

# Theme: Functional Material

## Subject : Lead-Free Piezoelectric Materials for Actuator Applications

### Introduction

Increasing production, application and thus amount of waste of electric and electronic equipment make the use of environmental-friendly materials in consumer products an urgent and important issue. Laws restricting the use of lead and other hazardous substances in electric and electronic devices are already enforced in the European Union and many other countries worldwide. Exemptions for special applications such as actuators, transducers and ultrasonic motors are still provided, but will be withdrawn as soon as an adequate substitution is available.

Since modern piezoelectrics are mainly made of lead-based ceramics such as lead zirconate titanate ( $\text{Pb}[\text{Zr}_x\text{Ti}_{1-x}]\text{O}_3$ , PZT), research on lead-free piezoceramics has become extremely important. Over the past few years, regulatory agencies world-wide began putting strict restrictions on the use of lead, with the exception of the electronics industry due to the lack of a suitable replacement to PZT. The challenge is to find non-toxic and affordable materials which provide good piezoelectric properties combined with temperature stability and easy manufacturing.

### Scope

Challenges that significantly advance in the development of lead-free piezoelectric materials include:

- Methods to overcome the current lead-free piezoelectric materials performance.
- Methods to form multilayer device with lead-free materials slurry (over 4 layers).

### Research questions

Additional research questions are open for discussion with research partners.

- Can lead-free systems exhibit morphotropic phase boundary (MPB) with properties comparable to those in lead-based systems?
- Can multilayer device (over 4 layers) be formed using lead free piezoelectric materials?
- What would be promising lead-free materials for actuator applications?

### Expected Deliverables

The following is open to discussion:

- Suggestion of new lead-free materials with MPBs and perovskite structure
- Presentation, discussions, and documentation on the result of the research study
- Upon agreement, sharing or co-owning of the intellectual property stemming from the research study
- Delivery of the developed lead-free material sample & if possible, demo sample of fabricated actuators