

Carbonyl chemistry developments for SHE studies

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We intend to summarize here the preparation status for experiments envisaging to assess for the first time directly the bond dissociation enthalpy in a transactinide molecule, Sg(CO)₆. On-line decomposition experiments with ¹⁰⁴Mo and ¹⁶⁴W performed at Bern University and RIKEN GARIS revealed a decomposition behavior of the corresponding hexacarbonyl compounds on silver surfaces correlated to their first-bond dissociation enthalpy (see figures) [1]. The 23 kJ/mol bond stability increase between Mo(CO)₆ and W(CO)₆ [2] lead to a decomposition temperature shift of about 100 K. A superimposed chromatographic adsorption-decomposition model combined with theoretically predicted FBDE for Sg(CO)₆ [3], allowed to predict an expected decomposition behavior of Sg(CO)₆ in an experiment similar to the model experiments, and thus, the design of a corresponding transactinide experiment.

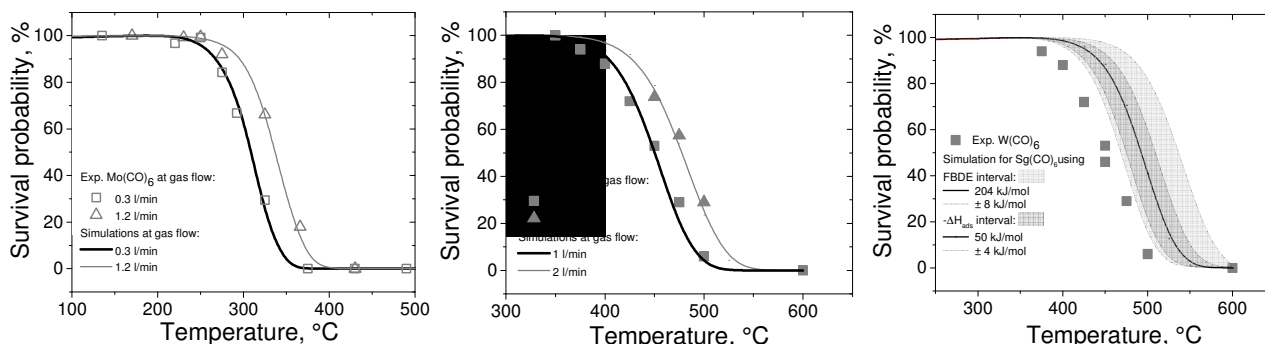


Fig. 1. Experimental decomposition curves of Mo(CO)₆ and W(CO)₆ at different gas flow rates (symbols) together with simulated decomposition curves (lines) using literature data for ΔH_{ads} and FBDE. The kinetic preexponential factor was deduced for all hexacarbonyl decompositions as $A = 8.6 \cdot 10^5$. The shaded area shows the e.g. response of the model to a variation of ΔH_{ads} within ± 4 kJ/mol [4]. The predicted behavior of Sg(CO)₆ in the same experiment including the uncertainties in FBDE [3] and ΔH_{ads} [4].

References

- [1] Usoltsev I, et al. Radiochim. Acta, 2015 (accepted).
- [2] Lewis, K.E. et al. J. Am. Chem. Soc. 106, 3905–3912 (1984).
- [3] Nash, C.S., Bursten, B.E. J. Am. Chem. Soc. 121, 10830–10831 (1999).
- [4] Even, J. et al. Science 345, 1491–1493 (2014).