

Biomedical Applications of Piezoelectric Materials

Prof. Dr. Aydın DOĞAN

Dept. of Materials Sci. and Eng., Eskişehir Technical University, Eskişehir, Turkey

Piezoelectric materials are smart materials that can work as sensor and actuator. Piezoelectric materials can convert electrical energy into mechanical energy or applied mechanical energy into electrical energy. Piezoelectric materials can find various application fields because of these unique properties. One of the applications is biomedical applications. This topic of the piezoelectric ceramics accelerated in 1980s. It is possible to classify the usage of the piezoelectric materials in biomedical field as follow:

- **Medical Diagnostic Applications**
 - Ultrasonic Probe, Imaging Systems
 - Blood Pressure Sensor, bubble sensors.
- **Surgical and Treatment Applications**
 - Ultrasonic Knife
 - Lithotripsy (kidney stones treatment)
 - HIFU (High-intensity focused ultrasound)
 - Dental Surgical Transducer
 - Ultrasonic Surgical Transducer
 - Nebulizer, Drug Delivery Systems,

Ultrasonic probes are essential elements of ultrasonic imaging systems for diagnostic purposes. The main component of ultrasonic probes are piezoelectric ceramics. Piezoelectric ceramics are the electro-active component in the structure which convert electrical signal to the acoustic waves that propagates and reflects inside the biological media. The ultrasonic imaging systems are information intensive, high value added and considered as advanced technology.

Micrometer level displacement can be generated in ultrasonic surgical devices. They have much better accuracy and precision while we compare these devices with rotating systems. They are versatile devices for medical surgeons during the surgical operations.

Piezoelectric charge constant and electromechanical coupling constant in piezoelectric materials significantly affect the sensitivity and wide band width characteristics of array transducers. Since 1950s piezoelectric materials and devices exhibits very important developments. Barium Titanate and Lead Zirconium Titanate are the most important commercial piezoelectric ceramic materials. Depending on the applications there are many compositions to fulfill the requirement of designed electromechanical or electronic devices. New materials include single crystals have different compositions and composite structures are developing to have better properties.