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Equation of state of $MgSiO_3$ with the perovskite structure based on experimental measurement

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Abstract

We studied $MgSiO_3$ with the perovskite structure heated to temperatures up to 1500 K at pressures between 36 and 110 GPa with in-situ X-ray diffraction. The new pressure-volume-temperature (*P-V-T*) data were combined with literature data to provide thermal expansivity α and compressibility β against T (in K): $\alpha_T = 2.71 \times 10^{-5} + 1.80 \times 10^{-9}\ T - 1.48\ T^2$ (Model 1) or $\alpha_T = 2.13 \times 10^{-5} + 7.57 \times 10^{-9}\ T - 1.02\ T^2$ (Model 2), and $\beta_T = 3.735 \times 10^{-7} + 3.27 \times 10^{-11}\ T + 6.60 \times 10^{-15}\ T^2$. Model 1 yields physical properties of perovskite that confirm Anderson's (1998) Debye approach; the model is valid for extrapolation to 3000 K or more. The parameters at 300 K are: $\alpha = 1.1 \times 10^{-5}$, K_0 (bulk modulus) = 261 GPa, $K_0' = 4$ and $(\partial K/\partial T)_P = -0.027$. Thermal expansivity from this model does not fit the data of Funamori et al. (1996) at high temperature for $P = 25$ GPa. Model 2 uses an equation for α based on the data of Funamori et al. (1996), fits the available experimental data closely, and maintains conformity with Anderson's Debye approach. Heat capacity, C_P, data for perovskite is given by either: $C_P = 110.8 + 8.031 \times 10^{-3}\ T - 1.302 \times 10^{-7}\ T^2 - 1.647 \times 10^{7}\ T^2 + 2.755 \times 10^{9}\ T^{-3} + 267.5\ T^{-0.5} + 9287\ T^{-1}$ (Model 1) or $C_P = 121.33 + 2.77 \times 10^{-3}\ T - 2.585 \times 10^{-6}\ T^2 - 1.710 \times 10^{7}\ T + 2.792 \times 10^{9}\ T^{-3} - 169\ T^{-0.5} + 15782\ T^{-1}$ (Model 2).