

## 5.06 Photo-Functional Applications of Semiconductor Nanomaterials<sup>☆</sup>

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### 5.06.1 Introduction

The everyday energy resources have switched from petroleum and nuclear energies to renewable forms of energy, due to the global urgent environmental and economic requirements. One hundred years ago, an Italian chemist predicted the use of the solar energy in 'the future'. He asked a question "So far, human civilization has made use almost exclusively of fossil solar energy. Would it not be advantageous to make better use of radiant energy?" [1]. Actually, nowadays solar energy is one of the most promising alternative energy sources. For solar energy, to date several principles and materials have been proposed as a practical technology. However, to realize the optimum energy conversion, further developments in equipments and devices are indispensable. A considerable enhancement in the efficiency of the energy conversion can be expected by nanostructuring the materials used for the system. From this point of view, in this chapter, two current technologies used for solar-energy conversions, that is, solar cells and photocatalysts, which are related with each other in terms of their basic principles, are taken up as main subjects. Among the relevant technologies, one is the development of sensitized solar cells (SSCs) in terms of the convenient generation of electricity at lower cost and another is the photocatalysts in terms of water splitting to generate hydrogen fuel.

One can overview the historical trends of research interests in the two technologies of solar cells and photocatalysis as shown in Fig. 1(a) and (b), respectively. The number of documents concerning the key words was searched in the SciFinder of the American Chemical Society. Fig. 1(a) shows the trend of the number of documents containing the key word 'solar cell' plotted with blue bars. Among the documents, the numbers containing words 'sensitiz', "perovskite", and "quantum dot" were given by refining the documents and shown by brawn, red and green bars in Fig. 1(a). Although the concepts of solar cell and sensitization have been reported for a long time, a report for 'solar cell' appeared first in 1958. Since then the number continued to grow up to 1980, then became constant. In contrast, the documents using 'sensitization' (brawn bar) for 'solar cell' appeared in the mid-1970s and the number increased notably in recent years (after 1990). The research of the application with quantum dot started in the mid-1990s and for perovskite increased

<sup>☆</sup>Change History: December 2017. Yoshio Nosaka and Atsuko Y Nosaka updated the text, changed the chapter tile, and replaced 23 Figures.

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