Chemical Photocatalysis

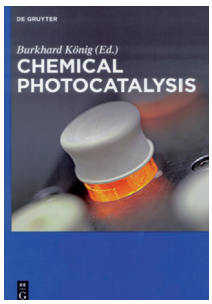
Chemical photocatalysis is a highly topical research area in photochemistry and organic chemistry, and has numerous applications. Some currently active topics are indicated in the introduction (Chapter 1). The second chapter is a historical review, and describes pioneering work up to the middle of the 20th century. In Chapter 3, some photophysical basics of photochemical reactions are described. Unfortunately, the reference part of this chapter is insufficient, with only one citation, and it fails to mention some important books and review articles. In the following chapter, photocatalytic reactions with flavin as catalyst are discussed. In Chapter 5, templated enantioselective photochemical reactions are described. Recently, many such transformations have been reported, and applications to organic synthesis have been indicated. Based on such investigations, chromophores have been linked to biomolecules such as nucleic acids or peptides. Photocatalytic reactions using these compounds are reported in Chapter 6. Photoredox catalytic reactions using transition metal complexes are described in Chapters 7–10. In these cases too, there is a focus on applications to organic synthesis. Most of these reactions are carried out with visible light. Many of these transformations can also be successfully performed by using simple organic dyes. The combination with organocatalysis is particularly interesting, since it opens numerous perspectives for organic synthesis. Chapter 11 deals with photochemical production of hydrogen using metal complexes, mainly of ruthenium, as catalysts. Such compounds may also be used for hydrogenations. Further objectives aimed at in these investigations are to achieve efficient water cleavage, or to develop photoelectrochemical cells. Heterogeneous photocatalysis is discussed in Chapter 12. In this context, materials based on TiO_2 are often used as the photocatalyst. Organic semiconductors are now frequently used for this purpose. In this case too, applications to organic synthesis are indicated. Chapter 13 deals with polyoxometalates.

In the last three chapters, the focus is again on theoretical and photophysical aspects. In Chapter 14, electronically excited states are discussed. Finally, Chapters 15 and 16 deal with transient analysis of intermediates that play important roles in photocatalysis.

The book particularly merits attention since it focuses on organic reactions and applications to synthesis. While catalysis is well established in organic chemistry, photocatalysis is less prominent in this field. Until recently, the term has appeared mainly in the contexts of photochemical wastewater detoxification with TiO_2 as heterogeneous catalyst, or of photochemical cleavage of water. However, for a considerable time now, photocatalytic reactions are being investigated in the area of organic chemistry, and numerous applications to organic synthesis have been reported. Recent systematic investigations of photoredox catalytic reactions with visible light and the versatile applications of such reactions to organic synthesis have given this research area an enormous impetus. In a more general context, these research activities contribute to an increased acceptance of photochemical reactions in organic chemistry and in industry. The contribution of such transformations to sustainable chemistry must also be pointed out.

Of course, not all aspects can be covered in one volume. Thus, the book lacks a chapter on photochemically assisted catalysis (metal carbonyl complexes, Vollhardt reaction, enzyme catalysis, etc.). Also, photo-oxygenation using singlet oxygen should be discussed more extensively, for example including the recent development of new heterogeneous catalysts for such transformations. Developments in the use of microreactors or of the continuous flow technique for photocatalytic reactions are other highly topical areas of research. Unfortunately, photocatalytic reactions using UV radiation are only discussed briefly, despite the fact that many photocatalytic reactions cannot be performed with visible light. In the past, many such transformations were carried out with UV light using simple photocatalysts (sensitizers) such as ketones. More complex concepts such as cocatalysis have also been applied. Under conditions such as these, selective activation of C–H bonds is possible.

Despite these omissions, I strongly recommend the book. It gives organic chemists a first overview of the current research activities in the field of photocatalysis, focused on applications to organic synthesis. For photochemists, the book is especially interesting because it covers a dynamically growing field of application of their concepts.



Chemical Photocatalysis
Edited by Burkhard König. De Gruyter, Berlin, 2013. 386 pp., hardcover, € 139.95.—ISBN 978-3110269161

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DOI: 10.1002/anie.201307399