Vaporization Behavior in the Lithium Oxide-Aluminum Oxide System†

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Lithium oxide has a potentiality for the blanket materials in nuclear fusion reactor[1] and high temperature behaviors of the systems with lithium oxide have been investigated. Besides pure Li_2O single solid, lithium aluminates are also considered to be useful for the blanket material. There exist several intermediate compounds, Li_5AlO_4, $LiAlO_2$ and $LiAl_5O_8$, in Li_2O-Al_2O_3 system, and several properties have been reported[2)~7)]. In this work Knudsen-effusion and mass spectrometric study of this system with various composition are undertaken, and some preliminary results are described.

The samples with each composition were prepared by usual solid state sintering method in vacuo at 1000°C of coprecipitation from aqueous solution of $LiNO_3$ and $Al(NO_3)_3$ and drying at 700°C[8]. Each sample was pre-heated in vacuo in Knudsen cell at a little higher temperature than the experimental temperature before the measurement. The samples with various composition were taken for chemical and X-ray analysis. The intermediate compounds such as $LiAlO_2$ and $LiAl_5O_8$ were determined clearly, but the presence of Li_5AlO_4 was not decisive by the interference of $LiAlO_2$. The Knudsen cell was made of platinum with an orifice of 0.5 mm diameter and is shown in Fig. 1. The platinum was found to be well compatible with this system at high temperature. The cell was heated by a tungsten resistance heater and the temperature of the Cell was measured by a W-WRe or a Pt-PtRh thermocouple.

Quadruppole type mass spectrometer, NEVA° II, was utilized for a preliminary measurement at a first step of this work, and 90°-sector magnetic type mass spectrometer, HITACHI RMU-K, was exclusively used in this experiment. The vapor pressure was calibrated with silver. The detailed procedure is described elsewhere[9]. Two major species of vapor molecule, Li^+ and Li_2O, were detected along with some minor species such as LiO, Li_3O and Li_2O_2 over 100% Li_2O in this experiment with shutter profile. The ionizing electron potential was selected to be 30 eV. The temperature variation of partial

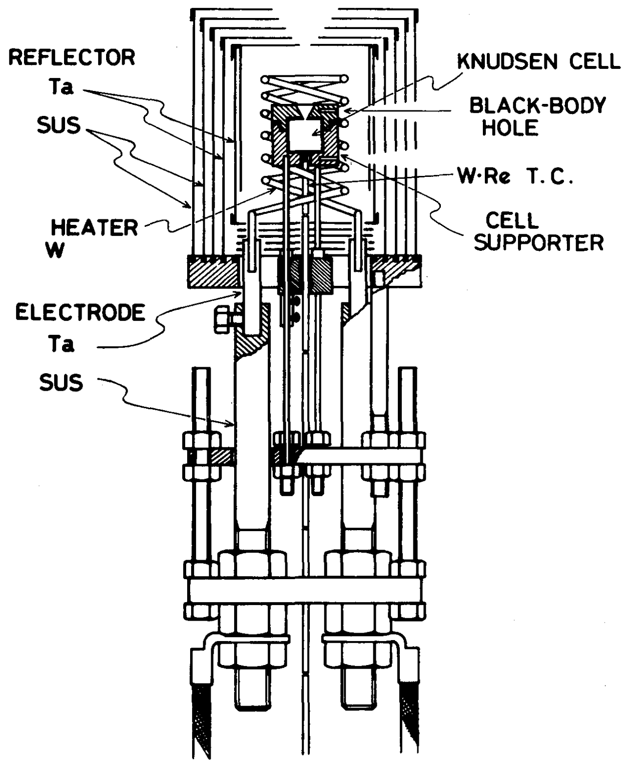

Fig. 1 Knudsen cell assembly

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pressures of these main species, plotted against the reciprocal temperature, is shown in Fig. 2, where the concentration of Li_2O was 64 mole %. Other vapor species were scarcely detected. The intensity of Li_2O and other minor species ions decreased with decreasing concentration of the lithium oxide in the sample and only Li^+ ion was detectable for alumina rich composition. The vapor pressure of Li was plotted against the composition at 1600K, as is shown in Fig. 3. It is shown from this figure that the high temperature stability of lithium oxide increases with increasing aluminum oxide. Also it is noted

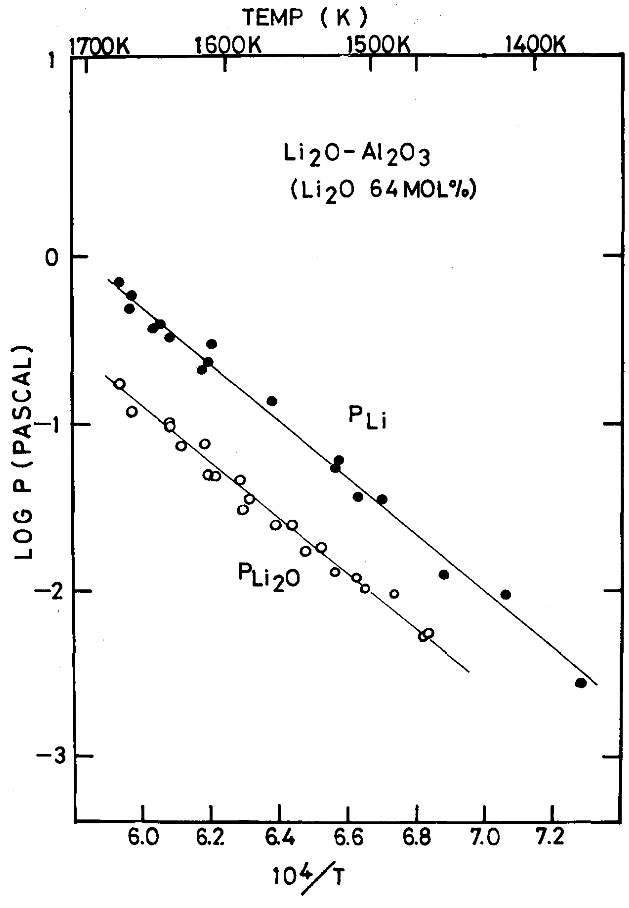

Fig. 2 Temperature dependence of Li and Li_2O pressures in the lithium aluminate containing 64 mol % Li_2O

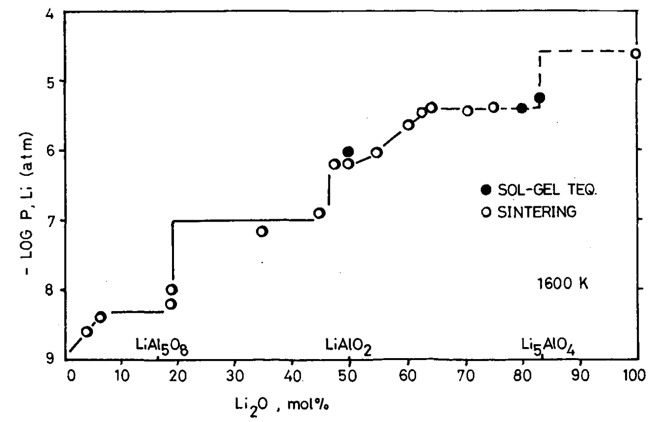

Fig. 3 Dependence of Li pressure upon Li_2O content in Li_2O-Al_2O_3 system

that the existence of some degree of solid solubility is suggested from the composition near 50 to 62 mole %. The possibility of solid solubility of lithium in $LiAlO_2$ at 1600K is inferred from this figure. The detailed discussion based on thermodynamics will be described.

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