
Redox interaction between Fe and secondary multivalent elements in soda lime silicate glass melts

Sohee Kang^{*1}, Kicheol Kim¹, and Kidong Kim^{†1}

¹Dept. Mat. Sci. Eng. Kunsan National University (KNU) – 558 Daehakro, 54150 Kunsan Chunbuk, South Korea

Abstract

Redox interaction between Fe and various multivalent elements in glass and melt have been examined using voltammetry and spectroscopy. Voltammograms of melts doped with Fe exhibited a pronounced peak due to Fe³⁺/Fe²⁺-reduction. The temperature dependence of the Fe³⁺/Fe²⁺-peak potential recorded in voltammograms showed a normal behavior, in other words the corresponding peak potential (E_p) moves toward the negative direction with a decrease of temperature, indicating that the equilibrium state of Fe redox reaction shifts towards to the oxidation state. However, when S or Sn or Sb or Ce was doped to those melts the Fe³⁺/Fe²⁺ peak potential was shifted to negative or positive direction depending on the secondary multivalent ion. For the glasses the depth change in absorption band of Fe²⁺ or Fe³⁺ in UV-Vis-NIR spectra showed also negative or positive direction under presence of secondary multivalent ion. Comparison of the results in both voltammograms and spectra indicated the same tendency in melts and glasses from the view point of Fe redox: Fe²⁺ was favored by presence of S and Sn. But Fe³⁺ is a favorite state under doping of Ce or Sb. Thus it confirms that the effect is derived from the melt state. The standard Gibbs free energy for the reduction of each multivalent ion determined in melt doped with redox pair supports strongly the equilibrium state of the suggested interaction reaction. To confirm the foregoing results oxygen activity for the corresponding melts was determined and the actual redox ratio $[Fe^{2+}]/[Fe^{3+}]$ in each melt was calculated.

Keywords: redox interaction, voltammogram, spectroscopy, oxygen activity, redox ratio

^{*}Speaker

[†]Corresponding author: kdkim@kunsan.ac.kr