

TABLE 2. Densities, Velocities, and Acoustic Impedances of Various Materials

Material	$\rho, \text{g/cm}^3$	$v_p, \text{km/s}$	$v_s, \text{km/s}$	$Z_p$	$Z_s$	Reference
$\alpha$ -quartz	2.65	5.75 <sup>a</sup>	3.92 <sup>b</sup>	15.2	10.3	McSkimin et al. [1965]
MgF <sub>2</sub> [100]	3.18	6.70	4.22	21.3	13.4	Davies [in preparation]
Fused quartz	2.20	5.9	3.8	13.0	8.4	Peselnick et al. [1967]
Spinel [100]	3.58	8.87	6.57	31.8	23.5	Chang and Barsch [1973]
276-V9 resin (20°C) (Dow-Corning)	-	-	-	2.2	1.0	McSkimin and Andreatch [1962]

a. For [100] (X-cut).

b. For [010] (Y-cut).

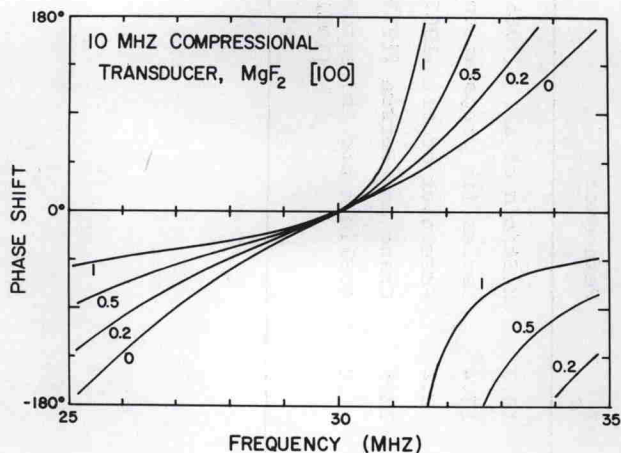


Fig. 4. Calculated transducer-bond phase shifts for compressional [100] waves in  $MgF_2$  with a 10-Mhz quartz transducer bonded to the sample with V9 resin. Curves are labelled with bond transit time  $\tau_f$  (nsec). Note that  $+180^\circ$  is equivalent to  $-180^\circ$  so that the curves in the lower right are continuations of the curves intersecting the upper margin.

$$\tan \psi_t = \frac{Z_t}{Z_s} \tan \theta_t. \quad (9)$$

For non-zero bond thickness, the calculated phase shift is not symmetrical. At multiples of the transducer resonance frequency, the effect of the bond is very small, as pointed out by McSkimin [1961], but the bond effect can increase quite rapidly away from resonance multiples, especially on the high-frequency side (Figure 4).

Figure 5 compares some measured and calculated phase shifts as functions of carrier frequency. A reference measurement was made using a fused quartz buffer rod bonded to the sample. As described in the next section, the slope of this phase line should be very little affected by the buffer-sample bond. Accordingly, Figure 5 also shows the measured phase residual, with transducer bonded to sample, relative to a line with a slope measured with the buffer rod and coinciding with the measurement of 30 Mhz. The measured residual is compared with calculated transducer-bond phase shifts with  $\tau_f = 0, 0.1, \text{ and } 0.2$  nsec. The form of the measured residual agrees well with that of the calculated phase shifts, and a value of  $\tau_f$  between 0.1 and 0.2 nsec can be inferred from Figure 5. This corresponds to a bond thickness of the order of 0.2 to 0.4  $\mu$ , which is perhaps thinner than might have been