

Capturing Reaction Intermediates of the Water Oxidation Reaction In Photosystem II

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The water oxidation reaction in nature occurs in Photosystem II (PS II), multi-subunit protein complex, in which the Mn₄CaO₅ cluster catalyzes the reaction. The reaction comprises four (meta)stable intermediates (S₀, S₁, S₂ and S₃) and one transient S₄ state, which precedes dioxygen formation occurring in a concerted reaction from two water-derived oxygens bound at the OEC. This reaction is coupled to the two-step reduction and protonation of the mobile plastoquinone QB at the acceptor side of PS II. Using serial femtosecond X-ray crystallography (SFX) and simultaneous X-ray emission spectroscopy (XES) with multi-flash visible laser excitation at room temperature, we have investigated all (meta)stable states. We also collected some timepoint data between the S-states in order to understand the sequence of events. The current status of this research and the mechanistic understanding of the water oxidation reaction based on the X-ray techniques is presented.