Preface

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The field of catalysis enjoys significant scientific prominence due to its importance in areas that affect the general public—clean energy, environmental protection, and conversion of sustainable feedstocks, for example. These driving forces, among others, will guide research efforts in our field for the foreseeable future. This volume of the Royal Society of Chemistry's Specialist Periodical Reports: Catalysis book series addresses these issues directly, providing up-to-date reviews on subjects of current interest.

First, Claus Christensen and colleagues Kresten Egeblad, Jeppe Rass-Hansen, Charlotte Marsden, and Esben Taarning (Technical University of Denmark, Lyngby) review the production of high-value chemicals and intermediates from biomass. This is important because a wide range of biomass feedstocks have the potential to replace fossil-based raw materials to produce these end products. Among other challenges, heterogeneous catalysts with extremely high activities and selectivities must be developed to compete with current processes.

James Anderson and M. F. Garcia (Univ. Aberdeen, UK) show that the significant challenges in developing processes for water purification can be addressed using photocatalytic reactions to remove both organic and inorganic pollutants. They point out the difficulties in studying the fundamentals of catalytic reactions in an aqueous medium, and the need to improve the typically low quantum yield in the processes—*e.g.*, by the addition of noble metals to titania.

Gabriele Centi and Siglinda Perathoner (Univ. Messina, Italy), report on approaches to the synthesis of titania catalysts, particularly ways to control the structure at the nanometer scale. They show approaches to develop specific active sites, and to direct the synthesis in a way that also produces a local 3-D environment around the active site with desired properties.

Computational catalysis has enjoyed rapid progress as computer speed and available codes have allowed more realistic catalytic cycles to be studied. Ye Xu (Oak Ridge National Lab, USA) shows that the transition in heterogeneous catalysis from a primarily empirical science to one that is based on first principles will provide new materials for experimental research. Coupled with new imaging methods with greatly improved spatial resolution, and atomically precise synthesis methods, computational approaches hold great promise for the development of catalysts with unprecedented levels of activity and selectivity.

In addition to their use as solvents, surfactants, and biocides, ionic liquids are attractive for use in catalytic reactions due to their ability to activate reactant molecules, the ease of separation from final products, thermal stability, solubility of gaseous reactants, among other properties. Amit Gujar and Mark White (Mississippi State Univ., USA) show, for example,

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how these liquids can be used in a number of different catalyst-liquid systems, *e.g.*, monophasic systems in which the catalyst and substrate are dissolved in the ionic liquid, or monophasic systems in which the ionic liquid acts as both the solvent and the catalyst.

Finally, Nora McLaughlin and Marco Castaldi (Columbia University, USA) provide a review of *in situ* techniques to study catalytic reaction mechanisms. Because the catalyst is not static but can change during a reaction, it is important to be able to characterize the surface at reaction conditions. In addition, identification of reaction intermediates can help us understand the reaction mechanism. The authors review surface measurement techniques and recent developments in spectroscopy that can help us examine these catalytic properties.

We greatly appreciate the efforts of the authors who have contributed to this volume. We thank the Royal Society of Chemistry for their support of this series. Comments are welcome.