Femtosecond X-ray liquidography captures the formation of chemical bond in the solution phase

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The pump-probe X-ray diffraction and scattering techniques have now been fully established as a powerful method to investigate molecular structural dynamics [1-5]. We have employed the techniques to study structural dynamics and spatiotemporal kinetics of many molecular systems including diatomic molecules, haloalkanes, organometallic complexes and protein molecules over timescales from ps to milliseconds. X-ray crystallography, the major structural tool to determine 3D structures of proteins, can be extended to time-resolved X-ray crystallography with a laser-excitation and X-ray-probe scheme, but has been limited to a few model systems due to the stringent prerequisites such as highly-ordered and radiation-resistant single crystals. These problems can be overcome by applying time-resolved X-ray diffraction directly to protein solutions rather than protein single crystals. To emphasize that structural information can be obtained from the liquid phase, this time-resolved X-ray solution scattering technique is named time-resolved X-ray liquidography (TRXL) in analogy to time-resolved X-ray crystallography where the structural information of reaction intermediates is obtained from the crystalline phase. We will present our recent results including the achievement of femtosecond TRXL by using an X-ray free electron laser.

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