system with 3 cathodes

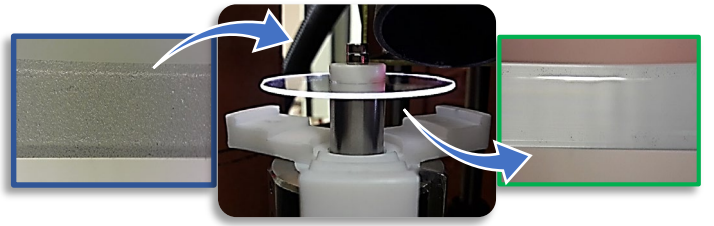
- Sputtering system (Perkin-Elmer) with 2 cathodes (8’’), one for DC one for RF sputtering; cleaning with back sputtering
- Sputtering system (Leybold) with 2 cathodes (4’’) one for DC and one for RF sputtering; sputtering cleaning

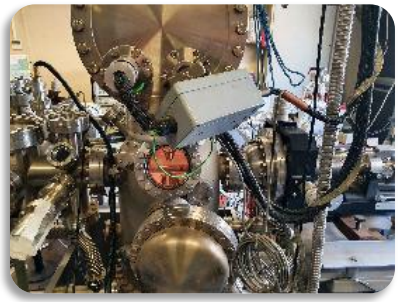
- RF Magnetron Sputtering system, target up to 6.5”, power up to 1000W, substrate temperature from cooled to 600 °C, Background pressure: 10^{-7}/ 10^{-8} Torr (in collaboration with IMM - CNR Roma)

Characterization facilities



- ***GeNS***: 1" - 3" diameter discs, @room T
- ***Oven for thermal annealing***: Lenton Laboratory Tube Furnace LTF 12, maximum temperature 1200 °C, 75 mm diameter, 610 mm heated length
- ***CO_2 laser polishing***: 20 W laser, for 1“ - 2" diameter, 0.5 mm - 1 mm thickness fused silica discs, online planar control



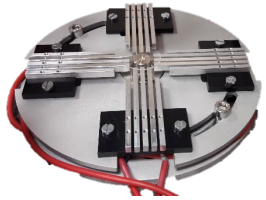


- ***Spectrophotometer***: Perkin-Elmer Lambda 850, 250-1700 nm and integrative sphere for scattering measurements
- ***Ellipsometer***: Woolam VASE, wavelength 250-1700 nm
- ***AFM:*** MultiMode AFM (Bruker Nanoscope IIIa)
- ***XPS***: Al/Mg twin anode X-ray lamp with Kα (1253.6/1486.6 eV) lines (XPS - resolution about 700/850 meV), and He I/II (21.22/40.81 eV) helium discharge lamp (UPS - resolution: 10-100 meV)

… So far

➢ Metrology

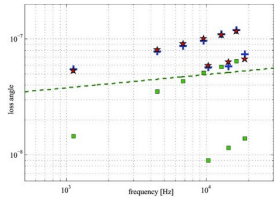
✓ Mechanical characterization with GeNS



Nodal suspension developed by Tor Vergata people and today worldwide considered one of the best tool for mechanical characterization in coating research. It permits to measure dissipation level, energy ratio dilution factor and elastic parameters.

C. Cesarini et al., A "gentle" nodal suspension for measurements of the acoustic attenuation in materials, Rev. Sci. Instr. (2009).

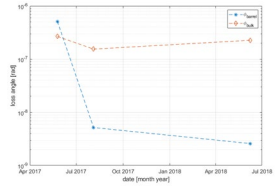
✓ Modeling of losses



Modeling bulk/shear losses edge losses and thermoelastic damping in disk resonator with FEA and analytical models

G. Cagnoli et al., Mode-dependent mechanical losses in disc resonators, Phys. Lett. A (2018), Vol 382

✓ Heating treatment on substrates and coating



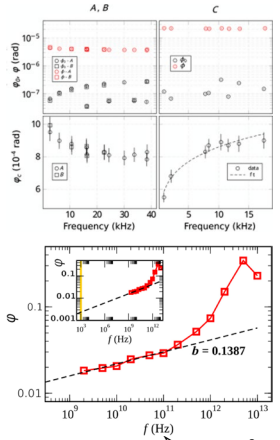
Annealing in air of silica substrates and coatings up to 1200 °C. Innovative technology of CO2 laser polishing for reduction of edge losses and ageing effects.

D. Lumaca et al., Stability of samples in coating research: from edge effect to ageing, J. Alloys Compd. (2023), Vol. 930

✓ Substrate's preparation procedure

➢ Carbides

✓ SiC (in collaboration with UniPD, LMA)



Extensive characterization of amorphous SiC coatings prepared by RF magnetron sputtering (INFN-LNL) and an ion-beam sputtering (IO-CSIC). Detailed study of structural, morphological, compositional, optical and mechanical characteristics, together with molecular dynamic simulations of the amorphous SiC structure.

G. Favaro et al., Measurement and Simulation of Mechanical and Optical Properties of Sputtered Amorphous SiC Coatings, Phys. Rev. Applied (2022), Vol. 18

➢ Nitrides

✓ GaN

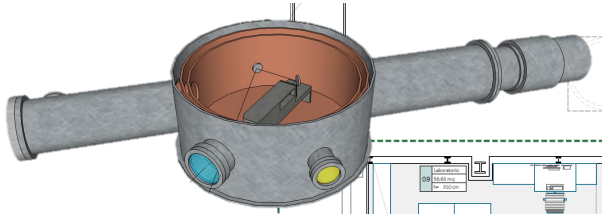
Characterization of amorphous GaN coatings deposited by RF magnetron sputtering (CNR). Study of structural, morphological, compositional, optical and mechanical characteristics ongoing

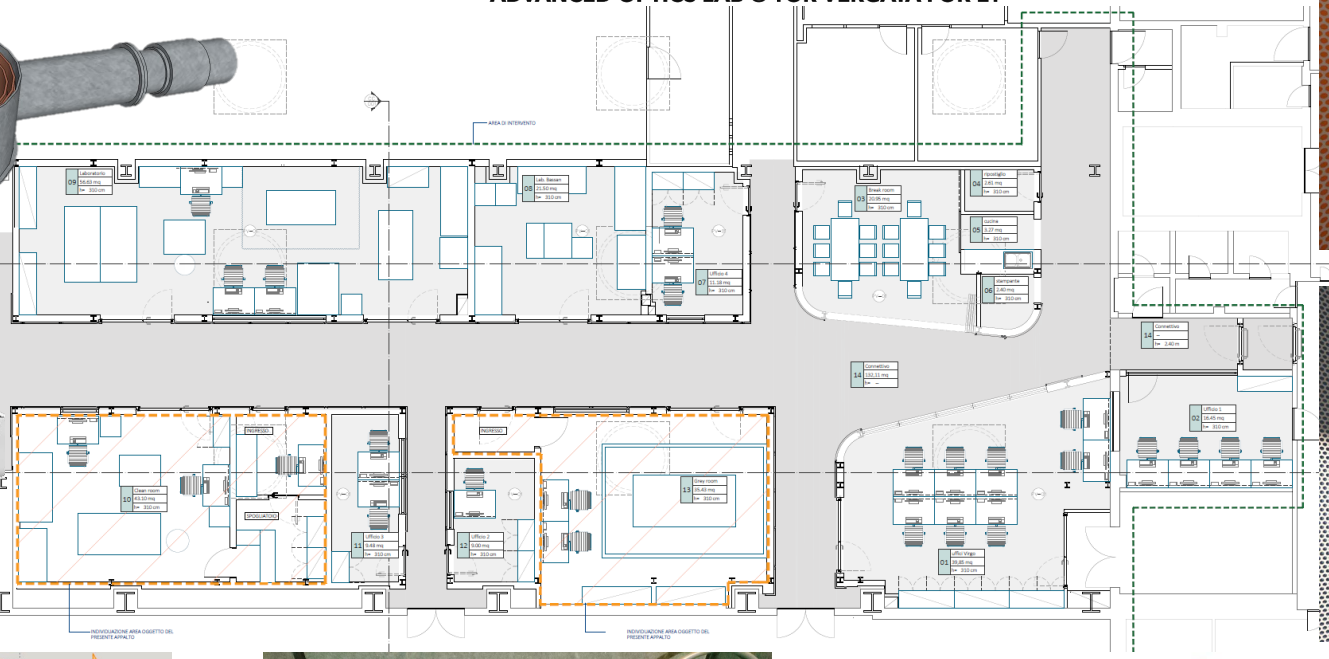
✓ SiN

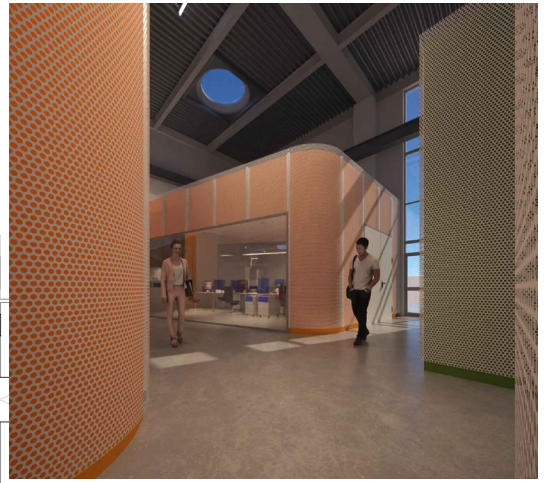
Initial growth of amorphous SiN

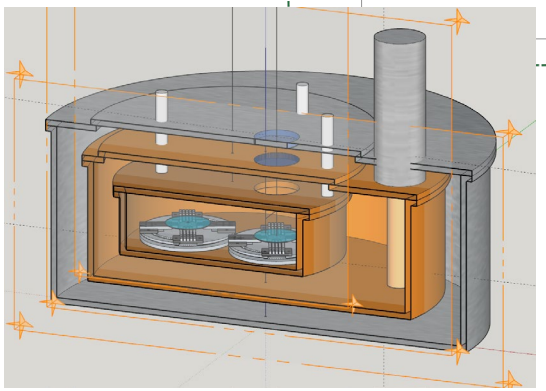
What's next?

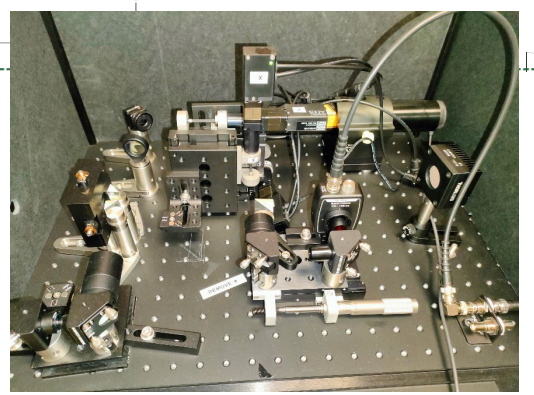
ADVANCED OPTICS LAB @ TOR VERGATA FOR ET







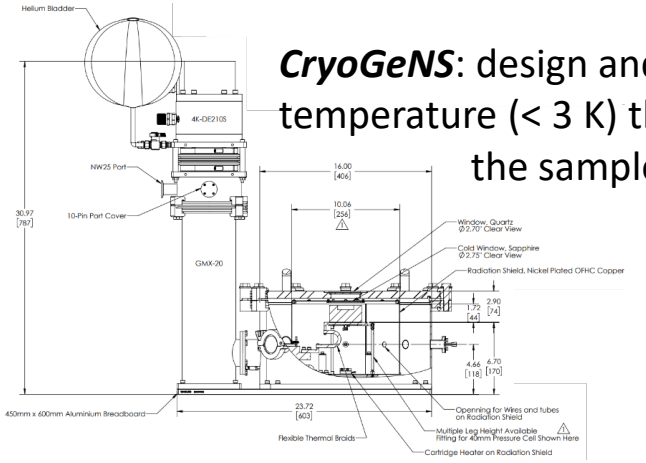




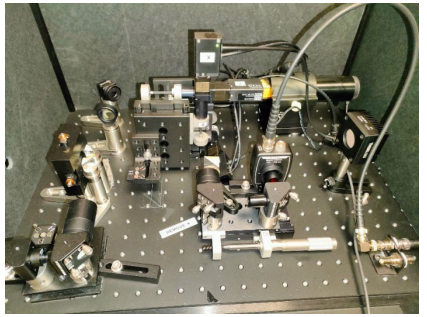
What's next?

ADVANCED OPTICS LAB @ TOR VERGATA FOR ET

- ***New oven for thermal annealing***: Carbolite GERO TS1 openable tubular oven, maximum temperature 1200 °C, 125 mm diameter, 600 mm heated length; inert atmosphere flux

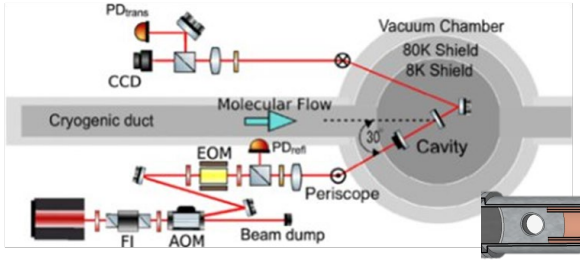


CryoGeNS: design and realization of a custom cryostat that can reach cryogenic temperature (< 3 K) through a low-vibration cryogenic cooler using Gifford-McMahon technology; the sample suspension will be motorized (JPE) and remotely controlled; twin sample available for temperature control

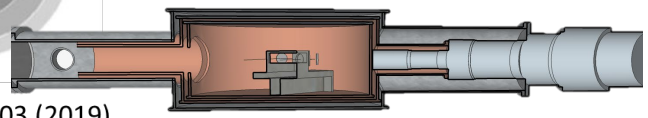


- ***Photo-termal Common-path Interferometer*** for optical absorption @1064 nm and @1055 nm

- ***Quadrature Phase Differential Interferometer***: for direct measurement of thermal noise at low T.



Hasegawa K et al, Phys Rev D 99, 022003 (2019)



- ***Diagnosis of mirror surface condition:*** Design of a dedicated Fabry-Perot cavity for the detection of the ice layer that can form on the mirror surface at cryogenic temperatures.

- ***Mirror surface conditioning:*** Design of a conditioning system based on the modeling of CO2 laser beams.

Thanks for your attention