Exploration of The Piezoelectric Effect

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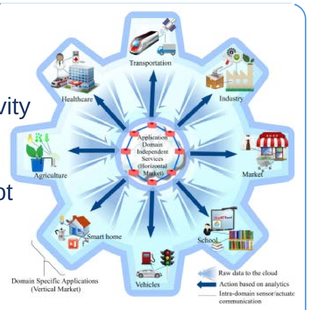
Summary

The Internet of Things (IoT) is a network of sensor embedded devices enabling connectivity for the exchange of data. The growth of this market and its potential to continually impact quality of life makes IoT of great interest to not only the STEM community but also industry.

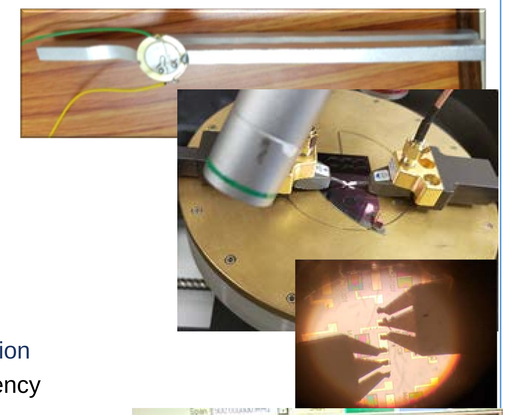


There is a wide range of sensors in today's smart devices; many of which are MEMS or microelectro-mechanical systems. MEMS devices were tested and characterized using resonant frequency (RF) and quality factor. The series of lessons presented was inspired by the properties of piezo materials and their application.

Research Activities

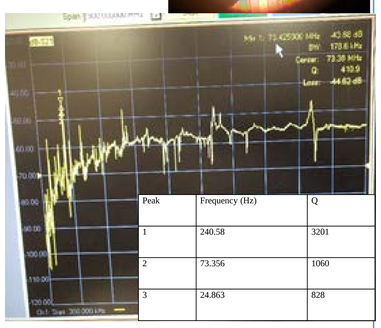
MEMS Resonators

- Applications
  - ✓ Microphones
  - ✓ Pressure
  - ✓ Temperature



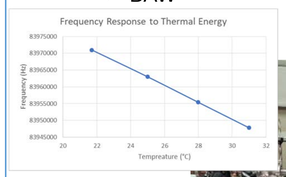
- Fabrication
  - ✓ Deposition
  - ✓ Patterning
  - ✓ Etching

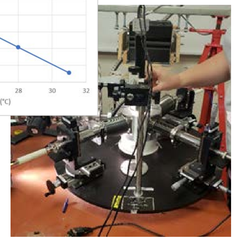
- Testing and characterization
  - ✓ Resonant frequency
  - ✓ Quality factor



Peak	Frequency (Hz)	Q
1	240.58	3201
2	73.356	1060
3	24.863	828

- Wireless sensing
  - ✓ SAW
  - ✓ BAW





- Introduction to Programming
  - C Program/Java

Lesson Plan

Piezoelectricity is currently exploited in a number of useful applications and a target of research for current and future sensor technology in "smart" devices making the topic interesting and relevant to high school students.

Goals:

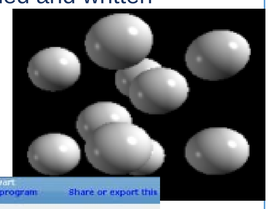
- Explore the properties of piezoelectric materials
- Compare the unit cell of a piezo substance and non-piezo substance
- Encourage interest in current IoT technology

Sequence:

Lesson 1: Properties of Compounds

Day 1: Research question -How can you tell an ionic compound from a covalent compound in lab?

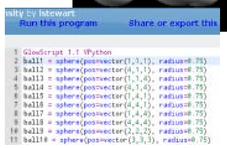
Day 2: Test question in lab using student researched and written methodology



★ Lesson 2: Ionic Bonding

Lattice energy/structure and coordination number

Model lattice structure using Glowscipt



Lesson 3:Covalent Bonding

Molecular geometry /polarity and Bond dissociation energy

★ Lesson 4: Exploration of the Piezoelectric Effect

Day 1: Research question -How can you tell if substance is Piezoelectric?

Day 2: Test question as demo using student researched and written methodology.

★ Lesson 5: Classification of Substances (Formal assessment)

Classify the 4 substances as ionic, polar covalent, nonpolar covalent, and/or piezoelectric

Lesson Learned

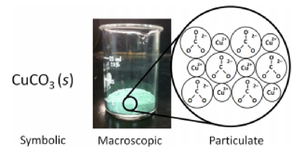
- Piezoelectric materials generate an electric charge in response to applied mechanical stress and vice versa.
- MEMS resonators are pressure and temperature dependent.
- Coding can be implemented into the chemistry class using Glowscript to create models of particles and compounds.

Implementation Strategy

- This lesson will be taught in the chemical bonding unit of an honors chemistry course.

- Strategies
  - Inquiry
  - Cooperative learning
  - Close read
  - Scaffolding
  - Think-pair-share
  - Multiple representations
  - Peer Review

What Close Reading Actually Means



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