American Mineralogist, Volume 90, pages 1597–1605, 2005

High-temperature density of lanthanide-bearing Na-silicate melts: Partial molar volumes for Ce_2O_3, Pr_2O_3, Nd_2O_3, Sm_2O_3, Eu_2O_3, Gd_2O_3, Tb_2O_3, Dy_2O_3, Ho_2O_3, Er_2O_3, Tm_2O_3, and Yb_2O_3

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ABSTRACT

This work presents the first systematic determination of the partial molar volumes of lanthanide sesquioxides in silicate melts. For this purpose, the densities of various lanthanide-bearing Na-silicate melts distributed along various binary joins, where the end-members are Na-disilicate and one of the lanthanide sesquioxides (i.e., Ce_2O_3, Pr_2O_3, Nd_2O_3, Sm_2O_3, Eu_2O_3, Gd_2O_3, Tb_2O_3, Dy_2O_3, Ho_2O_3, Er_2O_3, Tm_2O_3, and Yb_2O_3), have been measured using the double-bob Archimedean method. The present results show that the addition of any lanthanide to Na-disilicate leads to an increase in the melt density and that the melt density increases with increasing atomic number of the lanthanide. From the present density data set, the molar volumes of these melts have been calculated and the partial molar volumes of each lanthanide sesquioxide in these melts have been determined using a linear regression through each binary join (i.e., Na-disilicate-lanthanide sesquioxide). This study indicates an ideal behavior with respect to the molar volume (i.e., a linear variation of the molar volume along each binary join) for Na-silicate melts containing up to 6 mol% of lanthanide oxide. Comparison between the partial molar volumes of lanthanide sesquioxides obtained in this study and the molar volumes of molten lanthanide sesquioxides given in the literature raises the possibility, however, that this ideality is not maintained along the entire Na-disilicate-lanthanide sesquioxide binary joins. Excess volumes of mixing appear to be required to describe the combined volumetric data set.