THERMODYNAMIC INVESTIGATION OF THE
VAPORIZATION OF SOLID POLY CRYSTALLINE
ALUMINA WITH KNUDSEN EFFUSION MASS
SPECTROMETRY

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Summary

Within the framework of our studies of the corrosion of plycrystalline alumina the vaporization behavior of Al_2O_3 was investigated employing Knudsen Effusion Mass Spectrometry (KEMS). Even though the alumina vaporization has been studied extensively, there are discrepancies: (a) among the data derived using KEMS, and (b) between data recommended in database (e.g. JANAF and IVTANTHERMO) and those obtained by mass spectrometric studies.
New thermodynamic data for the species $AlO(g)$ and $Al_2O(g)$ have been derived and compared with those available in the literature. The consistency of the data in the presnt study are ascertained by deriving the thermodynamic data for $Al_2O_3(s)$.

Experimental

The vaporization studies were carried out by KEMS (see figure 1). Knudsen cells made of tungsten and tungsten cells lined completely with iridium were used in the measurements. The upper limit of the temperature range was set to 2285 K in order to keeo the alumina in the solid state during the entire course of the measurements.

Results

In the vapor of $Al_2O_3(PCA, s)$ the ion species Al^+, AlO^+, Al_2O^+, $Al_2O_2^+$, O^+, and O_2^+ were identified. Appearance potentials of for all species were determined and the ions were assigned to their neutral precursors $Al(g)$, $Al_2O(g)$, $O(g)$, and $O_2(g)$. $Al_2O_2^+$ might originate from $Al_2O_2(g)$. The partial pressures of the neutral species were determined from the measured temperature dependence of the ion intensities. The pressure calibration was carried out by vaporization of pure $Al(l)$ and referring to the equilibrium pressures according to the literature (JANAF [8]) . Figure 2 shows the equilibrium partial pressures obtained by use of a Ir-Knudsen cell. Figure 3 and 4 show comparisons of the equilibrium constants obtained in this work compared with literature values for the following reactions:

$$Al_2O(g) \leftrightarrow AlO(g) + Al(g) \qquad (1)$$
$$AlO(g) \leftrightarrow Al(g) + O(g) \qquad (2)$$
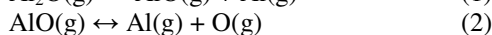
Second and third law enthalpies were evaluated for the equilibrium reactionss and compared with the literature data and the enthalpy of formation of $Al_2O_3(s)$ was calculated using these values.

References

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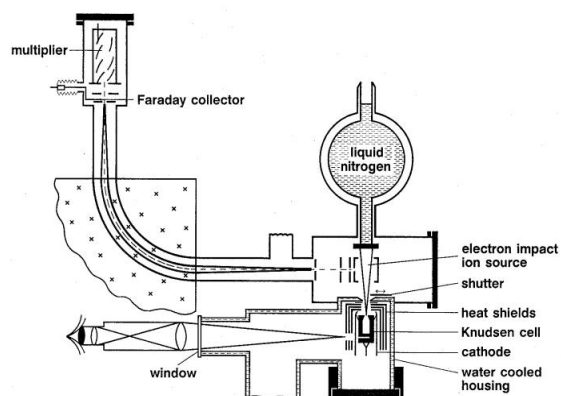[8] JANAF, Thermochemical Tables, 3rd Edition,

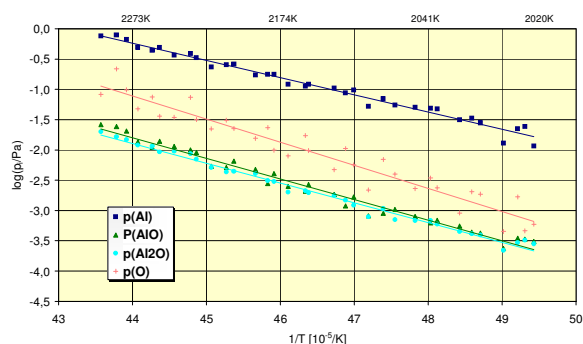Fig. 1: Schematic representation of the Knudsen Cell Mass Spectrometer

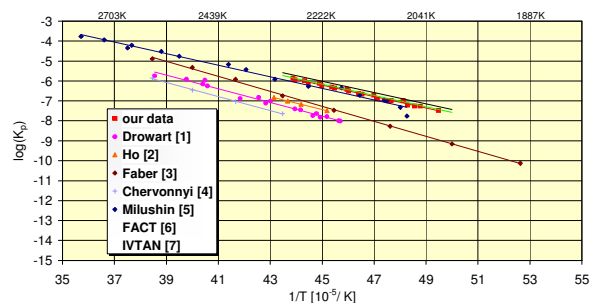Fig. 2: Partial pressures over Al_2O_3 (PCA, s) in a Ir-Knudsen cell

Fig. 3: Temperature dependence of the equilibrium constant kp for the reaction
$Al_0O(g) = Al(g) + AlO(g)$
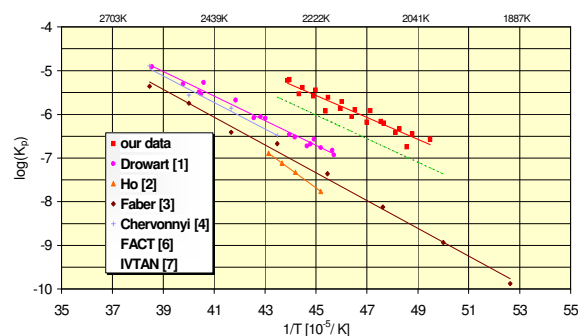
Fig. 4: Temperature dependence of the equilibrium constant kp for the reaction
$AlO(g) = Al(g) + O(g)$