

Elasticity and high-pressure behavior of $\text{Mg}_2\text{Cr}_2\text{O}_5$ and CaTi_2O_4 -type phases of magnesiochromite and chromite

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ABSTRACT

In situ high-pressure and high-temperature X-ray diffraction studies on magnesiochromite, MgCr_2O_4 , and a natural chromite, $(\text{Mg,Fe})(\text{Al,Cr})_2\text{O}_4$, using a laser-heated diamond-anvil cell technique were performed at pressures to ~45 GPa. Our results on MgCr_2O_4 at ~15 GPa showed temperature-induced dissociation of MgCr_2O_4 to $\text{Cr}_2\text{O}_3 + \text{MgO}$ below ~1500 K and formation of modified ludwigite (mLd)-type $\text{Mg}_2\text{Cr}_2\text{O}_5 + \text{Cr}_2\text{O}_3$ above ~1500 K. Above 20 GPa, only a single phase with the CaTi_2O_4 -type structure of MgCr_2O_4 was observed at 1400–2000 K. A second-order Birch-Murnaghan fit to pressure-volume data for the CaTi_2O_4 -type phase of MgCr_2O_4 yields zero-pressure volume (V_0) = 264.4(8) Å³ and bulk modulus (K_0) = 185.4(4) GPa, and for the CaTi_2O_4 -type structure of natural $(\text{Mg,Fe})(\text{Al,Cr})_2\text{O}_4$ yields V_0 = 261(1) Å³ and K_0 = 175.4(2) GPa. A second-order Birch-Murnaghan fit to pressure-volume data of mLd-type $\text{Mg}_2\text{Cr}_2\text{O}_5$ yields V_0 = 338.9(8) Å³ and K_0 = 186.5(6) GPa. The obtained high-pressure phase relations of chromite spinels can be used as an indicator for shock pressure in impact rocks and meteorites. The bulk moduli of the high-pressure phases of MgCr_2O_4 and FeCr_2O_4 can help develop a thermodynamic model for Mg and Fe end-member spinels in the upper mantle and transition zone.

Keywords: Magnesiochromite, chromite, CaTi_2O_4 phase, modified Ludwigite phase, equation of state