Visual Application of Calculated Thermodynamic Properties by Integration with SEM-EDS Element Maps

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ABSTRACT

Thermodynamic properties of oxide systems are of critical importance to all metallurgical operations. Interpretation and understanding of the thermodynamics relating to these systems is inherently complex, with common multicomponent systems requiring visualisation of multidimensional data. In heterogenous systems, application of typical phase diagram analysis can be restrictive, as it requires consideration of the spatial composition distribution. This is especially the case when >3 components are involved as some compositions must be fixed for expression in pseudo-ternary diagrams. One such system presents itself in the interaction of ferrous burden materials in the blast furnace cohesive zone. Specifically, interaction of the oxides generated by lump (primarily FeO, SiO_2 and Al_2O_3) and sinter (primarily FeO, CaO, SiO_2, Al_2O_3 and MgO). During the transition from solid to liquid, migration and interaction of liquid oxide across the interfaces of the dissimilar burdens has been observed and demonstrated to impact softening and melting performance. With the local variations in composition at the interface, comprehensive analysis of the interaction through pseudo-ternary diagrams is difficult. In this work, a novel mapping technique is demonstrated for direct overlay of calculated thermodynamic properties on micrographs of the physical system. The technique demonstrated integrates thermodynamic calculations with SEM-EDS element mapping to visually express calculated properties while preserving the spatial information of the sample. The developed methodology is used to analyse interrupted softening and melting tests containing mixed burdens of lump and sinter. Liquid formation and interaction are analysed in detail at the interfaces between the dissimilar burdens.