Exploring the soft X-ray energy range for next generation nanostructure metrology

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The continuously shrinking dimensions of the features in the semiconductor industry as well as their increasing complexity require innovative metrology solutions. Non-destructive methods with high throughput that are able to assess complex 3D structures are of major importance. Measurement techniques based on light-structure interaction allow fast and non-destructive inspection of structured areas and are already widely used from the infrared to the hard X-ray spectral range.

Soft X-rays are suitable for comprehensive and high-resolution metrology of nanostructured surfaces and thin layers. They are suitable for probing buried layers, and surface contamination and imperfections. In comparison to X-rays, higher angles of incidence are also possible without compromising the surface sensitivity. Therefore, this energy range is being systematically explored for the evaluation of nanostructured surfaces. However, the use of soft X-rays for metrology application is challenged by the limitation of optical data of the materials. Often, different sources report inconsistencies for many technologically relevant materials and mostly, the available optical data are given without calculated uncertainties. Here, we report on the on-going sensitivity studies in the soft X-ray energy range, where we focus on different layer thicknesses and evaluate, as well, fundamental parameters. Furthermore, the combination of scatterometry with fluorescence, in a so-called hybrid method, is also under exploration for the characterization of nanostructured surfaces.

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