

Catalyst characterisation techniques and reaction cells operating at realistic conditions; towards acquisition of kinetically relevant information

Nikolaos E. Tsakoumis^{*,a}, Andrew P. E. York^b, De Chen^a and Magnus Rønning^a

Abstract

The study of catalytic materials is commonly approached from three standpoints; catalyst preparation, catalyst characterisation and ultimately the evaluation of catalytic performance through reaction kinetic studies. These steps are iterated in order to optimize the catalyst. Ideally, structure–performance relations are in the focus of the investigations and are expected to assist towards better understanding and a rational design of more efficient catalysts. In the last two decades efforts have been made towards merging the field of catalyst characterisation with activity/selectivity testing in order to better address the structure–reactivity relationship in catalysis, and consequently characterisation of catalytic materials under reaction conditions with simultaneous monitoring of reaction kinetics has gained scientific interest. Applied chemical reaction kinetics can be significantly improved by the input from catalyst characterisation on working catalysts at industrially relevant conditions. Industrial interest on the best practice of such a combined approach is expressed by the Eurokin consortium, who's major focus is on best practice in industrial reaction kinetics in catalysis, while in the recent literature a large number of these combined studies concentrate more on the characterisation perspective rather than on the validity of the obtained kinetic information. The present review focuses on the current status of in situ/operando characterisation techniques performed in dedicated set-ups that provide structural as well as kinetic relevant information of high surface area catalysts. Concerns regarding technical details of the experimental techniques are highlighted, while techniques and combinations with potential in assisting mechanistic understanding are summarised.

a Department of Chemical Engineering, Norwegian University of Science and Technology (NTNU), NO-7491 Trondheim, Norway. E-mail: nikolaos.tsakoumis@ntnu.no

b Johnson Matthey Technology Centre, Blount's Court, Sonning Common, Reading RG4 9NH, UK