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The $MgTiO_3$-$FeTiO_3$ join at high pressure and temperature

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ABSTRACT

The phase relations at high pressure and high temperature for the $FeTiO_3$-$MgTiO_3$ 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 $MgTiO_3$ I (ilmenite structure) and a high pressure phase with the $MgTiO_3$ II (lithium niobate structure) after quenching. The enthalpy of transformation of $MgTiO_3$ I to $MgTiO_3$ 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 $FeTiO_3$-$MgTiO_3$ join, $Fe_{0.2}Mg_{0.8}TiO_3$, $Fe_{0.5}Mg_{0.5}TiO_3$ and $Fe_{0.8}Mg_{0.2}TiO_3$, and confirmed for $FeTiO_3$, 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 $Fe_{0.5}Mg_{0.5}TiO_3$ II in a diamond cell confirmed a room temperature transition at 28 GPa to $Fe_{0.5}Mg_{0.5}TiO_3$ III (a $GdFeO_3$-type perovskite structure), similar to the transitions previously observed in $FeTiO_3$ and $MnTiO_3$. The $Fe_{0.5}Mg_{0.5}TiO_3$ sample was heated to 802 °C at 21 GPa, and it was observed that the stable high temperature, high pressure phase is perovskite, $Fe_{0.5}Mg_{0.5}TiO_3$ III. The above data combined confirm the stability of a continuous perovskite solid solution at high pressure and temperature for the $FeTiO_3$-$MgTiO_3$ join.