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Probing dynamics in biology, chemistry and physics using ultrafast X-rays

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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] or following the photocycle in a light activated protein [2]. 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), 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.

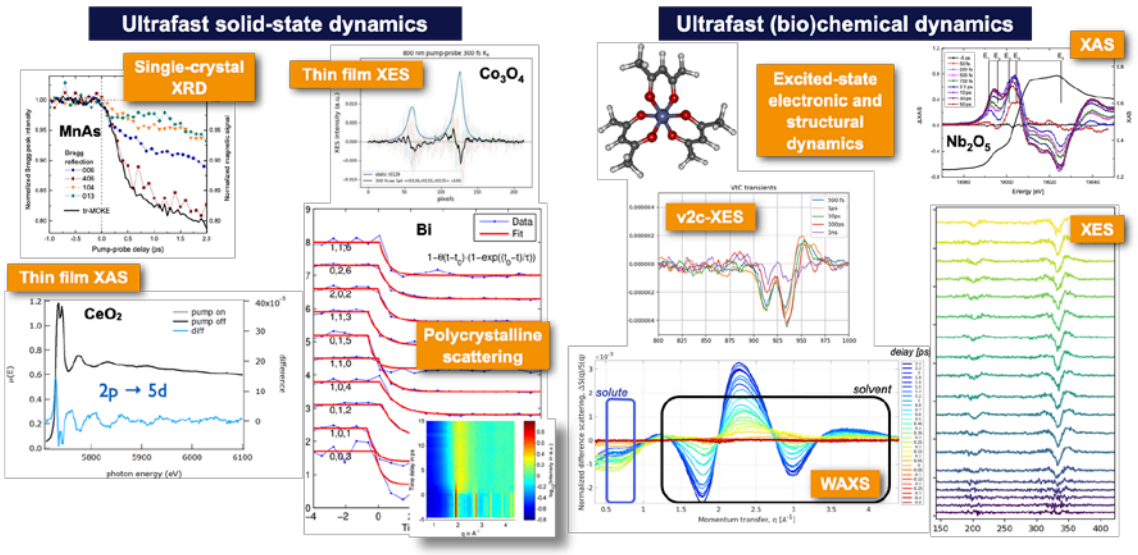

Fig. 1. Examples of the science and X-ray techniques performed at the FXE Instrument of the European XFEL

This talk will present an overview of how X-ray techniques are being used at XFELs to address topics in the natural sciences and the type of information the measurements can provide. The presentation will introduce the time-resolved capabilities of the European XFEL, a unique high-repetition rate XFEL facility located in northern Germany. Examples will be shown of the types of measurements XFELs can perform and the scientific questions that can be answered using ultrafast X-ray techniques, with a specific focus on research performed at the Femtosecond X-ray Experiments (FXE) instrument[3].

References

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