Thermodynamic properties of glassy mayenite and the impact of titania additives

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Abstract

The importance of high-quality thermodynamic data for glasses is growing in many fields: geo-chemistry and earth science, industrial glass production, metallurgy and novel low CO2 building materials. However, even for the low-dimensional systems like CaO-Al2O3 or CaO-Al2O3-TiO2 there is not enough thermodynamic data in the literature. For example, it is well known that the mineral mayenite (C12A7) in its crystalline state represents a series of compositions (Ca12Al14O33-δ)2δ+(2δe-), ($0 < \delta \leq 1$). However, there is no information about the probability to reproduce this feature in the glassy state. To study that, we synthesized the C12A7 glass by the classical quenching method using a platinum/gold crucible in air. After that, a series of the experiments we conducted with this glass to recrystallize it under different experimental conditions: atmosphere (Ar, O2, Air), temperature (900∘C, 1000 ∘C) and time (24, 48, 72 hours). Powder XRD analysis was carried out to determine the lattice parameter after the experiments as an indicator for the oxygen content in the crystalline state.
In addition, TiO2 additives to a C12A7 glass were studied from the thermodynamics point of view. The heat capacities were measured by two precise techniques: low-temperature (10-360 K) adiabatic calorimetry and high-temperature (300-850 K) differential scanning calorimetry (DSC Calvet Pro, Setaram). The temperature intervals were overlapped to verify the obtained results. High-temperature drop-solution calorimetry was used to investigate the enthalpy of dissolution and formation of the studied glasses. A negative deviation of the enthalpy of formation from the oxides at 298.15 K from the ideal-mixing straight line was found between amorphous C12A7 and TiO2.
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Keywords: Oxygen content, C12A7, titania

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