Influence of the model selection in analysis of EUV reflectometry data

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Many materials remain insufficient studied in the extreme ultraviolet (EUV) regime, where optical constants often deviate from literature values, as they are usually calculated based on older measurements of atomic scattering factors. When this literature data is used as a basis for optics design, it can cause critical discrepancies between expected and real performance. In optical metrology, it can even hinder the analysis of material systems, e.g. ultrathin film system with layer thicknesses in the ten nanometer range when utilized optical properties are not precisely known.

Even though metrology capabilities in this field have been improving steadily, and new databases [1] with state-of-the-art results are being established, samples often exhibit various modifications, such as oxidation or contamination, due to differences in fabrication processes or handling. Since the analysis is often performed based on an ill-posed, inverse problem, it becomes critical to consider a suitable model for the calculation of theoretical values.

Depending on the metrology setup, its parameter range, and accuracy, the influence of model selection can far exceed the intrinsic uncertainty of the reconstructed material and geometrical parameters.

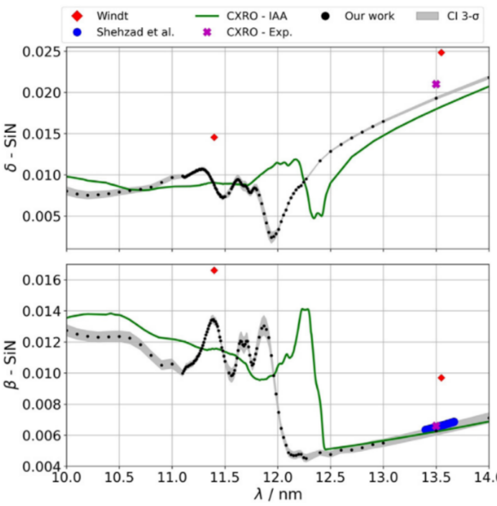

Figure 1: Illustration of the available optical constants in different databases including the large but old CXRO [2] and the new PTB optical constant database [1]. Image from Q. Saadeh et al. [4].

The authors present material and geometrical parameter reconstructions of different thin film samples with varying assumptions in their model representation, based on EUV reflectometry measurements in a grazing incidence configuration from 5° to 30° in a wavelength regime of 11 nm to 16 nm [3]. The model-selection uncertainty is an essential component within a detailed and reliable sample reconstruction. An effective approach to addressing the model-selection uncertainty is combining EUV measurements with complementary techniques for reference.

[1] T. Biskup, "The ocdb Python package", 2025, Zenodo. doi: 10.5281/zenodo.14945664

[2] B.L. Henke, E.M. Gullikson, and J.C. Davis., 1993, Atomic Data and Nuclear Data Tables **54(2)**, 181-342

[3] S. Schröder, L. Bahrenberg, B. Lüttgenau, S. Glabisch, S. Brose, S. Danylyuk, J. Stollenwerk, P. Loosen and C. Holly, 2022, JM3 **21(02)**, 021208.

[4] Q. Saadeh, V. Philipsen, J. Meersschaut, V. S. K. Channam, K.-A. Kantre, A. Sokolov, B. Kupper, T. Wiesner, D. O. García, Z. Salami, C. Buchholz, F. Scholze and V. Soltwisch, 2024, Appl. Opt. **63(36)**