Thermal Conductivities of R2O-SiO2 and CaO-R2O-SiO2 (R=Li, Na, K) Melts

Tsuyoshi Nishi*[1], Katsuya Ohnuma[2], Kento Tanaka[2], Takumi Manako[2], Hiromichi Ohta[2], Sohei Sukenaga[3], Hiroyuki Shibata[3], and Toshiaki Kakihara[4]

[1]Ibaraki University (Ibaraki Univ.) – Department of Materials Science and Engineering, College of Engineering, Ibaraki University,Nakanarusawa 4-12-1, Hitachi, Ibaraki, 316-8511, Japan
[2]Ibaraki University – Japan
[3]Tohoku University – Japan
[4]IHI Corporation – Japan

Abstract

The thermal effusivities of the R2O-SiO2, and CaO-R2O-SiO2 (R=Li, Na, K) melts were measured by using the front heating-front detection laser flash method. Then, the thermal conductivity was evaluated by combining the present thermal effusivity data with specific heat capacity and density. The relation among ionic radii of cations (Li+, Na+, and K+) and the number of non-bridging oxygens per tetrahedral cations (NBO/T) and the thermal conductivity of R2O-SiO2 and CaO-R2O-SiO2 melts was evaluated. It was found that the temperature dependences of the thermal conductivities of the R2O-SiO2 and CaO-R2O-SiO2 melts were small over the temperature range investigated. It was also found that the thermal conductivities of CaO-R2O-SiO2 melts were larger than those of R2O-SiO2 melts. It can be presumed that the network frame of CaO-R2O-SiO2 melt became dense due to the ion bonding between Ca2+ and non-bridging oxygen. Accordingly, the increase of the mean free path of phonon in CaO-R2O-SiO2 melts brought the large thermal conductivity. It was noteworthy that the thermal conductivities of the Li2O-SiO2 and CaO-Li2O-SiO2 melts were larger than those of another R2O-SiO2 and CaO-R2O-SiO2 melts. It can be considered that the large thermal conductivities of the Li2O-SiO2 and CaO-Li2O-SiO2 melts affected by the relatively large ionic radius of Li+ among those of cations

Keywords: CaO, R2O, SiO2 (R=Li, Na, K), melt, front heating, front detection laser flash method, ion radius of cation, NBO/T, thermal conductivity

*Speaker