Access Description

- Piezoelectric MEMS technology for energy harvesting and other applications

Technical Offering

- Piezoelectric MEMS devices modelling (FEM) and design including electro-mechanical (static and dynamic) modelling, thermal modelling and stress analysis
- Fabrication of piezoelectric devices in MEMS process with Aluminium Nitride (AlN) piezoelectric material on silicon (Piezo-MEMS process)
- Devices electro-mechanical characterisation
- Materials characterisation

Main Equipment

- COMSOL - Finite Element Modeling (FEM) software for multi-physics devices design and modeling
- Polytec Laser Doppler Vibrometer (LDV) – system for measurement of dynamic response of MEMS structures, e.g. mechanical resonance frequency, displacement level, bending profile
- Zygo White Lite Interferometer (WLI) – system for measurement of static profile of MEMS structures, e.g. devices profile due to dc excitation or material stresses
- Microscopy techniques: SEM, FIB, AFM, XRD
- Piezo-meter (Piezo-Test) for piezoelectric response measurement
- Probe Stations for precise electrical characterization
- Test laboratory equipment: oscilloscopes, power sources, signal generators, impedance meters, spectrum analyzers, semiconductor device analyzers, etc.
- Test methods: current-voltage, capacitance-voltage, impedance measurements, reliability tests and failure analysis
- Mechanical shaker for vibration tests with variable frequency and acceleration
- Environmental chamber (humidity and temperature)
- Vacuum chamber for pressure dependency measurement of vibrating structures (can be combined with Polytec system and electrical test equipment)
- Process line in clean room for Piezo-MEMS devices fabrication compatible with CMOS line

Typical Application

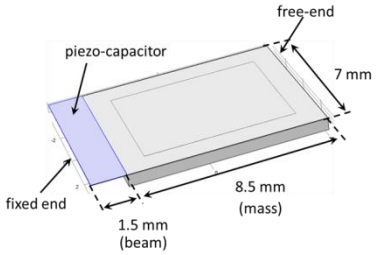
PiezoMEMS team in Tyndall is dedicated to developing piezoelectric MEMS devices and processes that can be used in multiple applications. The main material that we investigate is piezoelectric Aluminium Nitride (AlN). Typical applications include:

- energy harvesters for micro-power systems
- high frequency acoustic resonators for RF applications
- acoustic resonators for sensing applications
- piezoelectric micro-actuators
- ultrasonic devices

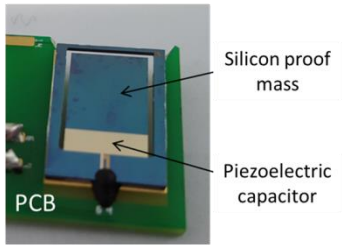
Case Study

❑ Vibrational Piezoelectric MEMS energy Harvester

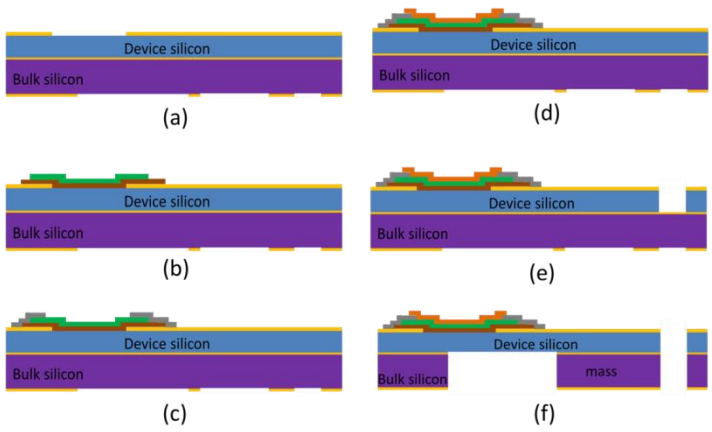
Schematic of a typical energy harvester in Tyndall



Top view of a typical energy harvester in Tyndall



❑ MEMS fabrication process based on SOI substrate



Responsible

Dr. Oskar Z. Olszewski

Dr. Ruth Houlihan

Key Specifications

- Piezoelectric MEMS process with AlN capability (CMOS compatible)
- Typical performance form energy harvester at resonance (design specific):
    - Tip displacement up to ≈1mm
    - Powers up to ≈10uW
    - Voltage (peak-peak) up to ≈10V
    - Resonance frequency ≈10's Hz – 100's Hz
    - Device impedance ≈ kΩ - MΩ
- Aluminium Nitride processing
    - Standard process of AlN on silicon
    - Typical FWHM ≈ 1.5°
    - Typical d_{33} ≈ 4.8 pm/V
    - Typicall d_{31} ≈ 2 pm/V
    - AlN process optimization and enhancement through doping