Chapter 5
RESULTS AND DISCUSSIONS

The thermal expansivity, ultrasonic velocities, density, and heat capacity results for copper-zinc and aluminium-zinc alloys are presented in this chapter.

The elastic properties of these specimens, Gruneisen parameter and other thermo-acoustic properties are also presented. The nature of variation of these parameters as a function of temperature for pure metals and alloys is discussed. The composition dependency of these parameters at specified temperatures is briefly discussed.

5.1 THERMAL EXPANSIVITY, ULTRASONIC VELOCITY, DENSITY AND HEAT CAPACITY

The coefficient of thermal expansion as a functional temperature for the alloys of copper-zinc and aluminium-zinc are presented in Tables 5.1.1 and 5.1.2. The corresponding graphical representations are already provided in Chapter 2.

The rate of change of $\alpha_t$ is normal for copper-zinc and aluminium-zinc alloys.

It is quite interesting to plot $\alpha_t$ versus composition. At constant temperature – Fig. 2.3.1 & Fig 2.3.2 shows the dependence of $\alpha_t$ at 50°C, 100°C, 200°C, 300°C and 400°C as a function of concentration. The $\alpha_t$ values tend to increase rapidly near those compositions at which the alloy exists in highly brittle state [134].

The velocity versus temperature behaviour of the alloys is already presented in Figs 2.2.1 to 2.2.4. The longitudinal and shear velocities are presented in Table 5.1.3 to Table 5.1.6 respectively. The velocity versus temperature variations do not exhibit prominent deviation from the usual behaviour except for shear velocity of aluminium-zinc alloys.

The density and heat capacity data are presented in Table 5.1.7 to Table 5.1.10 respectively. The variations in Fig.2.4.1 and
### Table 5.1.1 Experimental Thermal Coefficient of Expansion of Cu-Zn Alloys

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<thead>
<tr>
<th>$\alpha \times 10^6$</th>
<th>Experimental ($K^{-1}$)</th>
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### Table 5.1.2 Experimental Thermal Coefficient of Expansion of Al-Zn Alloys

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<th>300°C</th>
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Table 5.1.4 Experimental Longitudinal Velocities for Al-Zn Alloys

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Table 5.1.6 Shear Velocities of Al-Zn Alloys

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### Table 5.1.8 Experimental Densities of Al-Zn Alloys

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### Table 5.1.9 Heat Capacity at Constant Pressure of Cu-Zn Alloys \( C_p (J/mole) \)

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<th>( x^2 )</th>
<th>50°C</th>
<th>100°C</th>
<th>200°C</th>
<th>300°C</th>
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### Table 5.1.10 Heat Capacity at Constant Pressure of Al-Zn Alloys \( C_p (J/mole) \)

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5.2 ELASTIC PROPERTIES

The shear modulus $G$, and bulk modulus $B_s$ of the alloys at different temperatures (50°C, 100°C, 200°C, 300°C and 400°C) are plotted in Fig. 5.2.1 and Fig. 5.2.3 for copper-zinc and Fig. 5.2.2 and 5.2.4 for aluminium-zinc alloys. Copper-zinc is referred as alloy 1 and aluminium-zinc as alloy 2, unless otherwise mentioned.

The elastic behaviour reflects the combined behaviour of velocities and densities. The variation of elastic constants as a function of mole fraction of zinc for alloys 1 (at constant temperature) indicates that the variation is not appreciable in the range of $0.2$ to $0.4$. The concentration region between $X_z = 0.4$ to $0.8$ could not be studied since the specimens prepared are too brittle to handle. This corresponds to the phase change of the eutectic of the alloy [1].

The elastic behaviour of alloys 2 are quite normal except for the abrupt changes observed in 0.4 to 0.58 concentration of zinc. The Poisson's ratio is observed to increase accordance with $E$. However, the percentage increase of $\sigma$ is much lesser than the percentage in increase of $E$ or $G$ or $B_s$ for both alloys. The values of $E$, $G$, $B_s$ and $\sigma$ are presented in Tables 5.2.1 and 5.2.2 at 50°C, 100°C, 200°C, 300°C, and 400°C for the metals and alloys.

5.3 THERMO-ACOUSTIC BEHAVIOUR

The variation of isothermal compressibility is presented in Fig. 5.3.1 for alloy 1 and Fig. 5.3.2 for alloy 2. The variation is similar to bulk modulus as the compressibility is an inverse function of bulk modulus. The variation of $\beta_t$ as a function of concentration is quite smooth. The variation has some similarities with variation of $\alpha_t$.

The values of $\beta_s$, $\beta_t$ and $\gamma$ at temperatures 50°C, 100°C, 200°C, 300°C and 400°C for various alloys and metals are presented in Tables 5.3.1 and 5.3.2 respectively for alloy 1 and alloy 2.
Fig. 5.2.1 Shear Modulus of Cu-Zn Alloys
Fig. 5.2.2 Shear Modulus of Al-Zn Alloys

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Fig. 5.2.3 Bulk Modulus of Cu-Zn Alloys
Fig. 5.2.4 Bulk Modulus of Al-Zn Alloys
# Table 5.2.1 Elastic Constants of Cu-Zn Alloys

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Table 5.2.2 Elastic Constants of Al-Zn Alloys

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Fig. 5.3.1 Isothermal Compressibilities of Cu-Zn Alloys
Fig. 5.3.2 Isothermal Compressibilities of Al-Zn Alloys
Table 5.3.1 Compressibilities of Cu-Zn Alloys

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### Table 5.3.2 Compressibilities of Al-Zn Alloys

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5.4 GRUNEISEN PARAMETERS AND THE RELATED PARAMETERS

The lattice Gruneisen parameter $\Gamma$, Moelwyn-Hughes parameter $C_1$, first order isochoric temperature coefficient $X$, Beyer's nonlinearity parameter $\left( B/A \right)$, fractional free volume $V_a/V$, the repulsive exponent $n$, Sharma's constants $S_0$ and $S^*$, molecular constant $r$, thermodynamic Gruneisen parameter $\gamma$, and isochoric acoustical parameter $\delta$ (already discussed in chapter 3) are presented in this section.

The parameters $\Gamma$, $C$, and $X$ are closely related to each other as discussed in chapter 3. The parameter $\left( B/A \right)$ is related to the sum of $\gamma$ and $\gamma$ (ratio of specific heats).

It would be quite interesting to evaluate the values of $\Gamma$, $\Gamma'$, and $\Gamma''$ using experimental isothermal compressibility data and compare these with values derived theoretically. Using Eqn. (3.2.1 b) approximate $\Gamma$ values have been evaluated and these are designated as theoretical values. Through the experimental values of $\beta_\gamma$, using Eqn. (3.2.1) the so called $\Gamma_{\text{Exp}}$ have been estimated. These two values are compared in Table 5.4.1 for Cu-Zn and Table 5.4.2 for Al-Zn.

It is interesting to note that temperature derivatives of $\Gamma$ are negative while the temperature derivatives of $\Gamma_{\text{Exp}}$ have been observed to be slightly positive [1] unlike the present study.

It has not been possible to evaluate independently $\Gamma'$ since the compressibility data as a function of pressure is not available in literature. However such data is available in literature Bridgmann [135] as cited in reference 3, for Copper in the pressure range of 0-11600 atmospheres. The estimated experimental value of $\Gamma'$ for Copper at 5800 atmospheres turns out to be 5.04. This value is in reasonable agreement with average $\Gamma_{\text{Exp}} = 5.3$ estimated at 100°C. The values of $\Gamma'$ have been determined assuming $\Gamma' = \Gamma + \Gamma''$. Theoretical as well as experimental values of $\Gamma'$ so determined are presented in Table 5.4.1. The values of $\Gamma''$ have been estimated using Eqns. (3.2.4), (3.2.7), (3.2.21) and (3.2.24). The experimental estimates of $\Gamma''$ which are referred as $\Gamma_{\text{Exp}}$ are derived using Eqn. (3.2.3) using (extrapolated) values of $\beta^*$, internal pressure $P_i$ and thermal expansivity data. The experimental and theoretical values are plotted in Figures 5.4.1 to 5.4.4 as presented.
Table 5.4.1 Gruneisen Parameters of Cu-Zn Alloys

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Fig. 5.4.1 Gruneisen Parameter $\Gamma$ of Cu-Zn at 50°, 100° & 200° C.
Fig. 5.4.2 Gruneisen Parameter $\Gamma$ of Al-Zn at 50°, 100° & 200°C.
Fig. 5.4.3 Gruneisen Parameter $\Gamma''$ of Cu-Zn at 50°, 100° & 200° C.
Fig. 5.4.4 Gruneisen Parameter $\Gamma''$ of Al-Zn at 50°, 100° & 200° C.
The $\Gamma''_{\text{Expt}}$ values have been estimated by extrapolating the $\beta$ values for the metals and alloys except copper. Using the literature data [94], the $\Gamma''_{\text{Expt}}$ values of Copper have been evaluated. Excepting for Copper, $\Gamma''$ values are likely to be erroneous by 10% while $\Gamma''$ values of Copper are estimated to be 3% erroneous.

The $\Gamma'_{\text{Expt}}$ so derived by combining $\Gamma'_{\text{Expt}}$ and $\Gamma''_{\text{Expt}}$ are involved with the combined errors of $\Gamma'_{\text{Expt}}$ and $\Gamma''_{\text{Expt}}$. An error of 8% is expected for $\Gamma'_{\text{Expt}}$ of Copper while an error of 15% is expected for $\Gamma'_{\text{Expt}}$ of Aluminium and the other alloys.

The $\Gamma'_{\text{Expt}}$ and $K_{\text{Expt}}$ have been determined using data [64] at 150 K or -123°C. $\Gamma_{\text{Expt}}$ has been found to be 1.15 and $K_{\text{Expt}}$ to be 1.13. The data is not accurate enough to determine $(\Gamma-K)_{\text{Expt}}$. These $\Gamma_{\text{Expt}}$ support the trend of the experimental values of the present study predicting a positive temperature derivative of $\Gamma_{\text{Expt}}$.

It has been already stated in Chapter 3 that following Slater's [64] presentation of anharmonic nature of crystal lattice, the normal mode frequencies increase as it becomes harder. Using Debye theory of specific heats it has been shown that

$$\Gamma = K + (1/3) = K + 0.33 \quad (5.4.1).$$

while the value of $K$ is derived using Eqn. (3.2.1a) the values of $K$ have been estimated independently and presented in Table 5.4.3. The difference $\Gamma - K$ is supposed to be 0.33 at lower temperatures. It is quite interesting to note that $\Gamma - K$ has been found to be temperature dependent. The values appear to tend to 0.33 as the temperature is reduced to absolute zero. However the present experimental data being confined to the lowest temperature of 5° C, a confirmation is required by extending the temperature down to absolute zero.

The experimental data can further be used to evaluate $C_i$, $X$, $(B/A)$, $r$, $S_0$ and $S^*$. However in view of the close relationship between $\Gamma$ values and these data, we have not attempted to reestimate the above parameters using $\Gamma_{\text{Expt}}$. 

[57]
### Table 5.4.3 Isochoric Acoustical Parameter (K) of Cu-Zn & Al-Zn Alloys

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### Table 5.4.4 Moelwyn-Hughes Parameter of Cu-Zn & Al-Zn Alloys ($C_1$)

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Table 5.4.4 shows the Moelwyn-Hughes parameter $C_1$, at various temperatures and compositions. Table 5.4.5 shows the variation of $X$ as a function of temperature for various specimens. Table 5.4.6 shows the Beyer's nonlinearity parameters $(B/A)', (B/A)''$, $(B/A)_0$ and repulsive exponent $n$. The composition dependency of $(B/A)', (B/A)''$ and $(B/A)$ are plotted in Figs 5.4.5 to 5.4.6 for Cu-Zn at 50°C and 200°C respectively. Similarly Figs 5.4.7 & 5.4.8 represent a similar behaviour for Al-Zn alloys. The fractional free volumes are presented in Table 5.4.7. The Sharma's constants $S_0$ and $S^*$, the acoustical parameter $\delta$, and molecular constant $r$, are presented in Table 5.4.8.

In conclusion it may be stated that $\Gamma_{\text{expt}}'$ and $\Gamma_{\text{expt}}''$ have predicted the right magnitude for metals and their alloys when compared with the respective theoretical values. However the temperature derivatives of $\Gamma_{\text{expt}}'$ are in disagreement with the theoretical temperature derivatives. The $\Gamma_{\text{expt}}''$ values are in agreement with that of the theoretical values when the combined errors are considered. In the absence of the literature values of temperature derivatives of $\Gamma$ and $\Gamma''$, it is rather difficult to confirm the quantitative differences.

5.5 THERMODYNAMIC GRUNEISEN PARAMETER

It is quite interesting to note that thermodynamic Gruneisen parameter $\Gamma$, (We refer to it as Gruneisen parameter from here onwards) is closely related to compressibility, specific heat and thermal coefficient of expansion. Accurate measurement of these parameters serve to define the equation of state of solid. The equation of state has been predicted for copper, aluminium and other metals by various workers [96, 100, 114, 125-134]. Kharoo et al [128] showed that the thermodynamic Gruneisen parameter derived as evaluated through equation of state for copper appears to increase from a value of 1.6 at 30 K to 2.0 at 300 K. The experimentally evaluated values [94] are in agreement with theoretical evaluations. Tolpadi [125] has shown that the first order constant varies from 1.21 at 100 K to 1.86 at 500 K through equation of state evaluations. Tolpadi [98] improved the equation of state leading to the prediction of higher order parameters assuming that anharmonic parameters are
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Table 5.4.6(a) Beyer's Nonlinearity Parameters of Cu-Zn and Al-Zn Alloys

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| **B/A of Al - Zn Alloys** |      |       |       |       |         |
| 0.000E+00 | 4.707E+01 | 4.033E+01 | 3.125E+01 | 2.544E+01 | 2.145E+01 |
| 1.647E-01 | 4.645E+01 | 4.016E+01 | 3.153E+01 | 2.504E+01 | 2.184E+01 |
| 3.907E-01 | 4.323E+01 | 3.747E+01 | 2.990E+01 | 2.314E+01 | 1.920E+01 |
| 5.857E-01 | 4.565E+01 | 3.995E+01 | 3.263E+01 | 2.634E+01 | 2.210E+01 |
| 7.963E-01 | 4.253E+01 | 3.668E+01 | 2.944E+01 | 2.269E+01 | 1.855E+01 |
| 1.000E+00 | 3.276E+01 | 2.849E+01 | 2.270E+01 | 1.899E+01 | 1.648E+01 |

| **B/A' of Cu - Zn Alloys** |      |       |       |       |         |
| 0.000E+00 | 6.716E+01 | 5.746E+01 | 4.474E+01 | 3.683E+01 | 3.100E+01 |
| 1.824E-01 | 6.395E+01 | 5.430E+01 | 4.169E+01 | 3.365E+01 | 2.813E+01 |
| 4.062E-01 | 6.054E+01 | 5.128E+01 | 3.924E+01 | 3.175E+01 | 2.669E+01 |
| 8.984E-01 | 4.130E+01 | 3.570E+01 | 2.848E+01 | 2.378E+01 | 2.052E+01 |
| 1.000E+00 | 3.563E+01 | 3.114E+01 | 2.514E+01 | 2.124E+01 | 1.856E+01 |

| **B/A' of Al - Zn Alloys** |      |       |       |       |         |
| 0.000E+00 | 4.940E+01 | 4.253E+01 | 3.336E+01 | 2.748E+01 | 2.343E+01 |
| 1.647E-01 | 4.935E+01 | 4.286E+01 | 3.401E+01 | 2.825E+01 | 2.422E+01 |
| 3.907E-01 | 4.617E+01 | 4.004E+01 | 3.146E+01 | 2.571E+01 | 2.179E+01 |
| 5.857E-01 | 4.881E+01 | 4.177E+01 | 3.246E+01 | 2.633E+01 | 2.218E+01 |
| 7.963E-01 | 4.516E+01 | 3.898E+01 | 3.070E+01 | 2.482E+01 | 2.082E+01 |
| 1.000E+00 | 3.563E+01 | 3.114E+01 | 2.514E+01 | 2.124E+01 | 1.856E+01 |
Table 5.4.6(b) Beyer's Nonlinearity Parameters of Cu-Zn and Al-Zn Alloys

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<th>300°C</th>
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B/A" of Al - Zn Alloys

| 0.000E+00 | -2.320E+00 | -2.201E+00 | -2.111E+00 | -2.036E+00 | -1.876E+00 |
| 1.847E-01 | -2.897E+00 | -2.519E+00 | -2.400E+00 | -2.415E+00 | -2.376E+00 |
| 3.907E-01 | -2.944E+00 | -2.562E+00 | -2.506E+00 | -2.506E+00 | -2.506E+00 |
| 5.857E-01 | -3.100E+00 | -2.822E+00 | -2.658E+00 | -2.806E+00 | -2.806E+00 |
| 7.963E-01 | -3.235E+00 | -2.320E+00 | -2.262E+00 | -2.238E+00 | -2.217E+00 |

(B/A)_α of Cu - Zn Alloys

| 0.000E+00 | 6.439E+01 | 5.484E+01 | 4.227E+01 | 3.429E+01 | 2.870E+01 |
| 1.824E-01 | 6.157E+01 | 5.220E+01 | 4.062E+01 | 3.219E+01 | 2.623E+01 |
| 4.092E-01 | 5.022E+01 | 4.062E+01 | 3.718E+01 | 2.870E+01 | 2.479E+01 |
| 8.984E-01 | 3.818E+01 | 3.292E+01 | 2.580E+01 | 2.124E+01 | 1.819E+01 |

(B/A)_α of Al - Zn Alloys

| 0.000E+00 | 4.845E+01 | 3.971E+01 | 3.053E+01 | 2.483E+01 | 2.084E+01 |
| 1.847E-01 | 4.590E+01 | 3.952E+01 | 3.090E+01 | 2.520E+01 | 2.129E+01 |
| 3.907E-01 | 4.266E+01 | 3.692E+01 | 2.833E+01 | 2.257E+01 | 1.860E+01 |
| 5.857E-01 | 4.507E+01 | 3.839E+01 | 2.905E+01 | 2.263E+01 | 1.856E+01 |
| 7.963E-01 | 4.197E+01 | 3.612E+01 | 2.789E+01 | 2.213E+01 | 1.797E+01 |
| 1.000E+00 | 3.219E+01 | 2.793E+01 | 2.214E+01 | 1.843E+01 | 1.591E+01 |

Repulsive Exponent n of Cu - Zn Alloys

| 0.000E+00 | 1.229E+02 | 1.038E+02 | 7.867E+01 | 6.276E+01 | 5.177E+01 |
| 1.824E-01 | 1.172E+02 | 9.851E+01 | 7.344E+01 | 5.755E+01 | 4.670E+01 |
| 4.092E-01 | 1.055E+02 | 9.246E+01 | 6.851E+01 | 5.374E+01 | 4.382E+01 |
| 8.984E-01 | 7.052E+01 | 6.002E+01 | 4.584E+01 | 3.678E+01 | 3.056E+01 |
| 1.000E+00 | 5.857E+01 | 5.007E+01 | 3.657E+01 | 3.122E+01 | 2.825E+01 |

Repulsive Exponent n of Al - Zn Alloys

| 0.000E+00 | 8.702E+01 | 7.357E+01 | 5.547E+01 | 4.391E+01 | 3.588E+01 |
| 1.847E-01 | 8.572E+01 | 7.319E+01 | 5.507E+01 | 4.464E+01 | 3.689E+01 |
| 3.907E-01 | 7.946E+01 | 6.799E+01 | 5.068E+01 | 3.941E+01 | 3.155E+01 |
| 5.857E-01 | 8.428E+01 | 7.093E+01 | 5.231E+01 | 3.994E+01 | 3.147E+01 |
| 7.963E-01 | 7.808E+01 | 6.640E+01 | 5.007E+01 | 3.864E+01 | 3.031E+01 |
| 1.000E+00 | 5.857E+01 | 5.007E+01 | 3.857E+01 | 3.122E+01 | 2.625E+01 |
Fig. 5.4.5 Bayer's Non-linearity Parameter of Cu-Zn Alloys at 50°C
Fig. 5.4.6 Bayer's Non-linearity Parameter of Cu-Zn Alloys at 200°C
Fig. 5.4.7 Bayer's Non-linearity Parameter of Al-Zn Alloys at 50°C
Fig. 5.4.8 Bayer's Non-linearity Parameter of Al-Zn Alloys at 200 °C
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\( \bar{V}_\alpha/V \) of \ Cu - Zn \ Alloys

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independent of phonon-phonon interactions. The phonon-phonon interactions do introduce energy shift as a function of frequency [39-44,96]. The shift is likely to effect the third and fourth order derivatives of potential function. It has been theoretically predicted for copper that the value of thermodynamic Gruneisen parameter is likely to increase with the increasing temperature. It approaches a limiting value at higher temperatures. It would be quite interesting to compare the theoretically predicted values with experimental values particularly at higher temperatures.

To investigate this aspect, Anjaneulu [1] has assumed \(V, \beta_s, C_p\) and \(\alpha\) values of White [94] in the temperature region of 30 K to 300 K. On inclusion of these parameters in the extended temperature region 323 to 873 K, on smoothing the discontinuities between the two temperature regions, Cu-Al alloys were studied. The same procedure is adopted and good agreement found for the alloys under present study. These results are not included. However the salient conclusions derived by Anjaneyulu are presented in next para.

*The experimentally derived Gruneisxen parameter is in good agreement with the theoretically evaluated parameter right from lower temperatures to 373 K. The disagreement is large at higher temperature. The anharmonicity term plays an important role at higher temperatures. Tolpadi and other theoretical investigators have simplified their models with assumptions such as the isochoric and isobaric Gruneisen parameters are presumed to be the same for all 3 N phonon frequencies. Experimental investigations of Lowndes [138] in ionic crystals showed similar disparity between experimental and theoretically derived isochorioc self-energy* is the observation of Anjaneyulu which is apparently valid in the present study as well.

Since the parameter has not been evaluated at higher temperatures so far particularly at elevated temperatures, it is rather difficult to compare the literature values. However, the parameter can be derived using \(V, \beta_s, C_p\) and \(\alpha\) values of different investigators. The values so estimated for the two systems are presented in Figs 5.5.1 & 5.5.2 respectively for the two systems.
Fig. 5.5.1 Thermodynamic Gruneisen Parameter of Cu-Zn Alloys
Fig. 5.5.2 Thermodynamic Gruneisen Parameter of Al-Zn Alloys
5.6 CONCLUSIONS

Thermal expansions, compressibility, Gruneisen parameter and lattice Gruneisen parameter can furnish independent information on the equation of state [85]. Accurate measurements of these parameters may perhaps help to evaluate correct equation of state of solids [64]. The nature of variation of lattice frequencies or anharmonicity as a function of temperature and pressure provides additional information on the equation of state. The higher order temperature and pressure derivatives of equation of states are instrumental in developing the model presumed for equation of state.

In the present work an attempt has been made to derive the thermal coefficient, ultrasonic velocity, density of aluminium, copper and zinc alloys. The study is particularly of interest as their variations have been measured or determined at elevated temperatures. The elastic properties of pure metals and their alloys have been estimated as a function of temperature. The systematic temperature dependence of these properties have not been attempted so far [85]. Thermo-acoustic properties of metals and alloys have been studied at elevated temperatures which perhaps is the extended study to reference 1.

Lattice or microscopic Gruneisen parameters of the metals and alloys has thrown some light on the temperature dependency of these parameters. It has been possible to estimate the isobaric values of these microscopic parameters independently from the experimental study. The estimates of microscopic parameter derived throw approximations of theoretical assumptions have been found to be somewhat different. Our experimental studies are limited at atmospheric pressure. Estimation of these parameters as a function of pressure would throw more light on the equation of state of the pure metals.

Thermodynamic Gruneisen parameters of metals are studied are found to be in good agreement with with theoretical evaluations between 0 K and 400 K. The estimates above 400 K indicate that the experimentally derived parameters are much lower than the theoretical values. The theory predicts that the constant value at higher temperature while the experimental value is found to
decrease with temperature. This may be due to the assumptions made in formulating the equation of state or its derivatives. These theoretical assumptions are discussed in the relevant section.

The experimentally derived thermodynamic Gruneisen parameter or microscopic Gruneisen parameter could not be correlated with the independent equation of state terms of the pure metals because the phase diagram clearly indicate variation of phase terms with temperature. Qualitative predictions of the alloys in terms of the metals is possible. This has not been attempted since there is already disagreement between the theoretically predicted values and experimental values. This would perhaps be feasible if the models are modified to correctly predict the higher derivatives of equation of state.

It is not out of place to mention that aluminium-lithium alloys are good competitions to carbon fibre composites in air-craft industry. The systematic study of the industrial metals aluminium, copper, nickel, zinc and titanium and their alloys are gaining ground. These alloys belong to a class called 'memory metals'. Their applications were limited to military use so far. Depending on the composition of the alloy, the metals can change shape at certain triggering temperatures. The transformation takes place within a limited range of temperature. These are likely to find wide applications in consumer products. The alloys studied in this work have no special feature. This work is an attempt to build apparatus suitable for quick thermal expansion study of metals, alloys or other materials.