Integrated XUV Ultrafast Spectroscopy and Scatterometry of Nanostructures

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In this abstract, we propose a novel approach based on a table-top high harmonic generation (HHG) setup for evaluating structural and material-related characteristics of nanostructures. In the XUV domain, it is possible to exploit a reflection configuration to harvest and analyse the light scattered by a sample for extracting information about the dimensions and shape of nanostructures with nanometer precision. Additionally, we leverage pump-probe-based experimental techniques, enabling us to observe the dynamics of carriers down to the attosecond time scale. These processes reflect material-specific characteristics expressed by transient absorption effects and other dynamics occurring around absorption edges. The proposed system consists of an XUV scatterometer designed for analysing the 0^{th} diffraction order signal from the sample. The collected spectrum can be fit to numerical models for retrieving structural characteristics related to the periodic features. The setup will also incorporate a time-resolved detection scheme, to include the unique temporal resolution offered by ultrafast spectroscopy. The employment of HHG together with the use of few-cycle pulses enables to access the electrons and holes dynamics also in layered samples [1], providing insightful information about the charge transport across complex nanostructures. Advanced data analysis techniques will be employed to compare the collected data to models for deriving sample shape and probing the evolution of carrier population at the same time.

References

[1] Cushing, Scott K., et al., Layer-resolved ultrafast extreme ultraviolet measurement of hole transport in a Ni-TiO2-Si photoanode, Science advances 6.14 (2020): eaay6650.