Traceable metrology of soft X-ray to IR optical constants and – A new EMPIR project

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Innovations based on materials and devices in photonics and semiconductor manufacturing play a key role in many new developments. Therefore, research needs reliable databases of optical constants to support the photonics industry in developing innovative and tailored next-generation materials. To this end, publicly accessible databases for optical materials in different wavelength ranges have been established. However, the underlying data sets are of poor quality and are based on calculated and estimated values without reliable uncertainty estimates.

The project presented here is aimed to develop advanced mathematical and experimental methods to traceably characterise optical constants for ultra-thin layer systems and nanostructures, from soft X-ray to IR. It is intended to create a database of optical constants with associated uncertainties for bulk materials and ultra-thin film systems. The project starts on July 2021, consists of nineteen European partners and has a duration of 3 years.

The specific objectives are structured into four work packages (WPs).

In WP1, test and reference samples including ultra-thin layer systems, complex nanostructures (e.g. PillarHalls) and novel materials (high k-materials and other materials, e.g. 2D nanosheets) are selected and produced. In WP2, reflectometry, Mueller ellipsometry and scatterometry is developed as reliable and traceable thin-film metrology techniques in the soft X-ray to IR spectral range, for determining the layer thickness, optical properties (such as the refractive index, absorption coefficient, reflectivity) and dielectric tensors of the test samples developed. In WP3, advanced mathematical tools to solve the inverse problem in optical metrology are developed and applied. This includes the calculation of reliable uncertainties including measurement and model errors. In WP4, optical response functions form test and reference materials are determined and a database is assembled

In the presentation, the project objectives, structure and challenges will be discussed. It will be outlined which open research questions still need to be solved in order to establish traceable metrology of soft-X ray to IR optical constants and to generate a corresponding database.