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Knudsen effusion mass spectrometric studies on U-Al system: Thermodynamic properties over (UAl_2+UAl_3) biphasic region

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Abstract: Knudsen effusion mass spectrometric (KEMS) studies over (UAl_2+UAl_3) biphasic region in the U-Al system were carried out in the range 1115 - 1253 K. The vaporisation reaction was found to be incongruent and Al(g) was the neutral species in the vapour in equilibrium with the condensed phase. The temperature dependence of the partial pressure was derived as $\log(p_{Al}/Pa) = (-18215 \pm 157)/T + (12.12 \pm 0.13)$. From the values of the partial pressures, the enthalpy of the reaction $UAl_3(s) = UAl_2(s) + Al(g)$ at 298.15 K was deduced by applying the second and third law methods. The enthalpy and Gibbs energy of formation of UAl_3 were derived from the above data and were found to be $\Delta_f H^\circ_{298.15}$ = -112.1 ± 12.8 kJ mol^{-1} and $\Delta_f G^\circ_T$ (± 3.4) = -158.8 + 0.0591 T (kJ mol^{-1}). The vaporisation study on this system had been carried out for the first time.

Key words: U-Al; Knudsen effusion mass spectrometry; partial pressure; enthalpy of reaction; enthalpy and Gibbs energy of formation.

1. Introduction

Thermodynamic properties of U-Al alloys are of interest in nuclear technology since these alloys are used as fuel in research reactors [1]. Thermodynamic properties of U-Al phases serve as useful inputs for fuel design as well as in understanding their “in-reactor” behaviour of