Assessment of phase evolution in Al_2O_3–CaO–SiO_2–MgO system with varied Al_2O_3/SiO_2 ratio using in-situ high-temperature Raman spectroscopy and X-ray scattering.

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ABSTRACT

Metallurgical slag, such as refining slag, is essential to enhance or promote steel cleanliness. The Al_2O_3–CaO–SiO_2–MgO system is the primary source of oxides-based inclusions predominantly for Si-deoxidized steels and is essential for applications in various pyrometallurgical processes. Numerous thermodynamic databases and physicochemical properties of slag studies mainly focus on quenched samples and measurements at room temperature. Consequently, the present study explored the physicochemical, structural properties, and crystallization evolution for CaO-SiO_2-MgO-Al_2O_3 glassy slags via in situ high-temperature Raman spectroscopy and synchrotron X-ray diffraction. The study was carried out by synthesizing CaO-SiO_2-MgO-Al_2O_3 slag with varying Al_2O_3/SiO_2 ratios. The results from the situ high-temperature measurement demonstrated a pattern showing a transformation of a broad peak from the glassy matrix to crystalline peaks. The study showed crystallization of dominant phases such as Ca_2SiO_4, $CaAl_2O_4$, $Ca_5Al_6O_{14}$, $Ca_2Al_2SiO_7$, and $Ca_3Al_4O_9$ that correspond and are attributable to changes of structural units during in situ high-temperature measurements. The results further showed a correlation between an increase and transformation in crystalline phases observed from the spectra obtained from non-isothermal heating of the samples.