IMD: Software for modeling the optical properties of multilayers

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IMD is a point-and-click IDL application that can calculate the optical properties - reflectance, transmittance, and absorptance - of an arbitrary multilayer structure, i.e., a structure consisting of any number of layers of any thickness, and of any material. IMD includes a database of optical constants for over 150 materials, spanning the photon range from the X-ray region to the far infrared. It's also easy to use your own optical constants if necessary, or to create new X-ray optical constants for any compound, using the tabulated atomic scattering factors for 92 elements. IMD can be used for both modeling, and for parameter estimation by non-linear, least-squares curve-fitting (including confidence interval generation) to your own measured data. IMD can also compute the electromagnetic field intensity vs. depth in a multilayer structure.

The IMD point-and-click interface allows you to quickly define the multilayer structure you wish to consider. The general multilayer structure consists of any number of individual layers, which can be grouped together to create periodic multilayers, if desired. (You can even create groups of groups of layers, with no limit on nesting depth.) Layers and periodic multilayers can be inserted or removed anywhere in the stack.

Computations are performed using an algorithm that is based on recursive application of the Fresnel equations, modified to include interfacial roughness and/or diffuseness. The optical properties can be calculated as a function of incidence angle and/or wavelength, and it's easy to vary also any of the parameters that describe the multilayer structure, i.e., layer thicknesses, roughnesses, etc., and/or any of the parameters that describe the incident 'beam', i.e., polarization, spectral or angular resolution, etc. You can select as many as seven independent variables simultaneously.

The results of your computations can be visualized using a point-and-click graphics application, IMDXPLOT, that allows you to view (and print) 2D or 3D 'slices' through the multi-dimensional optical functions. IMDXPLOT makes it easy to overlay multiple curves on a single plot, and to include a variety of labels and legends. You can also overlay your own measured optical data in order to compare interactively your measurements to the calculations.

Finally, you can attempt to fit the calculations to your data, using non-linear, least-squares curve-fitting, with an unlimited number of adjustable parameters: any of the parameters (including optical constants) that describe the multilayer structure or the incident beam can be fit. Confidence intervals associated with the best-fit parameter values can be estimated as well, and IMDXPLOT can be used to view confidence interval 'slices' in parameter space.

IMD is freeware, and can be downloaded from www.bell-labs.com/user/windt/idl.