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Spinels Renaissance: The past, present, and future of those ubiquitous minerals and materials

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 $FeCr_2O_4$ and magnesiochromite $MgCr_2O_4$ 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 $\beta_V = |[(\Delta V/V_0)/\Delta P]|$, is 0.00468 and 0.00470 GPa^{-1}, 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) $Å^3$, K_{T0} = 184.8(1.7) GPa, and K' = 6.1(5) for chromite and V_0 = 579.30(4) $Å^3$, K_{T0} = 182.5(1.4) 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 $FeCr_2O_4$ and $MgCr_2O_4$ allowed us to fit the pressure-volume data of both to a single BM3 equation, resulting in a K_{T0} = 184.4(2.2) GPa and K' = 5.7(6).

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

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