

TABLE I. Measured isotropic elastic moduli of polycrystalline MgO, CaF₂, β -ZnS, ZnSe, and CdTe.

Specimen	Density (g/cm ³)	Elastic modulus ^a			Method of measurements
		Young's	Shear	Longitudinal	
IR-MgO	3.5819(\pm 0.0009)	30.72(\pm 0.12)	12.93(\pm 0.10)	...	Resonance
		...	12.90(\pm 0.03)	33.83(\pm 0.03)	Pulse superposition
IR-CaF ₂	3.1792(\pm 0.0008)	10.75(\pm 0.09)	4.07(\pm 0.07)	...	Resonance
		...	4.11(\pm 0.03)	14.87(\pm 0.03)	Pulse superposition
IR-ZnS	4.0791(\pm 0.0009)	8.38(\pm 0.09)	3.18(\pm 0.07)	...	Resonance
		...	3.17(\pm 0.03)	11.98(\pm 0.03)	Pulse superposition
IR-ZnSe	5.2664(\pm 0.0009)	7.46(\pm 0.10)	2.81(\pm 0.07)	...	Resonance
		...	2.89(\pm 0.03)	9.83(\pm 0.03)	Pulse superposition
IR-CdTe	5.8520(\pm 0.0008)	...	1.40(\pm 0.05)	6.07(\pm 0.06)	Phase comparison
		...	1.38(\pm 0.03)	6.08(\pm 0.03)	Pulse superposition

^a All values are at 298°K. All moduli are in units of 10¹¹ dyn/cm².

IR-CaF₂ was 3.1792 (\pm 0.0008) g/cm³ at 298°K, and this value compares well with an x-ray density of 3.179 g/cm³ at 298°K. The chemical purity of the specimen was 99.92% CaF₂, and a spectrochemical analysis showed the following impurities: Sr 700, Na 50, Mg 20, Si 3, and Mn 2 ppm with traces of Al, Ba, K, and Li. The IR-CaF₂ was highly translucent in the visible region as in the case of IR-MgO and it had the optical properties corresponding to a single-crystal CaF₂.

C. Polycrystalline β -ZnS

The β -ZnS specimen used in the present program is a typical Irtran No. 2 material. The measured density was 4.0791 (\pm 0.0009) g/cm³ at 298°K, and this should be compared with a x-ray density of 4.088 g/cm³ at the same temperature. The specimen has been referred to as IR-ZnS in the text, and it has a chemical purity of 99.997% ZnS. Among the impurities detected were Si 1 and Pb 1 ppm with traces of Cu, Fe, and Mg. X-ray diffraction patterns indicate the IR-ZnS was composed primarily of β -ZnS (i.e., sphalerite).

D. Polycrystalline ZnSe

One specimen of polycrystalline ZnSe used in the present program is a typical Irtran No. 4 material, and this has been designated as IR-ZnSe. The IR-ZnSe had the bulk density of 5.2664 (\pm 0.0009) g/cm³ at 298°K and this value compares well with 5.267 gm/cm³, the x-ray density at the same temperature. This specimen has a chemical purity of 99.995% ZnSe, with minor constituents including Mg 5, Cu 3, B 10, and Al 2 ppm and traces of Cr and Ni. The IR-ZnSe was translucent in the visible region and had the optical properties similar to single-crystal ZnSe.

E. Polycrystalline CdTe

One specimen referred hereafter to as IR-CdTe is a typical of Irtran No. 6 material. The measured density was 5.8520 (\pm 0.0008) g/cm³ at 298°K and this may be compared with 5.854 gm/cm³ calculated from the lattice constant⁷ of 6.5815 Å at 298°K. The chemical purity of the specimen was 99.98% CdTe and the specimen contained the following impurities: B 10, Si 10, Mg 3 ppm and traces of Al, Ag, and Cu.

2.2. Measurements of Isotropic Elastic Moduli

The present work utilizes primarily a modified Förster-type resonance method in the kilocycle range⁸ to determine the isotropic shear modulus and then Young's modulus of a bar-shaped polycrystalline specimen. Two ultrasonic methods⁹ (phase-comparison and pulse-superposition techniques due to McSkimin) often used in single-crystal measurements are also used, as complementary methods, for determining the elastic parameters of polycrystalline solids under investigation. Since a detailed description on all of these methods are found in the literature, this description is not reproduced here.

3. EXPERIMENTAL RESULTS

Table I lists the measured elastic moduli for all the polycrystalline specimens considered in the present work. For a given material, two sets of isotropic elastic moduli are entered. One set is the result obtained from the resonance method in the audio-frequency range and

⁷ P. W. Davis and T. S. Shilliday, *Phys. Rev.* **118**, 1020 (1960).

⁸ S. Spinner and W. E. Tefft, *Proc. ASTM* **61**, 1221 (1961).

⁹ H. J. McSkimin, *Physical Acoustics*, W. P. Mason, Ed. (Academic Press Inc., New York, 1964), Vol. I-A, Chap. 4.

Mat
reference

MgO

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