

# Updated Optical Data for Transition Metals in the EUV Range

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Transition metals are key constituents of EUV optical elements. Most transition metals have high melting points and are compatible with Ion Beam Deposition (IBD) alongside magnetron sputtering techniques. These techniques allow coating dense, very smooth and pure thin films. Metals are used as main coatings and also as secondary layers such as capping layers and interdiffusion barriers. The optical response of metallic films can be tuned by alloying, and the chemical stability can be improved with nitridation and other methods. Most metals are also suitable for Si and Si-based substrates. Those advantages made transition metals essential for soft X-ray and EUV optical elements.

However, the available optical data on transition metals in the EUV are rather inconsistent for different sources [1-3]. When designing optical elements, differences in the available data for the same material complicate materials selection. Inconsistencies are even observed for the oxidation resistant and environmentally stable Platinum-Group Metals, and that comes at a surprise. Presumably, that is due to the dispersion profiles of the overlapping N- and O-shells of these elements, which cannot be easily assessed by theoretical calculations. Such fine-structure in the dispersion profiles cannot be properly captured by older experimental data for discrete energies. This investigation therefore requires continuously tunable radiation sources, such as storage rings.

In our contribution, for the EUV spectral range, we present the determination of optical constants from eleven transition metals: Cr, Co, Ni, Nb, Rh, Pd, W, Os, Ir, Pt, and Au in addition to ZrO<sub>2</sub>. Synchrotron reflectometry was used on thin films with thicknesses ~30 nm to ~50 nm. Markov chain Monte Carlo (MCMC)-based Bayesian inferences were used to work out the relevant reflectometry inverse-problems. We present our results in comparison with external literature.

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[2] D. Windt, 1998, *Comp. Phys.* 12(4), 360-370.

[3] E. Palik (Ed.), 1985, *Handbook of Optical Constants of Solids*, Academic.