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Preface

The very definition of a catalyst is one that assumes a net invariance of the catalyst over the catalytic cycle. However, as is all too well known, catalytic materials have a nasty habit of changing whilst they are going about their business; and more often than not in ways that are unwanted from a process perspective. Within a catalytic cycle, however, structural change is implicit at some level: and whilst far from being "alive", catalysts are certainly intrinsically dynamic entities.

Heterogeneous catalysts are used in a plethora of industrial processes and technologies. As such they are the subject of intense research designed to understand how and why they work as they do. Equally, they come in a myriad of forms, and the demands placed upon them by the processes they are used to mediate, are extremely varied. They are often multifunctional – and multiphasic as a result – and comprised of components whose habit and interactions occur on a very wide range of length scales: from those of chemical bonds, to the micron and beyond.

A such the study of the dynamic, structural, and reactive behaviour of catalysts, requires methodologies and techniques that are, in the same breath, capable of: saying something about the structure – over the required length scales – of the catalysts under study; being able to do so whilst the catalyst is actually operating; and to be able to see with a time resolution that is sufficient to see inside the process under study rather than just the before and after.

This special issue of Catalysis Today arises from a workshop held at the European Synchrotron Radiation Facility, Grenoble, France, in February 2008. The aim was to try and assess to what level the variety of currently available X-ray based probes had evolved to these ends – with particular emphasis on the seconds and below timescales – and what new possibilities for observing the inner workings of heterogeneous catalytic processes might be arising.

The utility of using synchrotron based X-ray methods to look into the inner workings of catalysts has been recognised for as long as synchrotron facilities themselves have existed. It seems, however, that, in the last few years a real resurgence in synchrotron based, and specifically time resolved study, of catalytic processes has, and is, occurring, as the real power and potential of 3rd generation X-ray sources has started to be realised and expressed within this area. This can be seen as a direct result, not only of the existence the sources, but the concomitant development all sorts of technologies (such as X-ray optics and detectors) that are required to be brought together in order carry out experiments of the type present in this special issue.

At the same time, and with recognition that this too has a long history, it seems that the importance of studying catalysts or catalytic processes, in situ or "in operando", and (latterly) from synchronously applied multiple viewpoints, has also undergone something of a "revolution". More often than not this has also been centred on coupling, time resolving, structurally direct, X-ray techniques, with other spectroscopies (Raman, UV–vis, and infrared for example).

This special issue therefore sits at the confluence of these two areas and hopes give a coherent and useful insight to the wider catalysis community as to what may currently be achieved through the applications of state of the art experiments using, X-ray scattering, diffraction, absorption and emission techniques, and what exactly investigations of these types may bring to the overall understanding, at many levels, of heterogeneous catalysts and the processes they facilitate. One can only see that these possibilities are going to become greater as time goes by, both at the existing 3rd generation sources, those that are planned for the near future, and within the overall paradigm of the proposed hard X-ray free electron lasers (XFELs) which may offer a whole host of new opportunities to add to those that already exist.

Lastly, I should like to thank the following people for their varied contributions to this issue: Roberto Felici and Valerie Roux-Jallet, co organisers of the 2008 ESRF workshop: all those who participated in the workshop along with all those who graciously chaired the sessions and who subsequently submitted the papers for this special issue. Professor James Anderson (University of Aberdeen, Scotland), Professor Julian Ross (University of Limerick, Ireland) and Rosie Malone (Elsevier) are also gratefully thanked for their great patience and sage counsel.

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