EXPERIMENT 5: VELOCITY OF ULTRASOUND IN A SOLID MATERIALS

THEORY

A short mechanical wave will be generated with help of a piezoelectric ceramic by a short voltage pulse. If this wave is couled into solid state mateial it propagates linear and will be reflected on areas of acoustic impedance boundaries.

From the known distance (s) between the ultrasonic probe and the boundary or the solid and also the measured time of flight (t) the speed of sound (c) can be determined for perpendicular incidence of sound in the following way:

$$c = \frac{2s}{t} \tag{1}$$

Since nearly all ultrasonic probes are produced with a protective layer on the active surface (ceramics) this causes an error in measurement of the velocity of sound because the time of flight is measured through this layer. That means the measured time of flight (t) is built from the time of flight in the protective layer (t_L) and the time of flight in sample (t_s).

This error can be eliminated if the speed of sound (c) is determined by a difference calculation from two measurements (t_1 and t_2) of different sample lengths s_1 and s_2:

$$c = \frac{2(s_1 - s_2)}{(t_{s1} - t_{s2})} \tag{2}$$

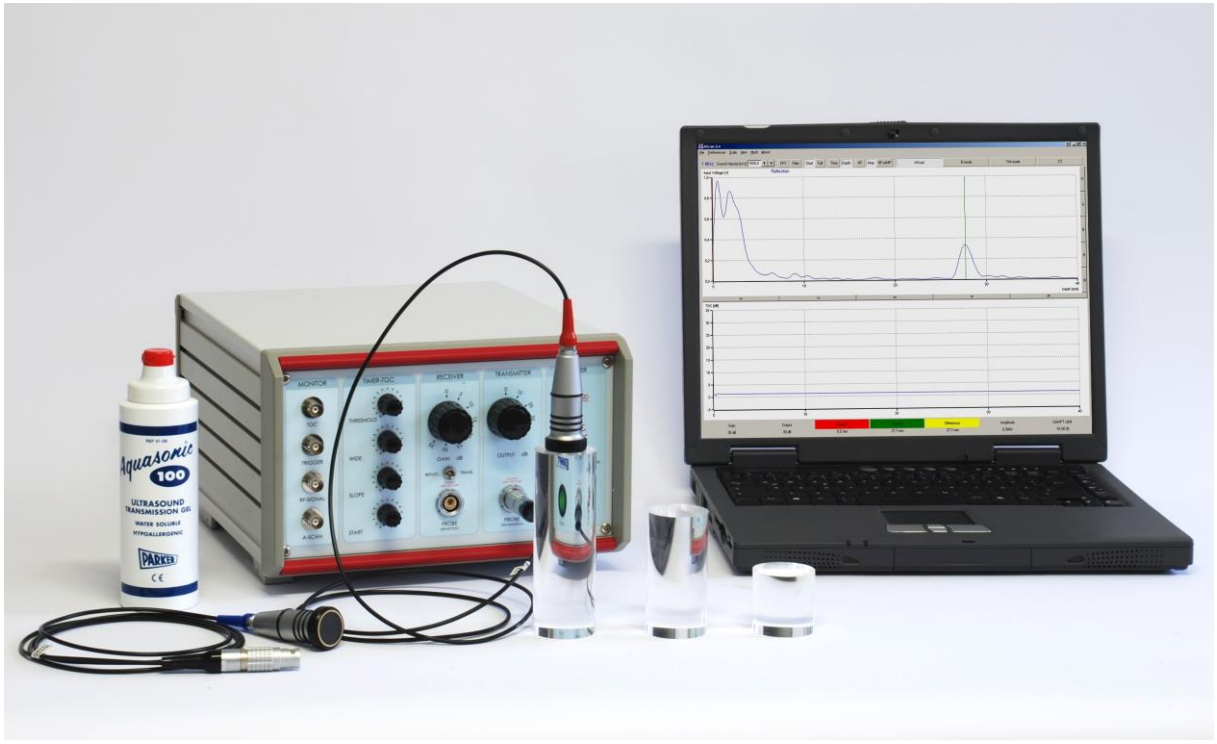

Fig.1 The Set-up of the experiment.

PROCEDURE AND CALCULATIONS

1. Calculate the speed of sound using formula 1 for each cylinder and record your results table 1.
2. Calculate speed of sound using formula 2 for each cylinder and record your results table 1.
3. If the speed of sound is 2800 m/s in the acrylics, find the percentage error value.

Cylinder	l (mm)	t_1 (µs)	t_2 (µs)	c (m/s) (Eq.1)	c (m/s) (Eq.2)
1	39.25	29.3	29.1		
2	79.30	58.8	58.6		
3	119.75	88.6	88.4		