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X-ray Transient Absorption Spectroscopy for Solar Energy Research

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Fundamental processes in solar energy conversion involve photon-matter interactions through light harvesting, excited state formation and subsequent transformation to convert light energy to electricity, heat and fuels. Intense pulsed x-ray sources from synchrotrons and x-ray free electrons lasers coupled with ultrafast lasers open up a new opportunity to reveal direct structural information of transient species in solar energy conversion processes, such as photocatalysts, photosensitizers, and photovoltaic materials. In particular, transient oxidation states of metal centers in electron donors and catalysts can be unambiguously identified with accompanying nuclear geometric transformations. X-ray transient absorption spectroscopy enables molecular snapshots after the photoexcitation, which will enable the make of molecular movies and have a tremendous impact on our understanding of the coupling between the electron transfer events and structural control parameters of participating partners in solar fuel and solar electricity generation. The lecture describes XTA method developments, the examples of its applications in solar energy research and the challenges and perspective.