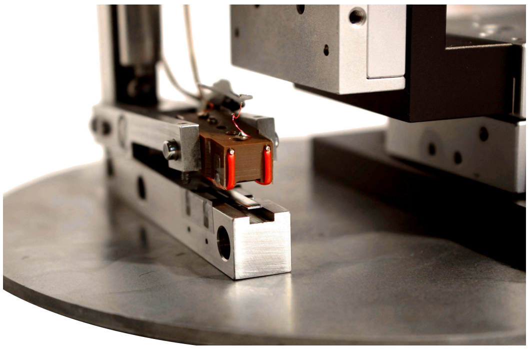
aix4PB

Piezoelectric thin film characterization system for MEMS

Electromechanical thin film properties are key characteristics for the design and layout of piezoelectric based micro-electromechanical system (MEMS) devices. Either the longitudinal piezoelectric coefficient d_{33} or the transversal piezoelectric coefficient e_{31} is used to realize the sensor or actuator functionality. The longitudinal coefficient can be measured with the aixDBLI system whereas the aixACCT 4-Point Bending (aix4PB) system is used for precise measurements of the effective transversal coefficient.

The aix4PB measurement system utilizes a modified 4-point bending set up, developed by aixACCT Systems in cooperation with the Swiss Laboratoire de Céramique (EPFL), which is especially adapted to piezoelectric thin film samples. This innovative set-up allows the application of homogeneous, well defined mechanical stresses to the thin film. which guarantees a precise extraction of the piezoelectric coefficient with well defined boundary conditions.

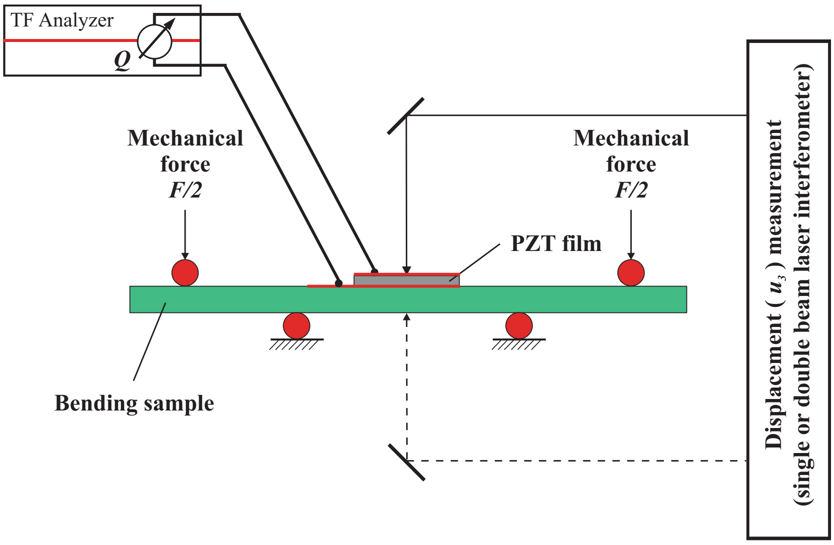


The standard aix4PB system consists of the 4-point bending sample holder, a TF Analyzer 2000, and a single beam laser vibrometer. It allows the following measurements:

- Full electrical characterization with polarization, capacitance, leakage current, and fatigue measurements like they are established in the TF Analyzer 2000 system.
- Measurement of the effective transversal piezocoefficient by applying an alternating homogeneous mechanical strain to the sample and measuring the generated charge.
- All these measurements can be performed under additional compressive or tensile static loads too which allows to predict the piezoelectric film behaviour in the fully processed MEMS device.

The measurement set-up is displayed in principle in the figure below.

As an option the system is extendable with the aixACCT double beam laser interfero-meter for differential measurements of strain and piezocoefficient $d_{33,f}$, which eliminates the influence of sample bending effects.



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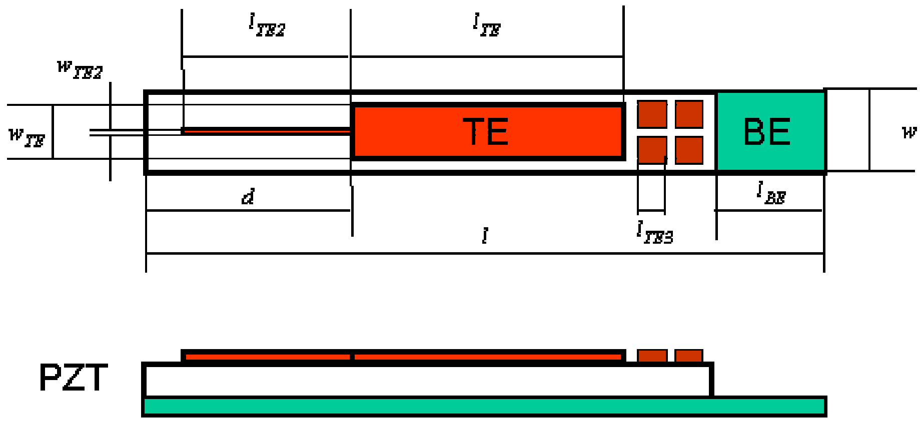
Features / Specifications

- 4-point bending sample holder with
  - piezo actuator for force generation,
  - fixture for laser vibrometer, and
  - easy contact to top and bottom electrode of the sample
- All measurement capabilities of the TF Analyzer 2000 system including
  - Windows 2000 / XP operating system
  - Remote access and script control available as option
- Single Beam Laser Vibrometer with a minimum resolution of 1 nm

Detailed specifications and overall performance are strongly dependent on the integrated single components

Sample Geometry

- The design of the bending samples typically looks like displayed below.



Sample length	l = 25 mm
Length top electrode	l_{TE} = 8 mm
Length top electrode contact	l_{TE2} = 7 mm
Length d_{33} top electrode (square)	l_{TE3} = 1 mm
Length bottom electrode	l_{BE} = 4 mm
Distance top electrode	d = 8.5 mm
Sample width	w = 3 mm
Width top electrode	w_{TE} = 2 mm
Width top electrode contact	w_{TE2} = 0.1 mm

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advanced customized characterization technologies

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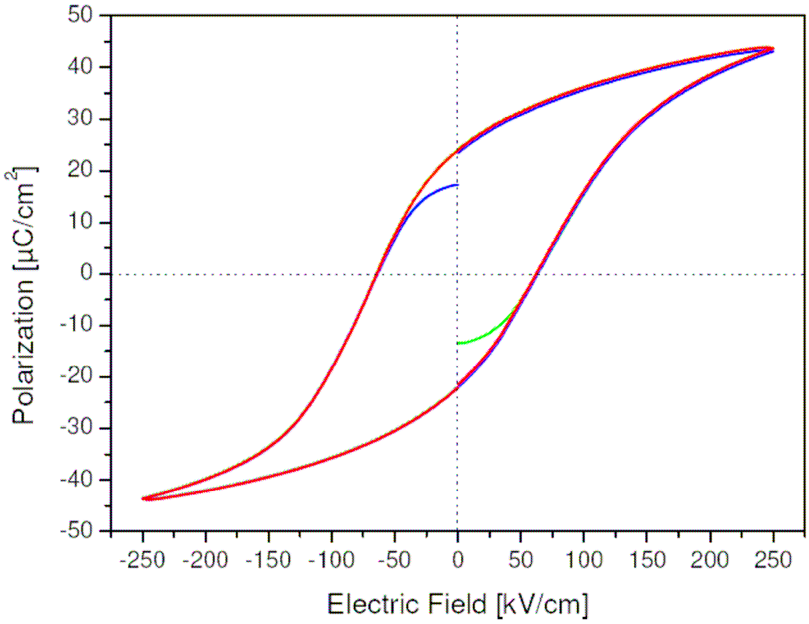
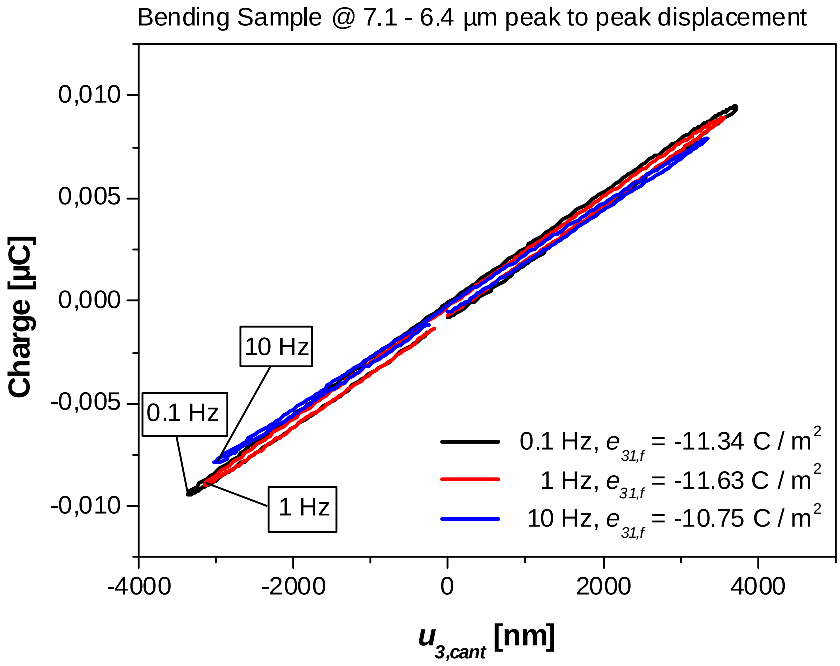
Sample Measurements

- Large signal polarization measurement.



- Effective transversal piezocoefficient measurements at different frequencies.



K. Prume, P. Muralt et al.: Extensive electromechanical characterization of PZT thin films for MEMS applications by electrical and mechanical excitation signals, submitted to *J. of Electroceramics*, 2006.

Supported by the European Commission through the 6th Framework Project "MEMS-pie", www.sintef.no/memspie

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