

The MgTiO₃-FeTiO₃ join at high pressure and temperature

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ABSTRACT

The phase relations at high pressure and high temperature for the FeTiO₃-MgTiO₃ join were determined using several different experimental methods. Through a series of multi-anvil experiments, a phase boundary with a negative slope was observed between MgTiO₃ I (ilmenite structure) and a high pressure phase with the MgTiO₃ II (lithium niobate structure) after quenching. The enthalpy of transformation of MgTiO₃ I to MgTiO₃ II was determined through transposed-temperature-drop calorimetry to be 28.78 ± 1.45 kJ/mol. The enthalpy of transformation from ilmenite to lithium niobate structure was also determined for three intermediate compositions on the FeTiO₃-MgTiO₃ join, Fe_{0.2}Mg_{0.8}TiO₃, Fe_{0.5}Mg_{0.5}TiO₃ and Fe_{0.8}Mg_{0.2}TiO₃, and confirmed for FeTiO₃, and was found to be a linear function of composition. These experiments represent one of the first successful calorimetric measurements on small samples (1 to 3 mg) synthesized at high pressures (15 to 21 GPa). X-ray analysis during compression of Fe_{0.5}Mg_{0.5}TiO₃ II in a diamond cell confirmed a room temperature transition at 28 GPa to Fe_{0.5}Mg_{0.5}TiO₃ III (a GdFeO₃-type perovskite structure), similar to the transitions previously observed in FeTiO₃ and MnTiO₃. The Fe_{0.5}Mg_{0.5}TiO₃ sample was heated to 802 °C at 21 GPa, and it was observed that the stable high temperature, high pressure phase is perovskite, Fe_{0.5}Mg_{0.5}TiO₃ III. The above data combined confirm the stability of a continuous perovskite solid solution at high pressure and temperature for the FeTiO₃-MgTiO₃ join.