a quadratic equation for the temperature. (Energy is now expressed for one gram of solid.) Internal energy E on the Hugoniot curve is known from the Rankine-Hugoniot relation. For a single shock from the ambient state the relation is

$$E_H = E_o + \frac{1}{2} P_H V_o (1 - X) \quad .$$

Besides calculating temperatures we can now perform the integration necessary for the resistivity model calculation (Eq. (3)),

$$I(X) = \int_1^X \frac{\gamma(X')}{X'} \, dX' \ .$$

The Dugdale-MacDonald formula gives

$$\gamma(X) = -\frac{X}{6} \; \frac{2AbX^{-\frac{1}{3}}\exp(b(1-X^{\frac{1}{3}})) + Ab^2\exp(b(1-X^{\frac{1}{3}})) - 10KX^{-\frac{4}{3}}}{-AbX^{\frac{2}{3}}\exp(b(1-X^{\frac{1}{3}})) + 2KX^{-\frac{1}{3}}} - \frac{1}{3} + \delta$$

(For silver, Zharkov and Kalinen give values of $A = 0.31495$ Mbar, $b = 11.9180$, $K = 0.33299$ Mbar, and $\delta = 0.163$ for the equation of state fit to shock and static high pressure data.) The integration was done numerically by the extension of Simpson's rule (Booth, 1957). Results for the Debye temperature

$$\frac{\theta}{\theta_o} = \exp(-I(X))$$

were fitted to a polynomial

$$\frac{\theta}{\theta_o} = 4.0465 \, X^2 - 10.523 \, X + 7.4770 \quad .$$

Aside from dependence on volume, the phonon spectrum as characterized by θ_D may also be affected by lattice defects. The Debye temperature may change linearly with dilute solute concentration by up to 1% per atomic percent solute (Berry, 1972). Defects generated by quasi-static plastic deformation can be accounted for in a solid's thermal behavior by a decrease in θ_D of 0.4% for saturation defect concentration (Berry, 1972). For the defect concentration generated by shock deformation the change would be greater, however these effects were neglected in computations in this work using θ_D.

C. Strength Effects

To a first approximation in these experiments silver can be treated as a fluid in calculating the shock (P,V,T) state. However, one would like an estimate of the significance of material strength effects for silver shock states. Also, one needs the strength for calculation of the work of plastic deformation. This work is important in analyzing the behavior of shock defect resistivity.

If material strength is significant, a number of adjustments have to be made. For an isotropic solid one defines a mean pressure by

$$-\overline{P} = \frac{1}{3}(\sigma_x + \sigma_y + \sigma_z) = \frac{1}{3}(\sigma_x + 2\sigma_y)$$

where σ_x is the stress in the direction of shock propagation. (Tensile stresses and strains are taken as positive.) In addition, equation of state calculations must be revised, accounting for the solid's elastic strength. For an ideal elastic-plastic, isotropic solid the work of plastic deformation is expressed

$$dW_{PD} = V \sum_j s_j \, de_j^P \qquad (5)$$

where the deviatoric stresses are defined by $s_j = \sigma_j + \overline{P}$ and for small strains deviatoric strains by

$$e_j = \epsilon_j - \frac{1}{3}\sum_k \epsilon_k \qquad (\epsilon_k \text{ is natural strain}).$$