Preface: catalysis—key to a sustainable future

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Catalysis is a key and enabling technology and plays a critical role in the fields of energy conversion, materials synthesis, environmental protection and human health care. The gradual depletion of oil resources—the basis of modern energy and chemical industries—coupled with growing public demand for increased ecological and environmental protection, has raised awareness of an urgent need for chemical innovation, which aims to achieve green and environmentally benign processes with high efficiency and low-carbon emission. Catalysis, the kernel of chemical industries, is facing great challenges. This requires new catalysts to activate not only the carbon–carbon bonds as in conventional processes, but also the carbon–hydrogen and carbon–oxygen bonds, as well as to achieve efficient carbon–carbon coupling for conversion of small molecules. Furthermore, catalytic processes will need to be operated under milder conditions (low temperature and low pressure), yielding high activity and selectivity, producing little waste with minimal environmental impact. While the discovery, understanding and potential applications of new catalytic materials have long been pursued, many scientific challenges remain. Such challenges include the improved rational design of catalytically active sites at the molecular and atomic level, understanding the underlying reaction mechanism with in situ characterization techniques at high resolution and under realistic conditions, as well as theoretical simulations approximating the complexity of real catalytic systems. These themes form important future research directions.

In this special topic, some distinguished and dedicated catalysis scientists provide their views and perspectives on catalysis science and technology, particularly the future opportunities and challenges. This, I believe, would help enlighten the development of catalysis both at home and abroad. Professor Gerhard Ertl, Nobel Laureate in Chemistry, and Professor Avelino Corma, the president of the International Association of Catalysis Societies, share their views in our interview. Perspectives from Professor Jens Norskov, Professor Gabriele Centi, Professor Can Li and Professor Bert Weckhuysen on directions of theoretical catalysis, energy catalysis, photocatalysis and in situ characterization of catalysis dynamics, respectively, are important guides for future catalysis research. Professor Yadong Li, Professor Zaiku Xie, Professor Dangsheng Su and the professors from my own research team also provide systematic reviews and highlight on recent progress in catalysis ranging from fundamental science to applications, which together present an overview of catalysis research in China.

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