Recent Advances in Synthesis and Characterization of Complex Organic Materials

Organic materials are the building blocks of life and the living species. It has become the scientific focus to advance the synthesis methods and the characterization techniques for organic materials discovery and development because of their wide applications in food, cosmetic, pharmaceutical and medical industries. A good understanding of relevant properties (e.g., composition, chirality, structure, thermal stability and phase transformation) of organic materials plays a vital role in food safety/processing, drug design/manufacturing, and medical applications. The increasing demand for a wide range of modern characterisation techniques has driven the development of these techniques faster than ever.

This thematic issue will, therefore, not focus on one particular technique, instead, it aims to highlight the latest advances, trends and challenges in modern analytical methods by collecting four mini-review articles on an emerging technique (e.g. Small-Angle X-ray Scattering, SAXS, in paper 2), as well as well-developed techniques (e.g., Nuclear Magnetic Resonance, NMR, in paper 3). These highlighted articles present some good examples to showcase the basics of relevant techniques and their potential application. They will inspire the large organic chemistry community to widen the already extensive applications to a large extent. Below is the summary of this thematic issue:

The first paper in this special issue is contributed by Prof. Jin Zhai’s group from BeiHang University in China. As Chinese Key Laboratory of Bioinspired Energy Materials and Devices, one area of their research is focused on the synthesis, functionalization and sensing applications of polymer membranes (particularly track-etch membranes) in monitoring or recognizing aqueous environmental stimuli, specific ions and molecules. This review gives a broad view of the potential applications of responsive organic materials in environmental or medical monitoring. It also serves as a good guide for organic chemists and materials scientists to systematically synthesize these stimuli-responsive functional organic molecules and expand the existing applications to a much wider dimension.

The second review comes from Prof. Karen Edler’s group from Bath University in the U.K. This is an excellent introduction to the application of small-angle scattering to problems in complex organic structures/materials. In particular, it describes how the model-dependent small-angle scattering can be used to study and understand the soft matter systems (such as polymeric organic materials). The authors have made particular efforts to tailor the article to the likely audience, and consequently, only the essential mathematical theory is provided, with more focus applied to the experimental design/constraints and potential applications of this technique to inspire more organic chemists who are not so familiar with the SAXS methods.

The third review of state-of-the-art NMR technique is written by Prof. William Price from Western Sydney University, who has a long record of publications in the field of NMR and diffusion studies. Given the omnipresence of molecular diffusion and its key-role in many phenomena and industrial processes, diffusion NMR is doubtlessly among the most important techniques within the impressively large spectrum of tools provided by NMR. However, its application is, as a rule, far from trivial, notably with problems deviating from conventional patterns. The present paper takes account of both of these aspects exceptionally well. The technique is introduced in a simple style to inspire early-stage researchers. Simultaneously, it discusses current limitations and particular challenges in NMR method which applicants may expect to be confronted with as soon as they approach the limits of conventional applicability. This is in particular true with respect to the optimum selection of solvent-solute pairs, where the solute is expected to provide the information about the relevant microstructural and/or–dynamic details, so that any disturbing influence of the solvent signal must be suppressed. This is much appreciated when diffusion processes of organic chemical systems are under investigation.

The fourth paper, according to the reviewers’ and editor’s best knowledge, is the first review summarising the life cycle of a family of pharmaceutically important molecules, Parabens. The article is contributed by the Guest Editor, Dr. Fan Zhang at KTH Royal Institute of Technology in Stockholm, and Dr. Huaiyu Yang at Imperial College in London. The authors provide a brief review on the recent development in synthesis, characterization, analysis of Parabens. Parabens’ life cycle is an interesting topic not only because it has significant pharmaceutical relevance but also parabens have wide appearance in nature. Parabens have attracted more debates than consensus in terms of their safe applications in our daily lives. For this reason, this paper can be regarded as a useful ‘handbook’ for chemists and engineers. Various technologies for charactering and assessing parabens, as reviewed in this article, represented the importance of modern analytical methods for the successful monitoring and manufacturing pharmaceutical compounds, especially when the associated safe dosage and risk assessment is not clear (or agreed) in the literature.
In summary, this thematic issue contains four original review articles illustrating various modern synthetic and analytical techniques in materials discovery and characterization. The authors are from four different countries. They contributed individually to a high-quality 'textbook chapter' to inspire organic chemists and engineers to apply/develop a wide spectrum of advanced techniques. The impressive list of referees includes but not limited to Prof. Yanlin Song (Chinese Academy of Sciences, China), Prof. Xu Hou (Xiamen University, China), Dr Andrew Parnell (University of Sheffield, U.K.), Prof. Julian Eastoe and Mr. Jonathan Pegg (University of Bristol, U.K.), Prof. Jörg Kärger (University of Leipzig, Germany), Prof. Günter Majer (Max Planck Institute for Intelligent Systems, Germany), Dr. Xi Yu (Aston University, U.K.) and Dr. Qinglin Su (Purdue University, USA), which reassures the world-class quality of this issue.

The Guest Editor would like to thank Bentham Science Publishers team and in particular, Abeerah Hashim and Sanober Maqbool, for their support and effective communication during the production of this special issue. Special thanks go to Prof. Marc-Olivier Coppens at UCL for supporting/encouraging the Guest Editor to be patient and persistent to complete this challenging project. Last but not the least, on behalf of the contributors and the Journal, the Guest Editor would like to thank the reviewers for their valuable time and invaluable comments which helped us tremendously to critically review the contributing articles, and make suitable changes accordingly.

Dr. Han Wu
Centre for Nature Inspired Engineering (CNIE),
Department of Chemical Engineering, University College London,
Torrington Place, London,
WC1E 7JE
United Kingdom
E-mail: han.wu@ucl.ac.uk