

SUNDYN: A novel setup for optical pump – X-ray probe spectroscopy at the ALOISA beamline

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Over the years X-ray spectroscopies have found widespread application in the study of materials, as they can be used to analyse the chemical composition and the electronic structure with atom-specificity. As new fields of research such as photovoltaics and femtochemistry have emerged, major efforts have been put on achieving pico- and femtosecond time-resolution in this class of spectroscopies, in order to follow the electronic structure dynamics which govern light-energy conversion processes and chemical reactions. A possible approach to this aim is represented by pump-probe measurements, in which the system is first pumped by a laser pulse and then probed with X-ray radiation while it is still out of equilibrium. Such measurements have recently become feasible at pulsed X-ray sources like free-electron lasers and synchrotrons, and several dedicated beamlines have been built to this purpose.

In this contribution, we present the setup for a novel laser pump – X-ray probe endstation at the ALOISA beamline at Elettra allowing for 1MHz time-resolved photoemission and X-ray absorption (NEXAFS). As a case study we report the time-resolved NEXAFS measurements on pentacene thick films. Pentacene is the prototypical material exhibiting singlet fission: after the absorption of an optical photon, the excited molecule can couple to a neighboring ground-state molecule and the process leads to the formation of two triplet excitons. We have been able for the first time to probe the molecules in the excited state by means of X-ray spectroscopy. We observed transitions in the Carbon K-edge NEXAFS spectra exhibiting 150 ps dynamics that can be associated to the molecules in the triplet state.

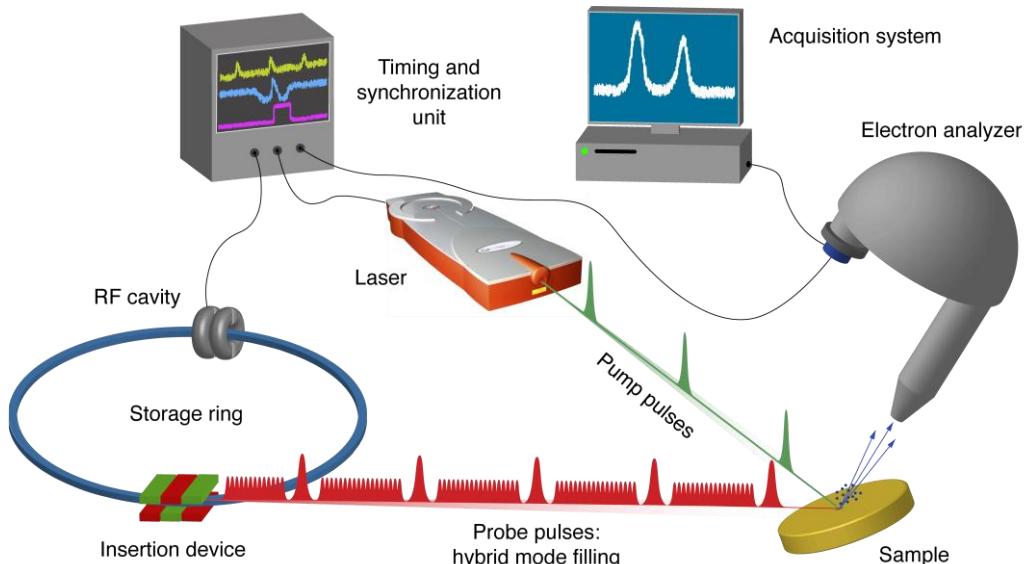


Illustration of the SUNDYN setup at the ALOISA beamline