

# **Piezoelectric Thin Films in FBARs and Other Microfabricated Devices**

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Piezoelectric thin films have applications in many devices including, at very high frequency, in film bulk acoustic resonators (FBARs), e.g. as components in communications systems and for biosensing, and at very much lower frequencies, in piezoelectric micromachined ultrasonic transducers (PMUTs), e.g. for fingerprint characterisation. These applications place specific demands on the films, including the choice of piezoelectric material - with AlN and ZnO often favoured over the (PbZr)TiO<sub>3</sub> used more commonly in bulk devices, the method of deposition, the subsequent microfabrication-based processing with other films and bulk components in an overall structure usually based on Si technology, and related material and functional characterisation.

This tutorial will begin with a brief outline of the spectrum of applications, common features of the structures by which they are realised, and how their demands are translated into piezoelectric thin film specifications. The presentation will touch on relevant issues in bulk piezoelectric materials as a starting point for consideration of the films themselves. The practicality of different materials will be considered with a view to feasible Si-based microfabrication, and performance will be compared. Device modelling will be described briefly, focusing on special purpose and finite element analysis techniques. Finally, three specific examples will be outlined, for communications, biosensing and ultrasonic applications, to bring together the many different issues that must cohere to deliver useful piezoelectric devices.