电子科技大学
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Physical Experiments I

Pre-lab Assignment

Measuring the Ultrasonic Speed

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Score

Answers to Questions (20 points)

(1) Describe the physical principle of an ultrasonic sound producer.

A piezoelectric transducer is a device that transforms one type of energy to another by taking advantage of the piezoelectric effect of certain crystals or other materials. The direct piezoelectric effect is the internal generation of electrical charge resulting from an applied mechanical force, as shown in the figure below (3.13-2). The reverse piezoelectric effect is the internal generation of a mechanical strain resulting from an applied electric field. It converts electrical energy into mechanical energy. The graph (3.13-3) below illustrates the technique produces ultrasonic waves for various uses. Electrical contacts are made to the opposite face of a crystal, such as quartz or strontium titanate ($SrTiO_3$). If an alternating voltage of high frequency is applied to these constants, the crystal vibrates at the same frequency as the applied voltage, emitting a beam of ultrasonic waves.

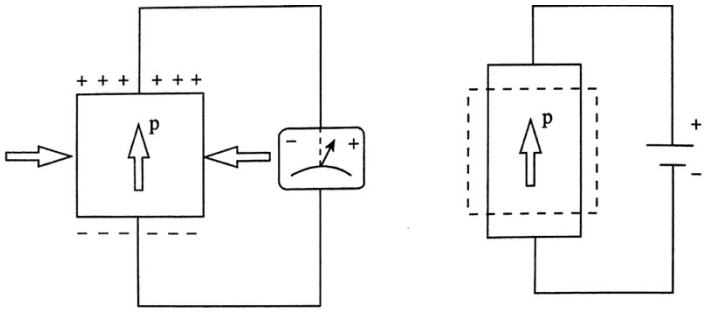

Fig. 3.13-2 Direct (a) and reverse (b) piezoelectric effect

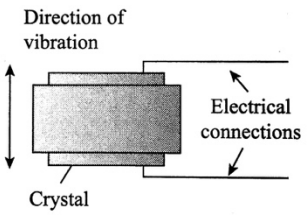

Fig. 3.13-3 An alternating voltage applied to the faces of a piezoelectric crystal causes the crystal to vibrate to produce ultrasonic sound

(2) The audible frequency range for normal hearing is about 20 Hz to 20 kHz. What are the wavelength s of sound waves at these frequencies? Assume that the speed of sound in the air is 343 m/s.

From the book I can get the formula: $\boldsymbol{v = \lambda f}$

$$\lambda_L = \frac{v}{f} = \frac{343m/s}{20Hz} = 17.15m$$

$$\lambda_S = \frac{v}{f} = \frac{343m/s}{20kHz} = 0.01715m$$

$Sound\ wave\ \lambda\ is\ in\ the\ range\ from\ \lambda_S = 0.01715m\ to\ \lambda_L = 17.15m$

(3) Diagnostic ultrasound of frequency 4.5 MHz is used to examine tumors in soft tissue. What is the wavelength in air of such a sound wave?

From the book I can get the formula: $v = \lambda f$

$$\lambda = \frac{v}{f} = \frac{343m/s}{4.5MHz} = 7.622\times10^{-5}m$$

So the wave length in air is $7.622\times10^{-5}m$.