

Physics of Ultrasound

Second lecture

Generation and Detection of Ultrasound

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Third Stage

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2022- 2023

1. The piezoelectric phenomenon

- ✚ Although a number of different methods are available for the production of high frequency mechanical vibrations, the most common method of generating ultrasound, and the one employed in the devices used in clinical ultrasound, relies on a phenomenon called the piezoelectric effect.
- ✚ This phenomenon is exhibited by some crystalline materials, and involves the reversible conversion of two forms of energy from one to the other, namely mechanical and electrical energies.
- ✚ The prefix piezo means pressure.
- ✚ When crystals of piezoelectric materials are compressed or stretched (i.e., when mechanical stress is applied upon them), electrical charge will appear on their surfaces.
- ✚ Mechanical energy will have been transformed into electrical energy. This process is called the piezoelectric effect.
- ✚ The following figure illustrates this effect, and also shows that the polarity of the induced surface charge is reversed between compressions and stretching.
- ✚ Conversely, when a potential difference is applied between the faces of a piezoelectric crystal, the crystal will respond by expanding or contracting.
- ✚ Electrical energy will have been converted to mechanical energy. This is the reverse piezoelectric effect.
- ✓ The piezoelectric effect is reciprocal, meaning:
 - A) A piezoelectric substance will respond to a mechanical force by generating an electric charge.
 - B) It will respond to an electric field by generating a mechanical response. This latter response is called the inverse piezoelectric effect.