



The European Institute of Piezoelectric Materials and Devices

www.piezoinstitute.com

Introduction

The Piezo Institute is the centre of European expertise and resources in piezoelectric materials and devices.

It has been created by the EU-funded MIND Network of Excellence and is an excellent example of collaboration between universities and industry.

The Piezo Institute will help European and international academics and businesses to use piezoelectric materials and devices within new applications.

Piezoelectric technologies are already delivering benefits in:

- healthcare
- transport
- energy harvesting
- the environment

Piezo technology is safe, efficient and environmentally friendly.

Objectives

The objectives of the Piezo Institute are to:

- Strengthen and develop expertise in piezoelectric material and devices
- Increase understanding of phenomena in piezoelectric materials and structures, and to apply this knowledge to the design of new and improved devices such as:
 - o Sensors – force, motion, acceleration, pressure, temperature (infrared radiation by the pyroelectric effect)
 - o Transducers – medical imaging, therapy, drug delivery and administration, non-destructive evaluation and testing, medical and industrial flow meters, underwater acoustics, airborne acoustics, SAW & BAW filters and resonators for telecommunications, industrial processing such as ultrasonic welding and soldering and ultrasonic medical nebulisers
 - o Active devices – actuators, micro-motors, micro-pumps, vibration control, noise reduction, hearing aids, fuel injectors for diesel engines, inkjet printer heads, production of energy from natural motion

Networks of excellence are designed to strengthen scientific and technological excellence on a particular research topic by integrating at European level the critical mass of resources and expertise needed to provide European leadership and to be a world force in that topic. This expertise will be networked around a joint programme of activities aimed principally at creating a progressive and durable integration of the research capacities of the network partners while, of course, at the same time advancing knowledge on the topic.

Networks of excellence are therefore an instrument designed primarily to overcome the fragmentation of European research. The main deliverable is a durable structuring of the way that research in Europe is carried out on particular research topic.

Research

Piezo Institute research into piezoelectric materials is applied to the design of new and improved devices that have applications ranging from medical diagnostics and therapy to industrial measurements and transportation.

Research by the Piezo Institute is currently focused on miniaturisation and integration of piezoelectric materials into MEMS devices, including Si-based technology.

Institute members are also researching multifunctional materials (such as multiferroic) and devices for applications in multiple sensing and intelligent structures, in which the piezoelectric properties are combined with other unique materials properties.

Services and expertise

The Piezo Institute offers a comprehensive range of materials and devices services from lab-based research and development to scientific management and educational programmes. The following details some of our more specialised and unique research capabilities. For a complete list please refer to www.piezoinstitute.com/services.

Processing techniques

- Synthesis of nanocrystalline powders by controlled mechanochemical routes – advanced techniques
- Equipment for spray drying, hydrothermal processing, HIPing, uniaxial pressing, tape casting, screen printing, laminating and sintering

Ceramic processing technique – industrial scale

- Fully equipped component production with state-of-the-art production and test equipment

Thin and thick film processing techniques

- World class capability in chemical solution deposition and spin coaters (Headway Research LS510-PCR, Chemat technology KW-4A)
- Sputtering System (5 Pascal)
- UV-assisted crystallisation of thin films
- Tape casting (Unique), Roll Mill (Exact), Screen Printer (Aurel)
- Belt Furnaces (BTU and DEC) – maximum temperature 900°C
- LTCC, viscosimeters

Physical deposition

- Vacuum deposition – thermal, e-beam, flash
- LB deposition

Microfabrication techniques

- Clean rooms class 10000 and 100 with the following equipment:
 - photolithography process
 - hot embossing
 - e-beam lithography
 - step and repeat UV projection
 - step and repeat wet etching
 - SEM-FIB dual beam
 - UV polymerisation system with real time control of photopolymerisation
 - replica moulding process
 - soft LIGA micro-optics
 - sputterers, evaporator, deep reactive ion etcher, reactive ion etcher, mask aligner rapid thermal annealer
 - electrical MEMS scale gold wire bonder machine
 - industrial scale packaging of piezo sensors and actuators

Characterisation techniques

- Scanning and transmission electron microscopy techniques – EDXS, WDXS, STEM, HRTEM, EELS, Z contrast, EBSD, TEM, FEG SEM, E-SEM, FIB-SEM, AFM, XRD, optical microscopes
- Equipment XRD technique x-ray diffractometer equipped with a four circle goniometer and position sensitive detector
- Neutron and synchrotron x-ray diffraction access at ISIS, Oxfordshire, or ESRF, Grenoble
- AFM, PFM, SPM – all modes, liquid cell, dry, STM (all basic modes – contact AFM/ LFM/ ResonantMode AFM (semicontact + noncontact) / Phase Imaging / Force Modulation (viscoelasticity) / Adhesion Force Imaging / Spreading Resistance Imaging / SCM / SKM / MFM / EFM / AFM, Voltage, RM Lithographies) for piezoresponse imaging
- Profilometers including white light interferometers
- Optical ellipsometry and reflectometry for investigation of thin films and multilayers

Mechanical characterisation

- Dynamic mechanical analysis in three points bending configuration for determining the low frequency Young's modulus and mechanical losses as a function of temperature
- Nanotest machine (high stiffness system) for macro-microscale materials mechanical property evaluation
- Ultra-rigid frame mechanical and electrical fatigue apparatus
- Commercial nanoindenter and microindentors Dielectric and ferroelectric characterisation technique
- Impedance analysers impedance and network analysers Wayne Kerr component analyser RLC bridge
- Ferroelectric testing equipment (PE loop and PSE loop)
- Temperature/humidity chamber for climatic testing
- Ferroelectric polarisation – pulsed ferroelectric hysteresis loop measurement Radiant Technologies high voltage ferroelectric characterisation system
- PE-HYS – NPL proprietary polarisation-field loop analysis system and software with strain options and modelling options built into software
- Sefelec electrical break-down strength apparatus

Piezoelectric and pyroelectric characterisation

- Scanning Laser Intensity Modulation Method (LIIMM) system for through thickness and spatial assessment of polarisation studies of ferroic materials
- PiezoMeter System – d33 and dh meter (bulk, MEMS and thin films)
- Actuator blocking force measurement systems – bulk, macroscale, microscale, and MEMS scale test systems
- Automatic iterative method for matrix determination of complex piezoelectric, elastic and dielectric coefficients from impedance data at resonance
- JAMIN-based differential optical interferometry for piezo thin films and bulk materials (0.02µm resolution)
- Microscanning laser Doppler Vibrometry

(Polytec) for out of plane piezo motion measurement with in-plane motion capability. With a MEMS vacuum environmental chamber to 10⁻⁵ mbar.

Thermal characterisation

- Simultaneous thermal analysis STA 429 (to 1700°C), STA 409 (to 1500/1550°C), DSC 200 Netzsch (to 520°C), Thermostar GSD 300D, Balzers)
- Includes thermogravimetry (TG), differential thermal analysis (DTA), analysis of evolved gases (EGA), differential scanning calorimetry (DSC)

Consulting management of EU and international projects

- Experience on management of EU and international projects including all aspects of project development phases – proposal preparation, writing, submission, IP issues and financial management
- Patent consulting and service

Technical consulting

- Knowledge of solid state physics and chemistry processing for engineering
- Piezo metrology and standards
- Manufacture and testing
- Micro and nanotechnologies

Development services

- New devices – projects on acoustics, ultrasonics, sensors, transducers, piezoelectricity and related topics
- Development of new equipment for piezoelectric applications, customised equipment for material or device testing
- Simulation and device design tools available – detailed knowledge of material properties in combination with experience in structures modelling (e.g. ANSYS with specific piezomaterial oriented extensions)
- Device design and prototyping

Education and training

The Piezo Institute offers industrial training, short courses, Masters degrees and PhD programmes to help Europe maintain its leading role in ferroelectric and piezoelectric ceramic technology.

The Piezo Institute's joint education programme is the first of its kind in Europe. It aims to increase research productivity and is focused on industrial needs and new applications.

The pan-European programme trains scientists and engineers in piezoelectric materials, devices and systems. It provides new skills in:

- Processes for ferro and piezoelectric fabrication
- Technologies including micro and nanotechnology
- Applications such as sensors, transducers, motors and actuators

These skills are essential for scientists and engineers working in materials science, chemistry, physics, electronics, mechanics and systems engineering. They equip the work force for jobs with material manufacturers, university laboratories, research centres and in industries such as automotive and electronics.

Piezo Institute training and education are controlled by an Educational Programme Committee (EPC). The Piezo Institute expects to initiate the joint degrees programme by September 2008. For more details please contact education@piezoinstitute.com.

Short courses for industry

The Piezo Institute offers short courses, tutorials and customised training for industry.

Typical content includes:

- Chemistry and process engineering
- Solid-state physics
- Material characterisation and measurement
- Micro and nanotechnology and microelectromechanical (MEMS) devices
- Numerical modelling
- Device design, manufacture and testing

Masters degree

In a European first, the Piezo Institute and its partner universities are offering comprehensive Masters degrees in piezoelectric materials and devices.

The range of available options depends on a student's professional objectives, financial resources and geographical preferences. More than 15 Masters degrees in nine countries have been identified as being compatible with the Piezo Institute joint education programme, and the list is expanding.

Internships are a key feature of the Masters degree, with support from partner companies and universities.

The degree is open to students who have earned a Bachelors degree or equivalent in a field related to materials science, chemistry, physics or engineering.

PhD programme

The Piezo Institute offers PhD opportunities with Europe's leading universities.

Funding opportunities allow students to be financially independent, and part-time employment may be offered.

PhD students will work under supervision of at least two Piezo Institute scientists from different member organisations. Topics should be relevant to the Piezo Institute Research Road Map, which is available directly from the institute.

The Piezo Institute PhD programme is open to students with a Masters degree (five years of university study) or equivalent in a field related to materials science, chemistry, physics or engineering.

A Piezo Institute scientist is nominated to help students with their applications. The Piezo Institute promotes joint PhDs and facilitates exchanges between partner universities.

Membership

The Piezo Institute has three categories of members:

- Full Members
- Contributing Members - two categories:
 - Contributing Associated Member = CAM
 - User Associated Member = UAM
- Correspondent Members

Benefits of Full Membership

- life members of Piezo Institute
- access to all services
- free participation in short courses and seminars
- free listing on the European Piezo Directory

Benefits of Contributing Associated Membership

- free subscription to the quarterly newsletter
 - 20% discount on registration fee for the first three participants for short courses and conferences organised by the Piezo Institute
 - 10% discount (up to €5,000 discount) on the services offered by the Piezo Institute (e.g. tests, commercial developments, materials and devices characterisation, software development, equipment calibration etc)
 - priority in the international projects and joint works as a potential member of the project
 - free listing on the European Piezo Directory
 - opportunity to become a Full Partner of the Piezo Institute after three years of continuous membership as an Associate Partner
- Membership is granted upon acceptance of the application by the Piezo Institute's General Assembly. Membership involves contribution in-kind (through staff, services, or access to equipment).

Benefits of User Associated Membership

- free subscription to the quarterly newsletter
- 20% discount on registration fee for the first three participants for short courses and conferences organised by the Piezo Institute
- 10% discount (up to €5,000 discount) on the services offered by the Piezo Institute (e.g. tests,

commercial developments, materials and devices characterisation, software development, equipment calibration etc)

- priority in the international projects and joint works as a potential member of the project
- free listing on the European Piezo Directory
- opportunity to become Full Partner of Piezo Institute after three years of continuous membership as Associate Partner

Membership is granted upon acceptance of the application by the Piezo Institute's General Assembly. The annual membership fee is €5,000 per member.

Benefits of Correspondent Membership

Industrial and academic

- free subscription to the quarterly newsletter
- 20% discount on registration fee for the first participant for short courses and conferences organised by the Piezo Institute

The annual membership fee is €300 per member.

Retired and students

- free subscription to the quarterly newsletter
- free listing on the European Piezo Directory
- 10% discount on registration fee for short courses and conferences organised by the Piezo Institute

The annual membership fee is €100 per member.

How to join

The Piezo Institute is in the process of registering as a legal entity. This is expected to be completed in Autumn 2008.

Anyone interested in joining the Piezo Institute should register on **www.piezoinstitute.com**.

We will reply to everyone who expresses interest in joining the Piezo Institute with updates and Piezo News.