Connecting dots between natural and artificial photosynthesis : magnetic resonance studies on light harvesting and the water oxidation reaction centre

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CHAPTER

Appendices

Summary

Decentralized plug and play systems for energy production are the future picture of our society. Artificial photosynthetic systems are used for this purpose. These systems are inspired by natural photosynthesis. Natural photosynthesis contains tetramanganese clusters to oxidize water and store the energy in the form of chemical compounds from atmospheric CO_2.

Chapter 2 illustrates the detailed construction of a three-flash flow cell to study light induced biological reactions, specifically the water oxidation reaction of Photosystem II. This instrument is capable of producing the S_2^+, S_3^+ and S_0^n intermediate states of the Kok cycle. I confirmed these by EPR experiments. The dead time is 2 ms for this instrument, which is the time between the last flash and hyperquenching of the sample by freezing using liquid isopentane as cryomedium.

In chapter 3, I study the mechanism of the major LHC II involved in conformational switching from light harvesting to the photoprotective state, in which excess light is dissipated as heat. I use MAS NMR as a non-invasive method to understand the structure and environment around Arg residues in Chlamydomonas reinhardtii LHC II. In this approach the Arg amino acid is selectively labeled with ^{13}C isotopes. Solid state NMR results shows that the conformations of the Arg residues are preserved in both the light harvesting and the photoprotective state. These residues are found in the α-helical regions near the stromal site and in the interlocked core of LHC II complex.

Chapter 4 studies the structure of self-aggregated semi synthetic Zn 3^1 amino chlorin that forms syn-anti parallel stacks according to the solid state NMR data. The small change of removing 3^3 methyl group of Zn 3^1 aminomethyl chlorin has significant effect on self-assembly. Solid State NMR analysis provides a direct link between subtle modification in the chemical structure and alterations in resulting packing structure.

Finally, chapter 5 provides an outlook on what steps can be performed next in hyperfreeze quenching NMR, LHCII studies, and artificial aggregates, based on the work presented in this thesis.