Application Note

Time Resolved Photoinduced Phase Transitions in $LaTe_3$ with an ARTOF analyser

A. Zong and N. Gedik et al. investigated photoinduced phase transitions in $LaTe_3$ with their time resolved (tr) ARPES setup using an ARTOF analyser [1]. With the pump-probe scheme and a controlled time delay between photon pulses, tr-ARPES allows the generation of non-equilibrium states and track the dynamics in momentum and energy-resolved fashion.

Prof. Nuh Gedik, Massachusetts Institute of Technology:
"The ARTOF is a very nice analyzer especially for performing time resolved studies. Operation is more involved than hemispherical analyzers and extra care must be taken to avoid MCP ageing. But having the capability to measure the entire dispersion of the 2D angular acceptance cone without having to rotate the sample or use sequential deflection is very useful".

ARTOF analysers are slit-free by design and acquire the full angular range of the 2D acceptance cone without the need for sequential movement of the sample or deflection of the angular pattern as used in hemispherical analysers. Therefore, with an ARTOF analyser no prior knowledge is needed to determine which part of reciprocal space has interesting dynamics to be explored with tr-ARPES. Instead, the full angular range of the acceptance cone is available as time resolved data, as shown for the 2D Fermi surface of $LaTe_3$ for a ±10 meV cut around E_F in Figure 1a. During the analysis phase arbitrary momentum cuts can be extracted from the data, to study the evolution of the band structure (Figure 2).

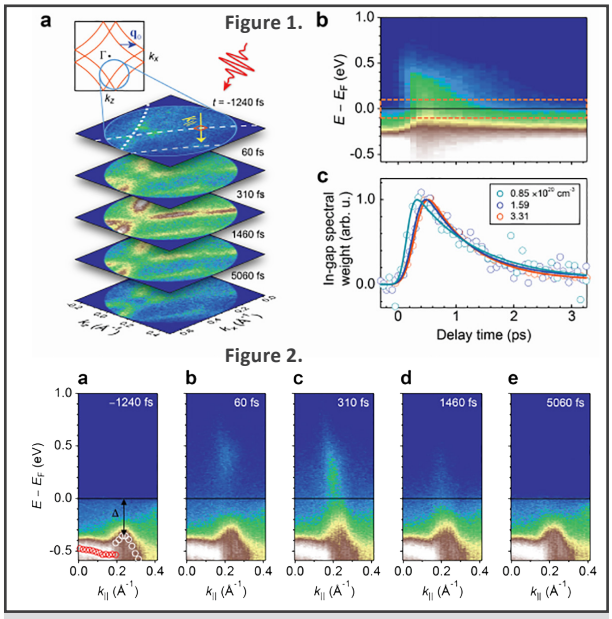

Figure 1. tr-ARPES measurements of the $LaTe_3$ sample. (a) Evolution of the Fermi surface for the full acceptance cone through the photoexcitation process. (b) Time evolution of the momentum integrated region (orange box in (a) for t=-1240 fs) with excited states above the Fermi level. (c) evolution of the spectral weight for ±0.1 eV marked in (b).

Figure 2. Evolution of the band structure for the $k_{||}$ cut marked yellow in Figure 1(a). As the tr-ARPES data is acquired for the full acceptance cone, arbitrary momentum cuts can be extracted during the analysis phase.

References:
[1] A. Zong et al., Nature Physics 15(2019) 27–31

ARTOF Analysers:

Hemispherical and ARTOF analysers both provide angular and energy resolution. Having no energy dispersive hemisphere, ARTOF analysers instead derive their energy resolution from a time-of-flight measurement using a pulsed light source. In contrast to hemispherical analysers, ARTOF analysers have a slit-free lens measuring the full acceptance cone at once without the need for sequential sample movement or deflection of the angular pattern. Accordingly, the transmission is extraordinarily high and especially useful for radiation sensitive samples, full cone tr-ARPES measurements, and applications with limited signal strength. The ARTOF-2 features the 2nd generation lens developed specifically for Angular Resolved Time-Of-Flight measurements, providing large energy dispersions for large angular and energy windows. The ARTOF-2 is available as part of the ARTOF Lab, which is easily connected to other modules (Figure 3).

Figure 3. 2020 installation of an ARTOF Lab equipped with the ARTOF-2 analyser and a 5 axis closed cycle manipulator. An UHV transfer connects the ARTOF Lab with the Lab10 module for thin film deposition seen in the background.