Extreme Ultraviolet Reflectance of Thin Films Deposited *In Situ*

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Typical thin-film samples that are made in vacuum and then exposed to the atmosphere, undergo some surface oxidation and contamination. Figure 1 illustrates the importance of having uncontaminated samples for determining optical constants. The three curves are calculated reflectance (R) at λ=310 Å for a W surface with and without surface oxide (WO_2) and carbon contamination as shown. All roughnesses (σ) are 15 Å rms with error function profiles. Contamination has a large effect on the R vs. θ curves. Fitting curves that are affected by contamination with a model that assumes only surface roughness leads to large errors in the fitted optical constants. For the most contaminated example shown in Figure 1, such a fit yields constants (n,k) of (0.94, 0.33) rather than the correct constants that would be found from the clean-surface curve (1.024, 0.163). The effect is less pronounced at shorter wavelengths, but is very significant throughout the EUV.

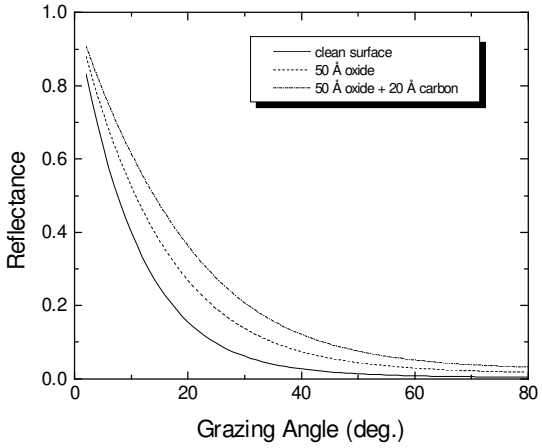

Figure 1. Calculated reflectance for a W surface with and without contamination.

We have built a sputter-deposition system that is attached directly to the NIST EUV reflectometer at SURF-II. The combined apparatus allows us to make measurements on samples that have been grown and transferred *in vacuo* to the NIST reflectometer. This procedure practically eliminates the problem of surface contamination and oxidation that plagues measurements made on samples produced in separate deposition chambers. With this equipment, we are able to acquire the most reliable data possible for the determination of EUV optical constants. Figure 2 shows an example of the data for a thick W film, measured at λ=335 Å, with the associated fit and optical constants. The complete study will be presented at the meeting. This work was supported by NIST.

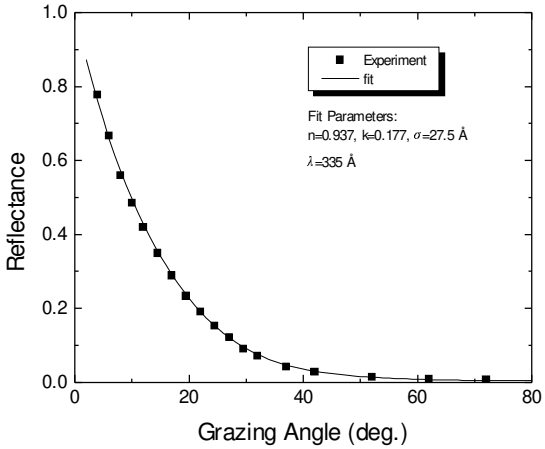

Figure 2. Measured data and a fit for a thick tungsten film deposited and measured *in situ*.