Metal–Organic Framework Materials

Metal–organic frameworks (MOFs), also known as porous coordination polymers, combine inorganic parts (metal ions) with organic parts (linkers) to form three-dimensional crystalline structures of tailored pore size. At present, there are four main classes of ordered nanoporous materials: zeolites, mesoporous aluminosilicate molecular sieves, carbon nanotubes, and, since the late 1990s, metal–organic frameworks.

Because they bridge the gap between purely organic and purely inorganic materials, MOFs possess unique physical properties in the domains of magnetism, luminescence, conductivity, adsorption, and electrochemistry. This exciting class of materials provides new opportunities for applications in gas storage, separation, sensors, including biosensors, optical and medical devices, catalysis, and more. However, it is now acknowledged that, due to their intrinsically greater thermal and chemical fragility, MOFs are unlikely to massively replace molecular sieves in adsorption and catalytic processes, especially for the refinery and chemical industries.

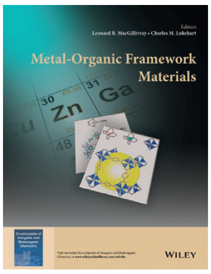
On the other hand, MOFs embody the dream of a functional solid material of a design that can be controlled at the nanoscale level; as a consequence, they offer perspectives in terms of chemical and physical properties that were not thought possible only a few years ago. The growing worldwide interest in MOFs for all of the domains listed above has been accompanied by a flood of publications (over 3000 per year) that are too numerous for anyone to read systematically. Thus, the time has come for a book presenting the main aspects and providing a broad but detailed overview of MOFs. This book's inclusion in the *Encyclopedia of Inorganic and Bioinorganic Chemistry (EIBC)* is definitely a success on these points, as it provides both the beginning research student and the active researcher with a critical distillation of the leading concepts, and offers a structured entry into the field of MOFs.

Although at first sight the book might appear to be merely a compilation of drawings of MOF structures, this is not the case; indeed, every chapter includes insightful discussions and in-depth descriptions of its key concept. The chapters and contributors have been carefully selected to cover a wide range of aspects of MOFs while limiting overlap. To summarize such an encyclopedic undertaking would pose a challenge, as a mere list of the chapter titles would barely fit onto this page. However, to make it simpler one can classify the content of the book under five categories that differ in size.

Two chapters deal with descriptive inorganic chemistry of interpenetrated and single-crystal-to-single-crystal transformations. Two other chapters describe original, yet very practical and promising, pathways for the synthesis of MOFs. In a systematic way, Friscic shows the great diversity of MOFs that can be obtained by a grinding process starting from an acetate or oxide powder precursor (mechanochemical synthesis). Burrows presents a comprehensive review of post-synthetic modifications, highlighting the infinite possibilities of MOF variations. Four chapters discuss the design and synthesis of MOFs with controlled formulations, sizes, and shapes. While the chapters written by Kitagawa and Maspoch describe bottom-up approaches using chemical nano-engineering, Styles and Janiak provide in-depth descriptions of top-down approaches such as patterning and the coating of polymer–MOF composites onto substrates. In the last of these chapters, the authors conclude that high performance in gas separation can be achieved with mixed-matrix membranes, which also have advantages in ease of production and handling. Five chapters focus on MOFs with specific structural features. Special emphasis is placed on functional linkers, especially fluorinated linkers and linkers based on porphyrin assemblies. In the latter assemblies, catalytic applications are of particular interest, as they bridge the gap between homogeneous and heterogeneous catalysis. The class of mesoporous MOFs is very well covered, with detailed descriptions of applications in medical devices. Although the number of MOFs that exhibit open metal sites (coordinatively unsaturated sites) is relatively limited, they have enhanced adsorption, separation, and catalytic properties. The synthesis and design of aluminum-based MOFs are described by Stock, a pioneer in the field. One might regret that the book does not include separate chapters on MOFs based on Fe and Zr, which are acknowledged to be among the most attractive solids for industrial applications.

A major part of the book describes the physicochemical properties of MOFs in separate chapters, which cover their magnetic, semiconducting, electrochemical, and—of course—adsorption properties. The applications of MOFs in adsorption processes are described in separate chapters dealing with gas storage, metal uptake, liquid separation, separation for analysis, and gas separation, especially for abatement of volatile organic compounds and respiratory masks. I also invite you to discover some surprising contributions to this book—the chapter on edible MOFs is only one of them!

As a general rule, the design of MOFs by rational construction is emphasized in the book,



Metal–Organic Framework Materials
Edited by Leonard R. MacGillivray and Charles M. Lukehart. John Wiley and Sons, Hoboken, 2014. 592 pp., hardcover, € 175.00.—
ISBN 978-1119952893

with a focus on the description of their physicochemical properties. An advantage of the book is that the contributors have focused their discussions on structure–property relationships, thereby establishing a basis for future rational design and the development of applications.

I strongly recommend the book *Metal–Organic Framework Materials* because it provides solid stimulation for new ideas in MOF design and applications. It is undoubtedly a valuable reference source for students and researchers in the field of MOFs, and more generally in the field of nanoporous materials. Even if you have a bookshelf, you will want to keep this book on your desk—unless one of your colleagues has already borrowed it!

David Farrusseng
CNRS, Université de Lyon 1, IRCELYON
Villeurbanne (France)

International Edition: DOI: 10.1002/anie.201504168
German Edition: DOI: 10.1002/ange.201504168