NAPLES, ITALY 23-27 JUNE
DSL2025 NAPLES
21st International Conference on Diffusion in Solids and Liquids

ABSTRACT

Transient Phenomena in Photoactive Materials: Insights from High-Resolution and Time-Resolved Photoemission Spectroscopy

M.G. Silly[1]

[1]Synchrotron SOLEIL, L'Orme des Merisiers Départementale 128,
91190 Saint-Aubin, FRANCE.

Photoactive materials are pivotal in a range of applications, from photovoltaics to photocatalysis, due to their ability to harness light energy and drive electronic and chemical transformations. Understanding the transient phenomena underlying their functionality is crucial for optimizing their performance. High-resolution and time-resolved photoemission spectroscopy (HRPES and TRPES) offers a powerful platform for probing these ultrafast processes, providing nanometric scale insights into electronic structure dynamics. This study presents an in-depth investigation of transient electronic states and charge carrier dynamics in a selection of photoactive materials, from bulk semiconductors (silicon[1], ZnO[2]) to 4th generation colloidal quantum dots[3]. By employing HRPES and TRPES, we resolve picosecond-to-microsecond electronic relaxation processes, revealing critical pathways for energy transfer, and recombination. The high spectral resolution further allows us to correlate these transient phenomena with surface chemistry, and defect states.
Through various examples measured at the TEMPO beamline in third generation synchrotron SOLEIL, we will demonstrate the potential of high-resolution and time-resolved techniques to unlock the transient behaviors that dictate the performance of next-generation photoactive materials.

[1] Pierucci, D.; Silly, M. G.; Tissot, H.; Hollander, P.; Sirotti, F.; Rochet, F. *236: 442-460. (2022)*.
[2] Spencer, B. F.; Graham, D. M.; Hardman, S. J. O.; Seddon, E. A.; Cliffe, M. J.; Syres, K. L.; Thomas, A. G.; Stubbs, S. K.; Sirotti, F.; Silly, M. G.; et al. *Physical Review B, 88* (19), 16, (2013).
[3] Spencer, B. F.; Leontiadou, M. A.; Clark, P. C. J.; Williamson, A. I.; Silly, M. G.; Sirotti, F.; Fairclough, S. M.; Tsang, S. C. E.; Neo, D. C. J.; Assender, H. E.; et al. *Applied Physics Letters, 108* (9), (2016).