fluid in the range covered by this work. Pressure was measured using the resistance of a manganin wire coil as discussed by Bridgman,[4] and by Darling and Newhall.[9] The freezing pressure of mercury at 0°C, 7640 kg/cm^2, was used as the high-pressure calibration point. Electrical leads into the bomb for the pressure gauge and for the experimental plug were insulated by pipestone cones.[10]

The design adopted for sealing the closure plugs and the moving intensifier piston are described in a recent article.[11] It will suffice to say here that these were such that it was possible to cycle the pressure repeatedly from 0 to 10 000 bars, permitting the acoustic measurements to be made in a particularly simple way, described in the section on measurements.

Sample Preparation

The copper single crystals and the silver crystal were grown in this laboratory using a modified Bridgman method. The gold crystal was purchased from the Virginia Institute for Scientific Research. The copper and silver specimens were prepared by first cutting off the crystals to the desired orientation and length (from 1 to 3 cm) using a water-cooled abrasive cutoff wheel. The gold crystal was received at the desired orientation and length. After etching to remove any cold-worked layer, the specimens were waxed into a lapping block and lapped flat using metallographic papers ranging from No. 2 to No. 3/0 grade. After this, each acoustic surface was given another light etch and the samples were lapped with Buehler 1557 AB levigated alumina in oil on a flat glass plate. A final very light etch completed the treatment. This final etch gave the surface a slight "tooth" which aided the cement in holding the transducer to the surface. It was possible after this treatment to obtain reasonably sharp Laue back reflection spots directly from the acoustic surfaces.

Grade 629 Polyethylene by Semet-Solvay Division, Allied Chemical and Dye Corporation was found quite satisfactory for cementing the 10 mc X- and Y-cut quartz transducers to the specimen. Every attempt was made to obtain reproducibility in attaching the transducers from run to run. The polyethylene was melted on the heated specimen, and the transducer placed on it with the desired orientation relative to the crystallographic axes of the specimen. The assembly was allowed to cool, then an 800 g weight was placed on top of it, and the assembly was again heated to well above the melting temperature of the polyethylene for several hours and allowed to cool slowly. The rf electrode was painted directly onto the transducer with du Pont 4817 silver paint. As was observed by Lazarus,[6] the quartz transducer shattered each time a set of pressure runs was made. The preponderance of cracks running perpendicular to the axis of greatest compressibility of the quartz in the case of the Y-cut transducers seems to indicate that it is differential compressibility between quartz and sample which causes the cracking. The cracking did not prevent taking of data, but pulse-echo amplitude usually decreased during a data run. If the metal crystal was etched after measurements had been made at high pressure, the lines along which the quartz had cracked would show up. Accompanying this effect was a slight broadening of the Laue back reflection spots. The fact that no significant dependence of the measured pressure derivatives on specimen length was found in this work indicates that this slight cold-working of the surface is relatively unimportant.

Measurements

For each crystal, the longitudinal and two transverse wave velocities, and their *changes* with pressure, were measured using the ultrasonic pulse-echo method[12-14] with modifications.[15] The gear used for this work incorporated a Tektronix type 121 wide band preamplifier and displayed the unrectified echo pattern on the face of the detecting oscilloscope. Thus the details of each pulse echo were shown, the 10-Mc/sec structure of each echo being observed along the time axis. The sweep delay helipot of the Dumont 256 D A/R oscilloscope was removed and combined with external resistance boxes in such a way as to make measurement of 0.001-μsec *changes* of echo arrival time possible. In practice the method used to take data on the changes of transit time with pressure was to measure the *change* in time of arrival of a particular maximum of the 10-Mc/sec echo structure, relative to a fixed time marker, as the pressure was cycled up and then down several times. It is felt that this arrangement using unrectified pulse

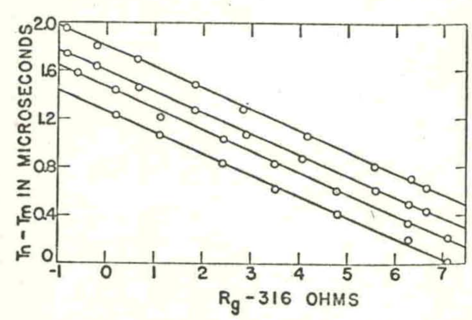

FIG. 1. Typical data plot showing difference between time of arrival of one maximum of an echo, and a nearby time marker as a function of pressure gauge coil resistance. The curves representing different runs are displaced for the sake of clarity. The data apply to runs 1 through 4 of experiment No. 1 for C_{11} wave in the 1.86 cm long copper crystal. The pressure range covered is about 9800 bars.

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