Probing ultrafast structural and electronic dynamics in chemical and biochemical systems using X-ray free electron lasers

Poster/Oral Presentation
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X-ray spectroscopy and scattering allow a unique combination of electronic and structural information to be obtained from a variety of different types of samples in many different forms (solid, liquid, gas). The extension of these methods into the time domain has allowed measurement of dynamic processes, for example the tracking the photoinduced charge carriers in a functional material[1,2] or following the photocycle in a light activated protein[3,4]. In recent years X-rays have started to become routinely used to measure light-activated processes using a pump-probe scheme, where the sample is photoexcited with light and then probed after a variable time delay using an X-ray pulse. These methods can measure dynamics over a broad range of timescales, allowing them to probe everything from protein dynamics to ultrafast electronic spin-state changes in molecular systems. With the recent development of X-ray free electron lasers (XFELs)[5], time-resolved X-ray techniques have moved into the ultrafast regime, where the timescales of electron and nuclear motion can be accessed using the femtosecond X-ray pulses available from these facilities.[6]

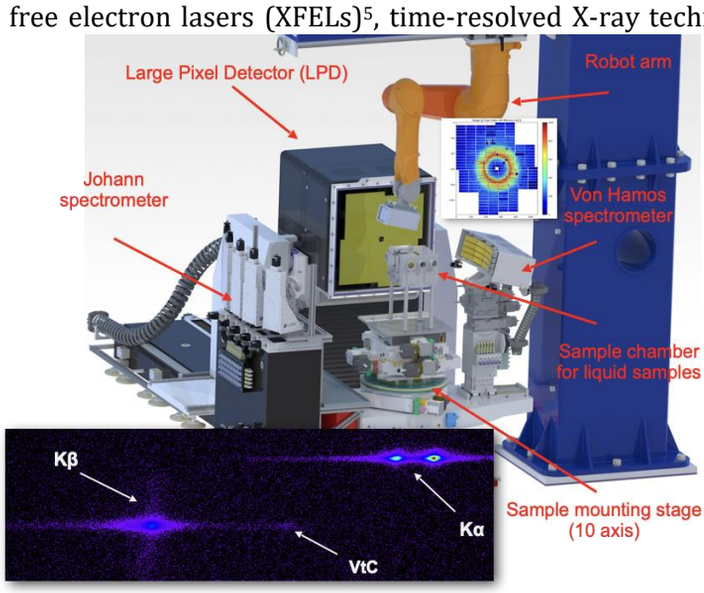

Figure 1. Layout of the FXE instrument for ultrafast X-ray measurements with some typical X-ray emission and scattering signals shown

This talk will present an overview of how X-ray techniques are being used at XFELs and the type of information the measurements can provide. The talk will introduce the European XFEL[7], a brand-new, high-repetition rate XFEL facility located in northern Germany, and its' Femtosecond X-ray Experiments (FXE) instrument which is focussed on measuring ultrafast dynamics in the condensed phase. Finally the lecture will present some examples of the types of measurements XFELs can perform and the scientific questions that can be answered using ultrafast X-ray techniques.

References

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