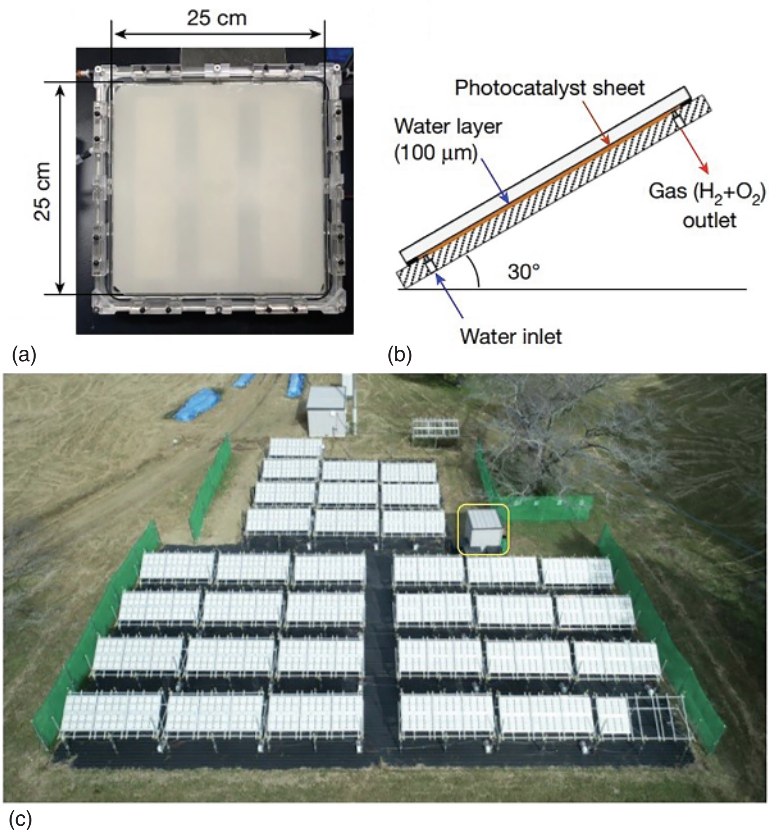

Figure 1.8 The 100-m^2 water splitting photocatalyst panel reactor, (a) A photographic image of a panel reactor unit (625 cm^2). (b) The structure of the panel reactor unit viewed from the side. (c) An overhead view of the 100-m^2 solar hydrogen production system consisting of 1600 panel reactor units and a hut housing a gas separation facility (indicated by the yellow box). Source: Reproduced with permission from Nishiyama et al. [55]/Springer Nature.

1.5 Conclusion

Photocatalysis has found numerous applications in various fields due to its ability to harness solar energy and drive chemical reactions. Researchers are continuously exploring novel materials and improving existing ones to enhance photocatalytic efficiency. Efforts are focused on designing materials with tailored properties, optimal band structures, and efficient charge separation, leading to higher QYs and faster reaction rates. The trend is shifting toward the development of visible light-responsive photocatalysts. Strategies such as doping, cocatalyst deposition, heterojunctions, and crystal facet engineering are employed to extend light absorption into the visible spectrum as well as to improve charge transfer efficiency, thereby increasing the overall photocatalytic performance.

By conducting thorough investigations that encompass various aspects such as scale-up studies and cost–benefit analysis, researchers can gain a comprehensive understanding of the real-world potential of photocatalysis and explore its practical applications in diverse fields, including water purification, air pollution control, self-cleaning surfaces, and renewable energy generation. Although significant progress has been made in solar-to-fuel conversion technologies, there remains a critical need to substantially enhance the current solar-to-fuel conversion efficiency, which hovers around approximately 1%. To achieve meaningful and widespread impact on solar fuels production, the efficiency must be raised to exceed 10%. This enhancement is essential for scaling up the technology and making it a practical and viable solution for sustainable energy production from solar sources. Continued research, development, and innovation are vital to address this challenge and unlock the full potential of solar fuels as a clean and renewable energy source.

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