

## Motivation

### Piezoelectric Material

- Piezoelectric materials generate a charge or voltage when stress/strained and vice versa. Piezoelectric materials have been around for over 100 years and have been used in a wide range of applications from telecommunications, sensors and actuators, to medical devices etc....
- Tyndall has developed a **state of the art** AlN deposition process, as well as a novel flexible AlN material, which is non-toxic, unlike other piezoelectric materials. The PiezoMEMS group seeks to exploit our AlN material in numerous applications, currently we are focused on energy harvesting and resonators.
- AlN- Aluminium Nitride is a thin film CMOS compatible piezoelectric material which can be easily integrated into a standard fabrication process by using sputter deposition techniques.
- Tyndall is also interested in enhancing the piezoelectric properties of AlN by modifying the material for specific applications

## AlN Material Development

### On Silicon

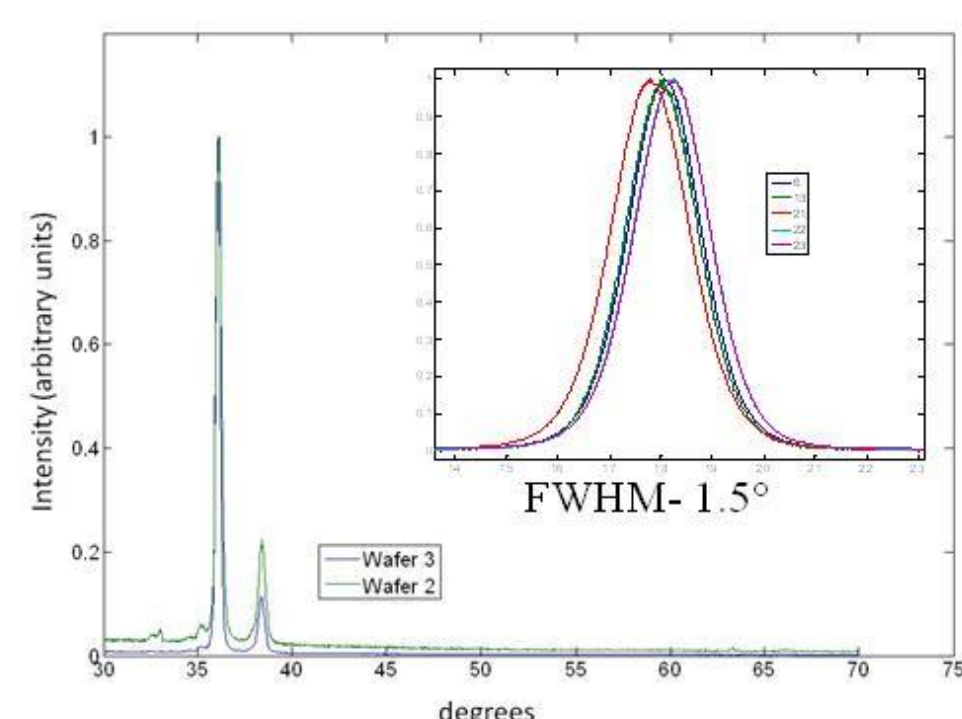
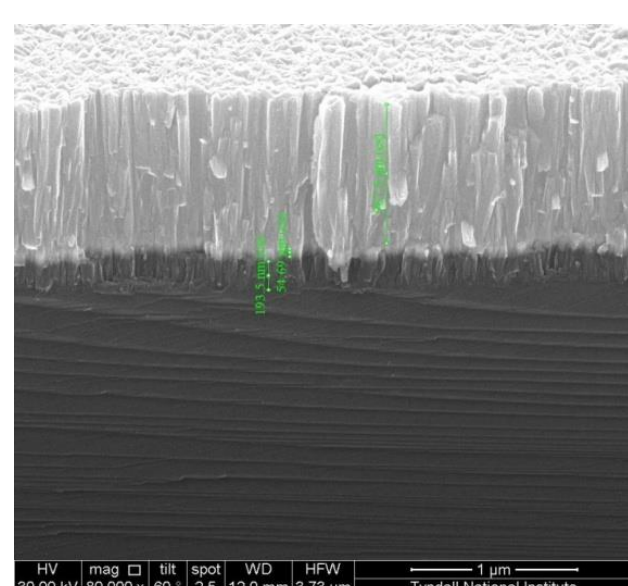


Figure- (left) XRD results showing the high crystallinity of the AlN with a FWHM of 1.5°. (right)- SEM image showing the columnar (002) AlN orientation



	PZT	Tyndall AlN	Typical values for AlN
Piezoelectric Constant d31 (pm/V)	100-300	2.97± 0.75	~2
K <sup>2</sup> % (electromechanical coupling)	18-25	15± 2.8	~10

### On Flexible Substrate

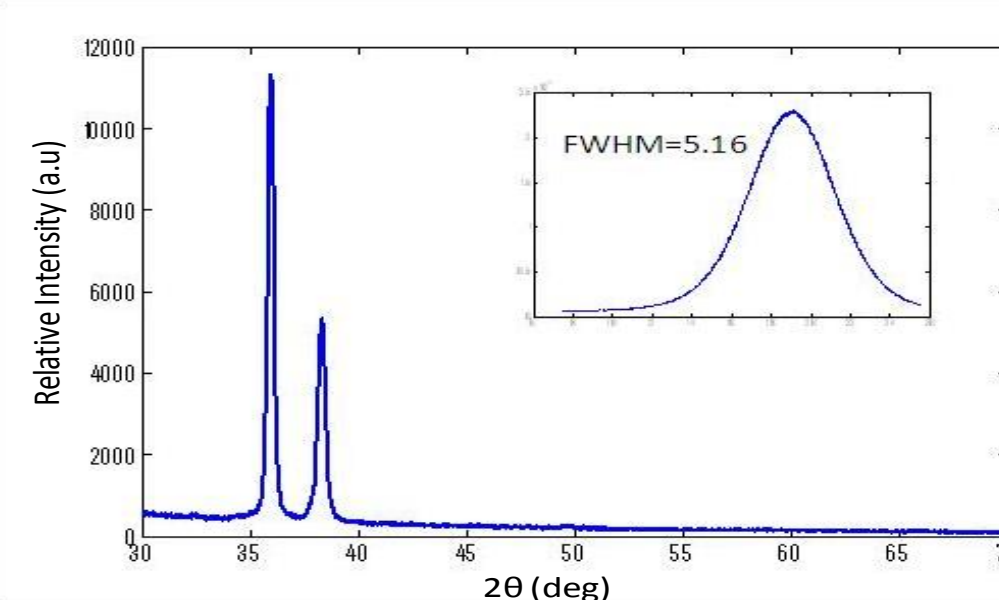


Figure left- XRD results showing the crystallinity of the AlN material (insert shows the rocking curve omega scan)

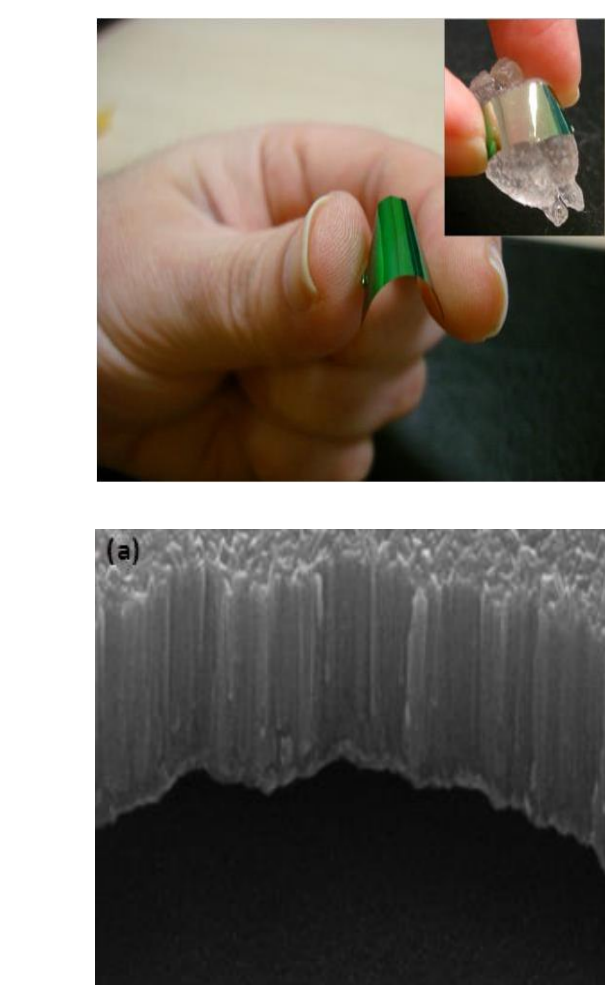
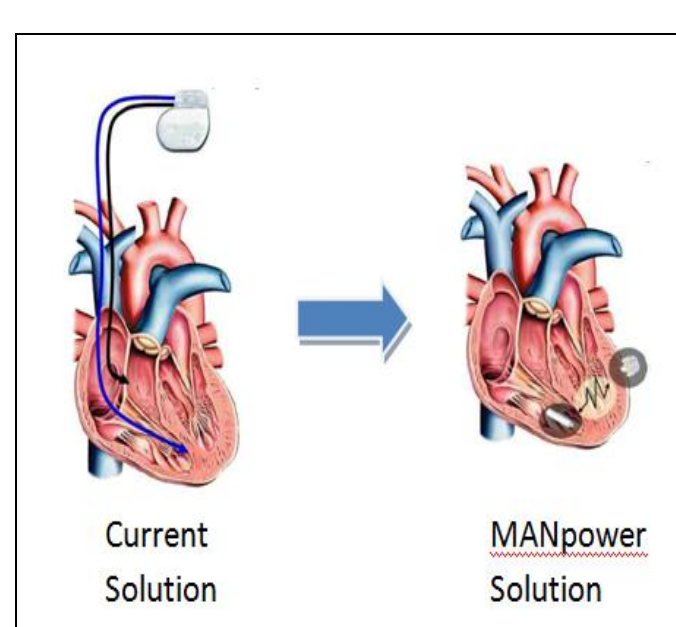
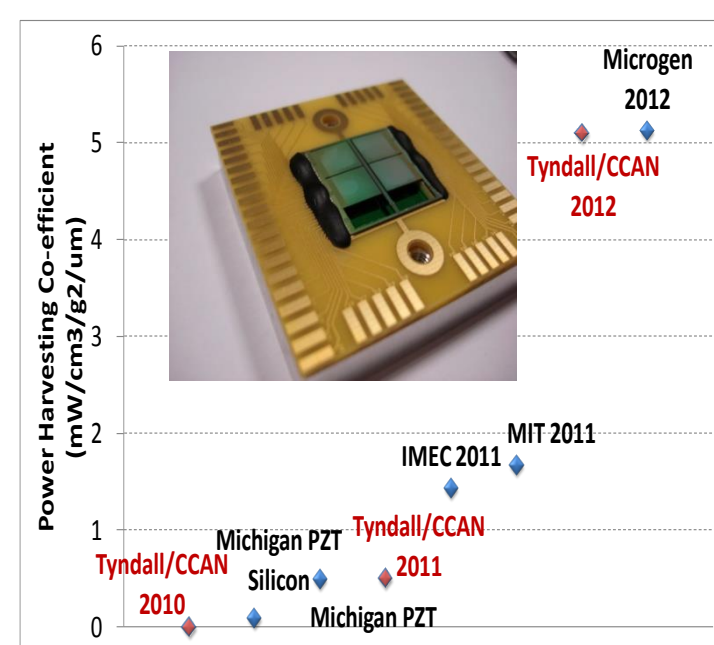


Figure- above picture showing flexible material and SEM image showing columnar AlN material

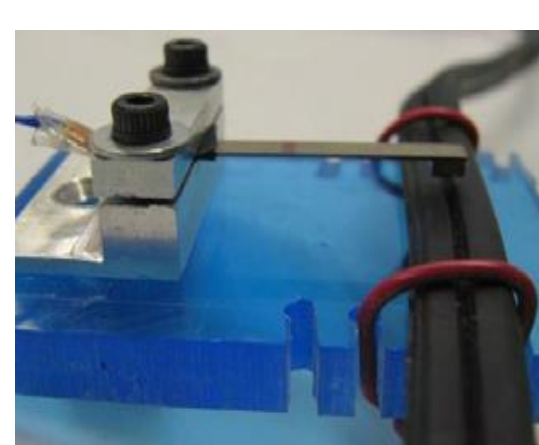
	Other Researchers AlN/Polyimide	Tyndall (AlN/polyimide)	Tyndall (AlN/Si)
FWHM (AlN)	8.16	5.16	1.7
Multiple peaks	Yes	No	No
D <sub>33,f</sub> (pm/V)	0.56	1.12	4.87
D <sub>15,f</sub> (pm/V)	NA	0.784	0.35

## Past and Current Applications

### Energy Harvesting

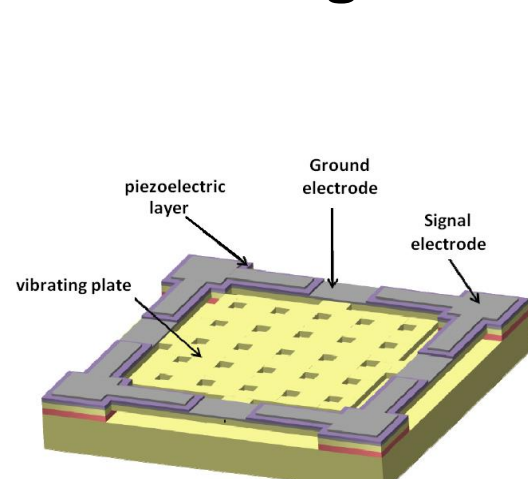


### AC MEMS Sensor/ Energy Harvester



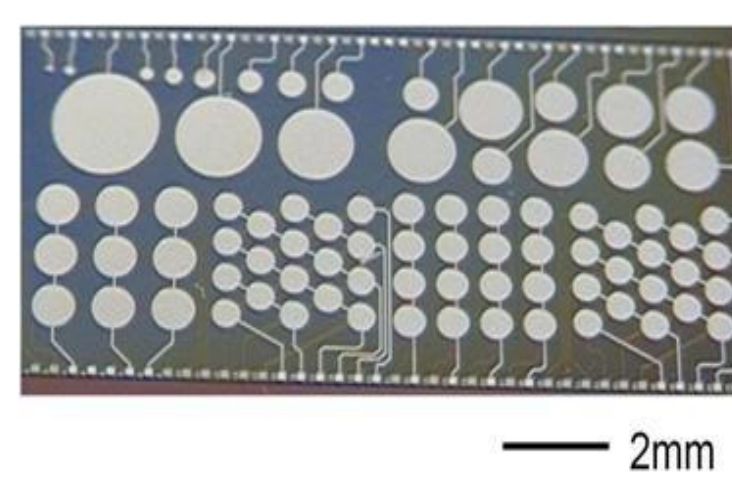
Visit our DEMO to see more

### MEMS atomizer (currently being used for drug delivery through nebulizer)

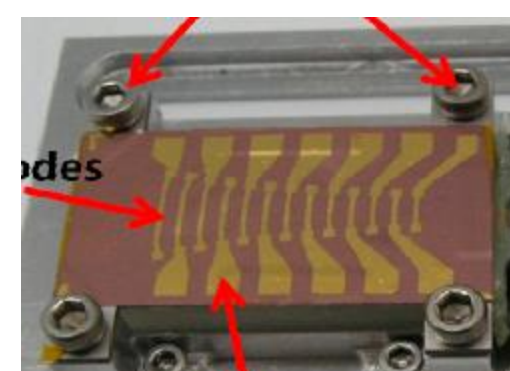


## Future Applications

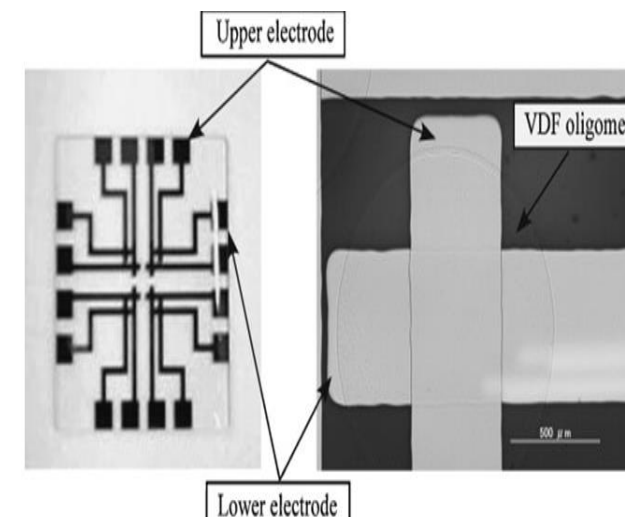
### Ultrasound Resonators



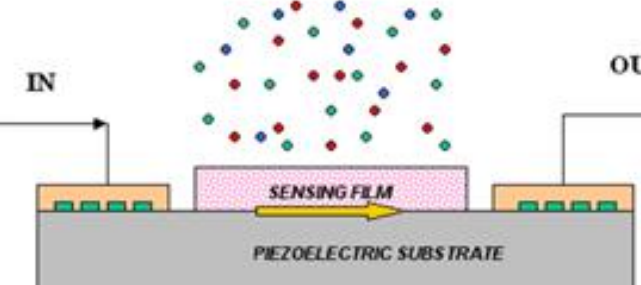
### Implantable Pressure Sensor or cochlear device



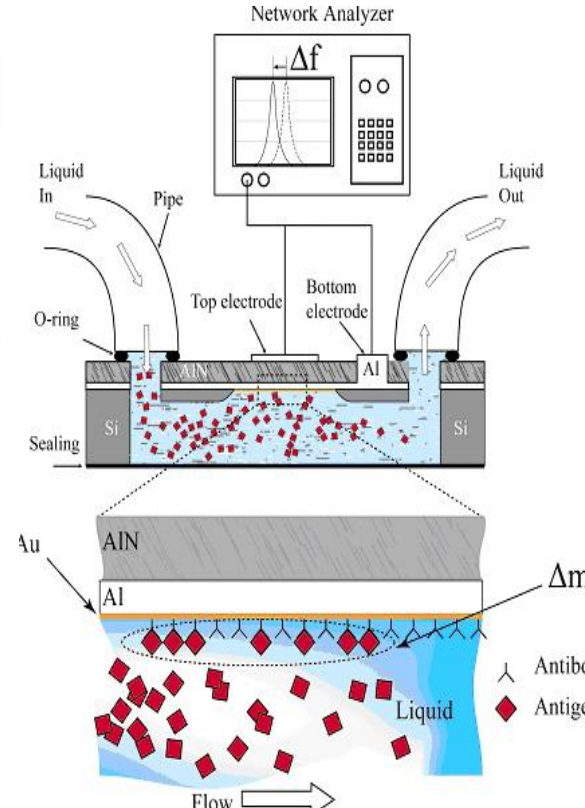
### Tactile Sensor



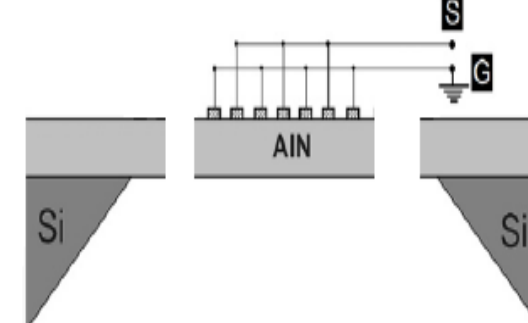
### Gas Sensor



### BioSensor



### Resonators (fbar, LWR, SAW) for filters, sensors, and oscillators



## Future Advancement in AlN Material

- Development of novel AlN deposition onto other **flexible materials**.
- Investigation into controlling **polarity and crystal orientation**, which could results in optimal piezoelectric efficiency for specific applications.
- Investigation into development of **novel AlN alloy's** to increase piezoelectric properties or modify properties for specific applications
- Continue to exploit and optimise AlN for novel MEMS applications, and start investigating other fabrication friendly piezoelectric materials.

## Contact Details

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