

Pump-probe spectroscopic ellipsometry

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Brief description of the available set up:

The femtosecond pump-probe ellipsometer measures the polarization response of planar samples which allows the calculation of the optical constants of the material in an excited state and during the time evolution of these states. It is a P_R - S - C_R - A_R ellipsometer. For transparent-double-side-polished samples, ellipsometry in transmission can be measured. Transient absorption and transient reflection spectroscopic measurements are also possible.

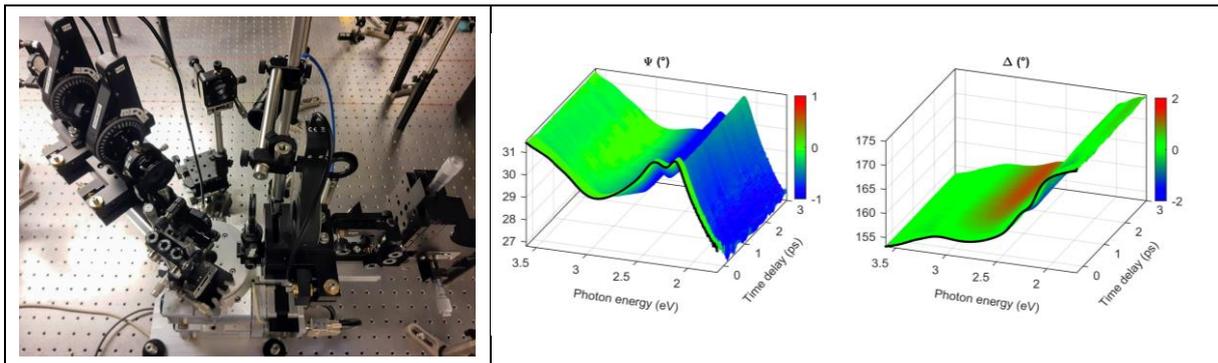


Figure 1. Left) Setup for pump-probe spectroscopic ellipsometry in operation in the E1 experimental hall. Right) Results of the pump-probe spectroscopic ellipsometry measurements.

Other characteristics of the system are:

Wavelengths pump beam: The user might chose to pump the material with 266 nm, 400 nm or 800 nm generated by a third harmonic generation kit or to pump with any wavelength between 350 - 2000 nm generated by an Optical Parametric Amplifier (maximum intensity that can be reach at each wavelength varies)

Spectral range probe: 350 nm - 750 nm (1.65 eV - 3.54 eV) based on supercontinuum generation.

Probe spot size at the sample: $\sim 100 \mu\text{m}$

Time range: 5 ns

Time resolution: 100 fs - 200 fs depending on the geometrical configuration of the pump and probe beam.

Dynamic range: 10000:1 (Changes in the signal as small as 0.01% could be measured)

Characteristics of the laser pulses: 35 fs, 1 KHz repetition rate (Laser Astrella from Coherent)

Angle of incidence of the probe: 0-90 degrees measured from the normal of the sample.

Sample size: The system can measured samples with an area of $200 \mu\text{m} \times 200 \mu\text{m}$

The transient absorption, reflection or ellipsometry spectra are obtained from a series of background and luminescence corrected reflectance spectra. In case of the ellipsometry measurements, the data are provided to the user as a series of Ψ and Δ spectra in function of the pump-probe delay. In order to get the actual optical constants of the system, further modelling is required. In case of need, guidance and support can be provided to the user during the modelling and interpretation of the results.

Reference about the setup

[1] Broadband femtosecond spectroscopic ellipsometry. Steffen Richter, Mateusz Rebarz, Oliver Herrfurth, Shirly Espinoza, Rüdiger Schmidt-Grund, and Jakob Andreasson.

Review of Scientific Instruments, 92, 033104 (2021)

<https://doi.org/10.1063/5.0027219>

References about already obtained results

[2] Transient dielectric functions of Ge, Si, and InP from femtosecond pump-probe ellipsometry. S. Espinoza, S. Richter, M. Rebarz, O. Herrfurth, R. Schmidt-Grund, J. Andreasson, and S. Zollner. Appl. Phys. Lett. 115, 052105 (2019);

<https://aip.scitation.org/doi/10.1063/1.5109927>

[3] Ultrafast dynamics of hot charge carriers in an oxide semiconductor probed by femtosecond spectroscopic ellipsometry. Steffen Richter, Oliver Herrfurth, Shirly Espinoza, Mateusz Rebarz, Miroslav Kloz, Joshua A Leveillee, André Schleife, Stefan Zollner, Marius Grundmann, Jakob Andreasson, Rüdiger Schmidt-Grund.

New Journal of Physics 22 (8), 083066 (2020)

<https://iopscience.iop.org/article/10.1088/1367-2630/aba7f3>

[4] Transient birefringence and dichroism in ZnO studied with fs-time-resolved spectroscopic ellipsometry. O. Herrfurth, S. Richter, M. Rebarz, S. Espinoza, J. Zúñiga-Pérez, C. Deparis, J. Leveillee, A. Schleife, M. Grundmann, J. Andreasson, and R. Schmidt-Grund. Physical Review Research 3 (1), 013246 (2021)

<https://journals.aps.org/prresearch/abstract/10.1103/PhysRevResearch.3.013246>