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CHEMISTRY

A breakthrough of artificial photosynthesis

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Photosynthesis in plants, algae and cyanobacteria uses light energy from the Sun to convert CO_2 and water into carbohydrates and oxygen, thus sustaining all aerobic life forms on Earth. Photosynthetic water splitting into oxygen, protons and electrons, is catalyzed by the oxygen-evolving center (OEC) in photosystem II (PS II), which is crucial in global bioenergetics and has shaped the atmosphere by oxygen production. Due to the broad fundamental interests and potential applications in artificial photosynthesis, the structure and mechanism of this natural catalyst have attracted extensive attentions during the last two decades. Recent X-ray structure of PSII reported by Dr Shen's group have revealed that OEC is comprised of a unique asymmetric Mn_4Ca-cluster [1,2] (Figure 1 left), which provides a blueprint for the development of efficient and cheap artificial catalysts for water-splitting reaction to overcome one of the bottleneck of artificial photosynthesis. However, it is of a great challenge for chemists to synthesize the whole structure of the OEC in laboratory [3].

Dr Zhang has been devoting to work on the structure and mechanism of the biological OEC in PSII since 1997 when he was my PhD student, and he succeeded in predicting the binding mode of calcium—one of key cofactors of the OEC in 1999 [4].

After more than 18 years investigation on both natural photosynthesis and artificial photosynthesis, recently, Dr Zhang and his team have reported the first artificial asymmetric Mn_4Ca-cluster [5]. This new artificial model complex displays remarkable structural similarities as that of the OEC in nature in respects of the asymmetric Mn_4Ca core structure and peripheral ligands (Figure 1 right). Like the natural OEC, the artificial Mn_4Ca-cluster can undergo four redox transitions and display two low-temperature electron paramagnetic resonance (EPR) signals. More interestingly, Dr Zhang and his team have demonstrated that the artificial Mn_4Ca-cluster might be able to serve as a potential catalyst for water-splitting reaction similar to the biological OEC. However, to elucidate the catalytic properties of this artificial Mn_4Ca-cluster, more investigations are required in future.

Recent artificial Mn_4Ca-cluster reported by Dr Zhang's team [5] has mimicked the OEC of natural photosynthesis. This work should be considered as a breakthrough in the field of artificial photosynthesis. It provides a reasonable chemical model of Mn_4Ca-cluster to investigate and understand the structure and properties of the OEC in natural PSII. More importantly, it may promote to develop new generation of efficient and low-cost artificial catalysts for photo water-splitting, which is one of important ways to generate green fuels energy by using solar energy in future.

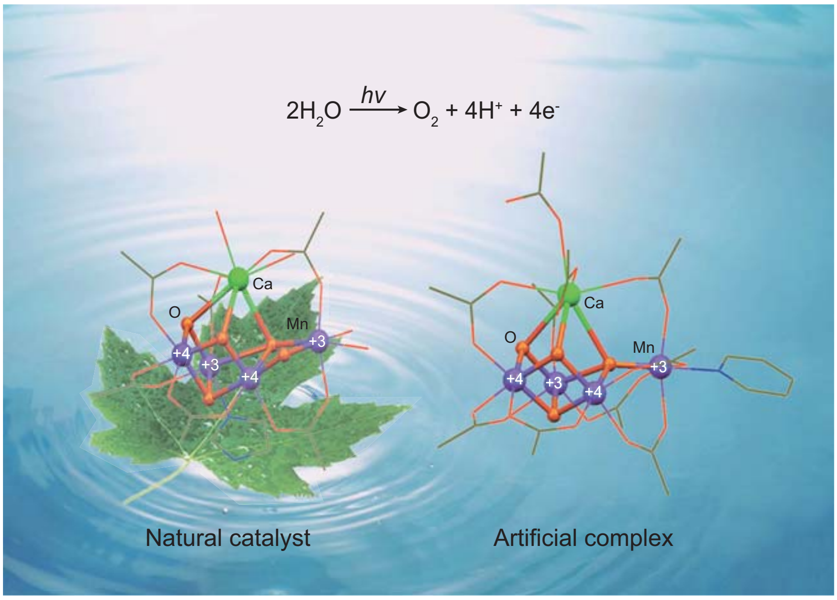

Figure 1. The Mn_4Ca-cluster in PSII (left) and in artificial complex (right).

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