The Influence of a Reducing Gas Atmosphere on the Temperature Dependence of Surface Tension for Molten Metals

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Surface tension of molten metals has often been measured under a reducing atmosphere such as H$_2$ containing gas to suppress oxidation of the melt surface, in which oxygen partial pressure of the ambient atmosphere becomes lower by condensing the H$_2$O formed from the following reaction,

\[ H_2 + (1/2)O_2 \rightarrow H_2O. \]

The oxygen partial pressure varies depending on the sample temperature due to the temperature reliance of the equilibrium constant of the above reaction. However, the influence of temperature dependence of the oxygen partial pressure on surface tension of molten metal has not considered carefully in many cases though surface tension is strongly affected by the oxygen partial pressure. A conventional technique for a surface tension measurement such as the sessile drop method can assure only the measurement at a comparatively low temperature to prevent the contamination of the sample by the measurement device and it is very difficult to measure the surface tension of high melting point molten refractory metals such as iron and nickel.

In this study, surface tension of liquid iron and nickel were measured over a very wide temperature range in consideration of the influence of the oxygen partial pressure by electromagnetic levitation (EML). The purpose of this investigation was to discuss the effect of temperature dependence of oxygen partial pressure of reducing gas atmosphere on surface tension measurement of liquid metal. When surface tension of molten iron and nickel was measured under the H$_2$-containing gas atmosphere, surface tension did not show a linear relationship against temperature. The temperature dependence of the surface tension shows unique kink at around due to competition between the temperature dependence of oxygen partial pressure and that of the equilibrium constant of oxygen adsorption.