Pressure-volume equation of state for chromite and magnesiochromite: A single-crystal X-ray diffraction investigation†

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ABSTRACT

The pressure-volume equation of state for the two spinel end-member compositions chromite FeCr2O4 and magnesiochromite MgCr2O4 was determined for flux-grown synthetic single crystals at room temperature up to 8.2 and 9.2 GPa, respectively, by single-crystal X-ray diffraction using a diamond-anvil cell. The pressure-volume data show that the linear volume compressibility (here used only for purpose of comparison), calculated as $\beta_V = \frac{|(\Delta V/V_0)/\Delta P|}{\text{GPa}^{-1}}$, is 0.00468 and 0.00470 for chromite and magnesiochromite, respectively, with a negligible difference below 0.5%. The experimental data were fitted to a third-order Birch-Murnaghan equation of state (BM3) allowing a simultaneous refining of the following coefficients: $V_0 = 588.47(4) \text{ Å}^3$, $K_{T0} = 184.8(1.7) \text{ GPa}$, and $K' = 6.1(5)$ for chromite and $V_0 = 579.30(4) \text{ Å}^3$, $K_{T0} = 182.5(1.4) \text{ GPa}$, and $K' = 5.8(4)$ for magnesiochromite.

The difference in $K_{T0}$ is reduced to <1.5% going from Fe to Mg end-member composition, whereas the first pressure derivative seems not to be affected by the chemical variability. The limited difference in the equation of state coefficients recorded for FeCr2O4 and MgCr2O4 allowed us to fit the pressure-volume data of both to a single BM3 equation, resulting in $K_{T0} = 184.4(2.2) \text{ GPa}$ and $K' = 5.7(6)$.

Keywords: Magnesiochromite, chromite, high-pressure, diamond, equation of state

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