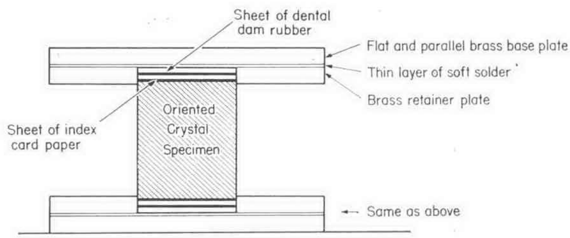

FIG. 2. A drawing of the "retained" resilient pressure pads used to provide good stress homogeneity on crystal surfaces.

An Eastman Kodak lead sulfide detector with a 1 $cm.^2$ window was used to measure "intensities" for curves A, D, and F, and a 1P28 photomultiplier tube was used for curves B, C, E, and G listed above. Transmission maxima were adjusted to a common value by means of the detector output signal amplifier. This procedure was maintained during piezobirefringence investigations.

The observed values of band pass and average wavelength at one-half "intensity" are given in Table 1. These values have been found to be reproducible to ± 0.005 micron. Therefore, data given in Table 1 are considered as correct to the second decimal place.

TABLE 1. BAND PASS AND AVERAGE WAVELENGTH (IN MICRONS) OF THE "SNOOPERSCOPE" INFRARED IMAGE CONVERTER TUBE (OPERATED AT 3000 VOLTS A.C. WITH FILTERS AS INDICATED)

	0.15 cm. thick polished silicon filter	0.15 cm. silicon +2.70 cm. water filter	0.15 cm. silicon +Corning No. 5850 filter
Band pass at $\frac{1}{2}$ "intensity"	0.14	0.08	0.10
Av. wavelength at $\frac{1}{2}$ "intensity"	1.140	1.113	1.110

Briggs (6), Fan (7), and more recently, Salzberg and Villa (8) have determined the index of refraction of silicon in the wavelength region covered in this work. Because of the absorption cutoff, a significant dispersion exists in this part of the spectrum. For example, from the data of Briggs (6), the index of silicon at a wavelength of 1.05 microns is 3.565, whereas at 1.40 microns it is 3.499. Because of this appreciable dispersion, a small error in establishing the correct value of wavelength can cause an appreciable error in computing the values of the piezobirefringence constants. It will be shown later that the piezobirefringence constant is proportional to the wavelength and inversely proportional to the cube of the index of refraction. At present, however, there is no theoretical explanation available by which refractive index dispersion may be related to possible piezobirefringent dispersion.

It has been shown (1, 2) that the application of a homogeneous stress to crystal surfaces is one of the most serious experimental problems encountered in stress-optical studies. In order to minimize this source of error, "retained" resilient pressure pads similar to those which Poindexter (1) developed and used successfully in his work on diamond were constructed. The pads are placed on the specimen pressure surfaces in order to minimize the effect of mechanical deficiencies in contact surfaces, and directional error in stress application. Each pad consists of a section of flat and parallel 1/32 inch thick brass plate tinned on one side with soft solder to a thickness of approximately 0.020 inch. Four similar but smaller pre-cut brass plates are then soldered to the base plate in such a way as to create a depression to fit the crystal specimen. For silicon and materials of similar thermal behavior, the finished oriented parallelepiped specimen itself may be used as a soldering template. Excess solder can be scraped from the depression by a sharp pointed jeweler's file or pocket knife. A thin sheet of dental dam rubber, cut to the proper size, is then inserted into the depression, followed by a sheet of index card paper of proper dimensions. The primary purpose of the paper is to act as a dam to prevent extrusion of the rubber between the crystal and brass retainer walls. A schematic diagram of the pressure pads mounted on a crystal is given in Fig. 3.

The retained Bridgman type of packing described above has been found to provide a very uniform distribution of stress on specimen surfaces up to pressures of approximately 700 kg./cm.^{2}. The homogeneity of stress distribution can be established qualitatively by visual inspection (infrared image converter tube) of the uniformity of polarized light transmission through the stressed crystal. Quantitative verification was carried out by measurement of the half wavelength positions of stress-induced light retardation.

Sources of Error

The following sources of error are recognized in this study of the piezobirefringence in silicon:

1) Non-homogeneous stress distribution
2) Misalignment in polar orientation
3) Misalignment in crystal orientation
4) Spectral characteristics of the optical system
5) Non-monochromaticity of the light used
6) Error in the determination of the light wavelength
7) Error in the refractive index of silicon