

## **Will the real optical constants please stand up: Problems in obtaining optical constants for materials in the VUV**

Matthew B.Squires, R. Steven Turley, David D. Allred, Department of Physics and Astronomy, Brigham Young University, Provo, Ut 84604

We are constructing a data base of critically reviewed optical constants for commonly used optical materials in the range of 10 to 200 eV. Accurate determination of these optical constants is complicated by three factors: discrepancies between critically reviewed data sets, uncertainties in determining optical constants of compounds from those of the constituent elements, and the paucity of data in this energy region.

We will illustrate these problems and their solutions by using the example of Si, a-Si and SiO<sub>2</sub>. When the deltas of crystalline Si from Palik for Si are compared to Henke tables there is an average difference of 26%+-15% over the range 30 to 200 eV. While the reliability of optical constants below 100 eV is known to be poor, the error above 100eV is also very erratic. In addition, there is a substantial difference between the optical constants of a-Si and Si even when we taken into account the differences in density of the two materials.  $k$  for Si (corrected to 90% density to match a-Si) and a-Si are respectively, 0.065 and 0.03 at 40 eV, for example. These differences can substantially effect the calculation of multilayer reflectance for certain material combinations.

A special problem in the VUV portion of the EM spectra arises in deciding how to treat compounds. The usual approach to computing the optical constants of compounds in the x-ray portion of the spectrum is to average the atomic scattering factors of the elements weighting them according to the stoichiometry of the compound and using the known density of the compound to get  $n$  and  $K$ . This approach ignores the chemical bonds of the compound and is patently wrong in the visible and near UV portions of the spectrum. Somewhere in the VUV for a material like SiO<sub>2</sub>, this approximation, however, should become a good approximation for most energies, yielding computed optical constants which generally differ from the measured ones by a decreasing fraction with increasing energy. We observed that the discrepancies due to uncertainties in the measured constants is so large as to render this activity futile at the present even for a well known material such as SiO<sub>2</sub>.

Below 30 eV the availability of optical constants is poor, and critically reviewed literature is largely unavailable. We will discuss what methods we have used to calculate and to measure optical constants in the lower energy regions. It is critical that better constants for the spectral range between 10 and 100 eV are obtained.