10 nm and that it reflects light as a good mirror; (2) refractive index measurements are reported for several alkali halides both below and above anticipated melt conditions and for a number of fluids; (3) absorption coefficients are found to depend strongly on temperature and to be tenfold to hundredfold larger than at room temperature and pressure for several alkali halides; (4) thermal brightness measurements are used to infer melting and equilibrium radiation is observed in some cases; (5) shock-induced luminescence from electrical and other sources is mentioned.

5.1. Index of refraction, photoelasticity

A surprising number of measurements of refractive index on shock-loaded samples have been reported but, except for those reviewed by Kormer [68K5], they are largely uninterpreted. Kormer's measurements involve such large compressions and high temperatures that they are difficult to interpret in the absence of other data. Nevertheless, he found reasonable agreement between his data on the change in index of refraction with shock pressure and static high pressure or conventional piezooptic measurements for LiF, KCl, NaCl, KBr, KI and CsBr. This observation of a linear piezooptic effect to such large compressions is surprising since the effect is thought to be nonlinear [66V3, 67V1] and phase transitions are known to occur in KCl, NaCl and KBr.

The volume and strain dependence of refractive indices [74T2] and low-frequency permittivities have been of interest as indicators of the effect of deformation on electronic polarizabilities. The relative influence of deformation on electronic polarizability, as indicated by index-of-refraction measurements, and on lattice polarizability, as indicated by low-frequency permittivity measurements, is well illustrated by the case of MgO for which the effects of pressure have the same tendencies [66V2]. In the alkali halides index of refraction and low-frequency permittivities have the opposite tendencies with pressure [66V2]. In MgO the decrease in electronic polarizability dominates the change of index of refraction with pressure, whereas the lattice polarizability dominates the change in alkali halides. These considerations make it clear that the change of index of refraction with strain or pressure is too complex to be described by a single simple model. A summary of Mueller's theory in which an empirical factor is used to correct the Lorenz–Lorentz relation for changes in polarizability is given by Vedam and Schmidt [66V2] as is a more general and basic theory by Yamashita and Kurosawa. Samara [75S5] has pointed out the importance of changes in electronic polarizability with pressure.

The collected data on index or refraction obtained at various shock compressions are shown in fig. 5.1. Two types of experiments are available. Those at the largest compression are obtained by Kormer in explosive loading experiments in which states of very high pressure and temperature were achieved but for which the data do not extend to atmospheric pressure conditions. Those data extending continuously from atmospheric pressure are obtained in projectile impact loading experiments. The data of Barker and Hollenbach [70B2] and of Asay and Hayes [75A3] are obtained from velocity interferometer measurements. In compiling the data for fig. 5.1 the relation between index of refraction and the reported changes in fringe frequency is taken from Hardesty [76H1]. The data on sapphire are all well within the elastic range as are those for vitreous silica. Measurements above 6% compression in vitreous silica may be influenced by a possible higher-order phase transition [72G2]. PMMA is viscoelastic to about 7% compression [70B2].

Setchell [79S4] has found that the index of refraction versus strain data for vitreous silica and sapphire can be well fit by a modified Gladstone-Dale relation which incorporates a power law strain dependence. His expression is:

$$\frac{(n-1)}{(n_0-1)} = \frac{v_0}{v}\left[1 - \alpha\left(\frac{v}{v_0} - 1\right)^\beta\right],\tag{5.1}$$

where n is the index of the uniaxially-compressed material, n_0 is the initial index of refraction, v_0 the initial specific volume, v the specific volume of the compressed material, and α and β are material constants. For vitreous silica, Setchell found $\alpha = 0.02996$ and $\beta = 0.6571$ and his fit to the data is shown as the solid line on fig. 5.1.
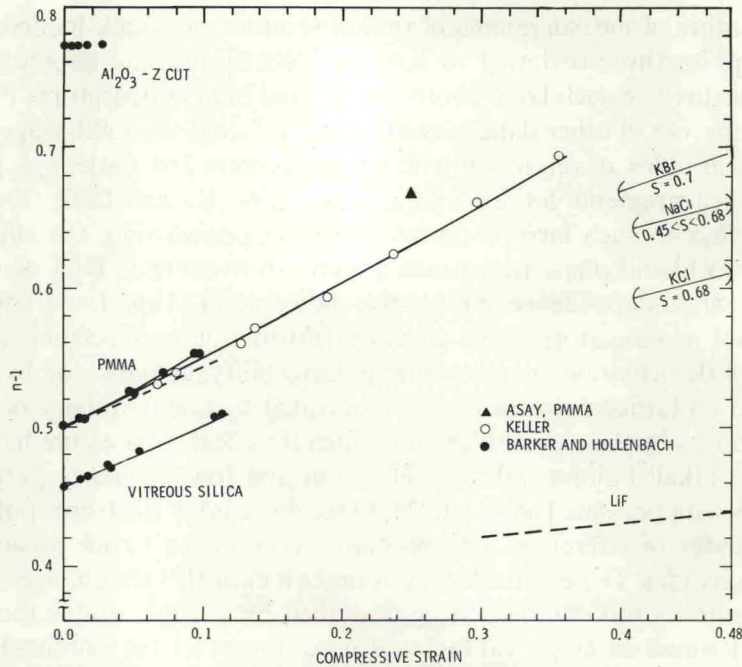

Fig. 5.1. The strain dependence of index of refraction has been investigated under shock loading at relatively small strains (datum points shown) and at large compressions (brackets and dashed lines shown for the right side of the figure). For measurements in the elastic range, the linear relations derived from the shock data are shown by the short dashed lines. The solid lines fit to the sapphire and vitreous silica data are from Setchell's corrected variant of the Gladstone–Dale relation. Most of the large compression data of Kormer [68K5] are off the scale of the figure but the slopes he observed over particular compression ranges are shown within the brackets. The LiF data are from Kormer [68K5]; his data on CsBr are off scale and are not shown. Other data are from Asay and Hayes [75A3], Barker and Hollenbach [70B2], and Keller [68K2].

Setchell [79S4] has also calculated the strain-polarizability coefficient of Mueller [66V2] for both vitreous silica and Z-cut sapphire under uniaxial strain. The resulting functions are found to be distinctly nonlinear. Data on the temperature dependence of the strain-polarizability coefficient can be extracted from elevated temperature measurements of Asay [77A3] at 473 K.

The work of Setchell well demonstrates the capability for studies of strain dependence of polarizability under shock loading which could profitably be carried out in a variety of solids with large Hugoniot elastic limits.

Kormer [68K5] has reported good agreement between his measured coefficients of index of refraction at very high pressures and similar values reported at room temperature and modest