Reprinted from:

THE REVIEW OF SCIENTIFIC INSTRUMENTS

VOLUME 43, NUMBER 11

NOVEMBER 1972

A Multiple-Crystal Holder for Ultrasonic Measurement

Y. C. CHEN, R. H. MARTINSON,* AND ARTHUR L. RUOFF Thurston High Pressure Laboratory, Cornell University, Ithaca, New York 14850 (Received 30 June, 1972; and in final form, 4 August 1972)

A multiple-crystal holder for simultaneous ultrasonic measurement on several crystals is presented. Figures are included to show clearly how it is assembled and how each component works.

In ultrasonic measurement one usually measures a single mode velocity in one crystal as a function of pressure and/or temperature, then removes the crystal from the holder which is inside a pressure vessel or temperature control unit, changes specimen or changes modes (e.g., from longitudinal to shear mode) by changing transducers, and then repeats the experiment.¹ It is thus very time consuming. Moreover, when a measurement is made at a pressure P (or temperature T), the pressure (or temperature) is not exactly identical to that obtained on the other crystals or modes. It is therefore necessary to analyze each run and interpolate at a specific temperature or pressure for all crystals or modes. Hence, it is desirable to have a holder which can hold several crystals so that all the necessary measurements (and possibly redundant measurements) can be carried out on all the crystals at the same T and P conditions. This paper describes a simple four-crystal holder which can be easily constructed for

measurements on cubic crystals. This could readily be extended to six or so crystals for studying hexagonal, tetragonal, and trigonal systems.

The schematic arrangement is shown in Fig. 1, which reveals the cross-sectional view. The holder consists of (1) a cylindrical shell made of brass partially open on two sides to make handling and alignment of the specimen easy; (2) an Amphenol socket; (3) four identical electrode complexes (A,B,C,D) each of which on one side (top) houses the specimen base and provides an electrode on the bottom side; (4) the holder base (E) which is simply half of A, namely, the top half of A; and (5) a small thermocouple (or diode) in A to monitor the temperature. In between each complex is the specimen chamber where the specimen with the transducer bonded on top of it can be manipulated by pushing against the specimen base, which is supported by three identical base springs. The total stress exerted on the specimen by the base springs

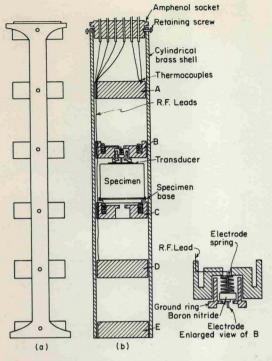
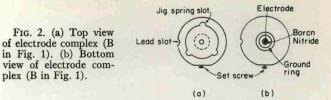


FIG. 1. (a) Side view of holder. (b) Cross-sectional view of fourcrystal holder (only B and part of C are shown in detail).

is less than 0.05 bars (0.7 psi) so that no damage results to the specimen.

The electrode is connected through an insulating material (high purity boron nitride). The electrode lead is shielded inside the electrode complex and is led through



the lead slot of the complex up to the pin on the Amphenol socket. This socket is matched to the feedthrough connected to a Bridgman seal, and the lead is eventually led out of the pressure vessel (or through a feedthrough in a temperature box). The electrode is pushed against the transducer by an electrode spring carefully chosen to give a good contact, yet not exert too much stress on the transducer. The ground ring sits on top of the outer ring of the transducer. The diameter of this ring has to match the size of the transducer. Figure 2 shows the top view and the bottom view of B where the relative configuration of the electrode and the ground ring is clear.

Specimens of varying stiffness, ranging from sodium to silicon, have been studied from 4 to 350 K, up to 10 kilobars at 5 to 40 kHz. The performance is excellent.

We wish to thank R. E. Terry for help in constructing these devices and the U. S. Atomic Energy Commission for their support.

* Present address, Lockheed Palo Alto Research Center, Palo Alto, Calif. 94303. ¹K. M. Koliwad, P. B. Ghate, and A. L. Ruoff, Phys. Status Solidi **21**, 507 (1967).

A multiple envertal holder for sin altavelyes altra such the anergement on reviral organic in presented. Fugure are included to show easily from this assembled and how each camponent houses.

> In ultranity in one orystal, as a harrion of possine mode velocity in one orystal, as a harrion of possine and/ar temperature, then removes the covital framitic bulder which is inside a pressure vestel of temperature framinantity, changes specimiet or changes moles (ever and then registas the expanient or changes moles (ever constrained that is free model by change framadures and then registas the expansional. It is thus vegiciture constraine. Moreover, when a measurement is study it a pressure P (or temperature P), the pressure (or before three also described in that abusine or the even on and interpolate at a specific temperature of here and interpolate at a specific temperature of pressure for all types of moles. Here, it is de thatle to here a ballier which can hald several cover the or that all the measure P (and pressile) or that abus the other all three all types or moles there, it is de thatle to here a ballier which can hald several cover the organity and the extent of an appedic temperature of bar all the measures is an hald several cover the organity at the remeasing F and F conditions. This paper describes a simple same F and F conditions. This paper describes a simple interval baller which can be carried out on all the organity at the interval baller which and the apper describes a simple

musurements on color crystals. This could readily be related to six of an crystals for studying beingmal

10 Alternative retringement is shown in Fig. 1, which reveals the cross entional view. The bold c consists of (11 a cylindrice) theil grade of incas partially optim on an offer to robic handling and alternates of the specifien carry (2) an Amphenol as Las, (2) four identical cleartools complians (A.B.(20) clark of which in any side (40) houses the optimum have and provides an electrools of houses the optimum have and provides an electrools of house the optimum have and provides an electrools of house of A membry (4) the isolate base (E) which is simply the two additions of the indice of A: and (5) a small hour of A membry, if a tap half of A: and (5) a small the two additions and the indice of the specimer base of the manual of the indice of the indice of the specimer base of the manual of the pushing against the specimer base which is rippented by pushing against the specimer base which is rippented by pushing against the specimer base which is rippented by pushing against the specimer base which is rippented by pushing against the specimer base which is rippented by pushing against the specimer base which is rippented by pushing against the specimer base which is rippented by pushing against the specimer base which is rippented by pushing against the specimer base.