where the initial bulk modulus is

$$B_0 = \left\{ -V\left(\frac{\partial P}{\partial V}\right)_T \right\}_{P=0},$$

and the corresponding pressure derivative

$$B_0' = \left\{ \left(\frac{\partial B}{\partial P}\right)_T \right\}_{P=0}.$$

The elastic constants of Bell and Rupprecht [5] were used to calculate $B_0 = 1{\cdot}76 \times 10^3$ kbar and the best fit to our data was obtained with $B_0' = 4{\cdot}4$.

One can determine the Grüneisen parameter for $SrTiO_3$ from the Grüneisen relation[7]

$$\gamma = \frac{\alpha V_m}{\beta C_v},$$

where α is the volume thermal expansion, V_m is the molar volume, β is the compressibility, and C_v is the specific heat at constant volume. At room temperature and atmospheric pressure, the values of the various parameters are $\alpha = 2{\cdot}6 \times 10^{-5}$°K[8], $\beta = 5{\cdot}67 \times 10^{-13}$ cm²/dyne[5], $C_v = 20{\cdot}7$ cal/mole-°K[9] and $V_m = 35{\cdot}7$ cm³/mole; using these values, one calculates $\gamma = 1{\cdot}89$. The B_0' obtained from the least squares fitted Murnaghan equation can be used to calculate the Grüneisen parameter by an independent method; Anderson[10] has shown that

$$\gamma = \frac{B_0' - 1}{2}.$$

As mentioned previously, the data was best fit with $B_0' = 4{\cdot}4$, and thus $\gamma = 1{\cdot}7$, in reasonable agreement with the value calculated above.

Acknowledgements—The $SrTiO_3$ sample used in this investigation was kindly provided by J. E. Hesse and J. Matsko of this laboratory. The authors gratefully acknowledge the technical assistance of Clarence Huddle.

Albuquerque,
New Mexico 87115,
U.S.A.

L. R. EDWARDS
R. W. LYNCH

REFERENCES

1. LYNCH R. W., *J. chem. Phys.* **47**, 5180 (1967).
2. BRIDGMAN P. W., *Proc. Am. Acad. Arts. Sci.* **76**, 1 (1945).
3. RICE M. H., McQUEEN R. G. and WALSH J. M., *Solid St. Phys.* **6**, 1 (1965).
4. WYCOFF R. W. G., *Crystal Structures*, p. 394. Wiley, New York (1964).
5. BELL R. O. and RUPPRECHT G., *Phys. Rev.* **129**, 90 (1963).
6. MURNAGHAN F. D., *Proc. natn. Acad. Sci. U.S.A.* **30**, 244 (1944).
7. KITTEL C., *Introduction to Solid State Physics*, p. 154. Wiley, New York (1956).
8. KRIKORIAN O. H., University of California Radiation Laboratory Report UCRL-6132 (1960).
9. COUGHLIN J. P. and ORR R. L., *J. Am. chem. Soc.* **75**, 530 (1953).
10. ANDERSON O. L., *Phys. Rev.* **144**, 553 (1966).
Sandia Laboratories.

THE JOU
VOLUME 31,