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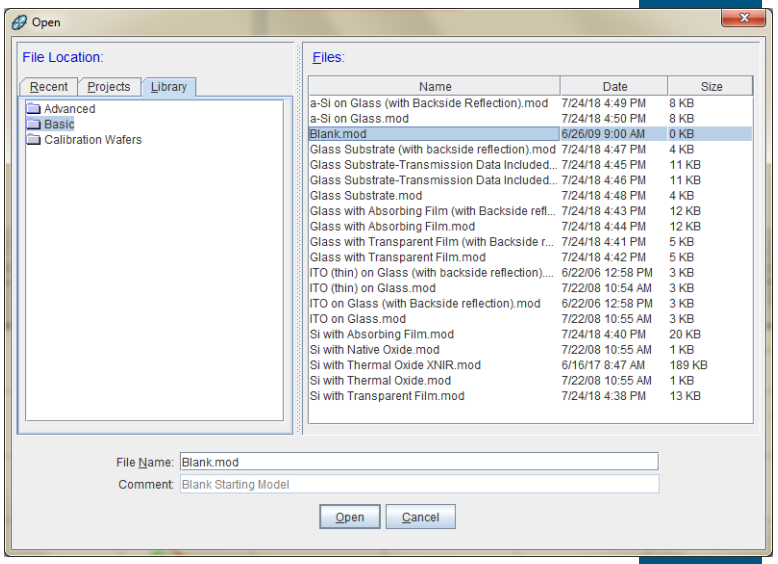
Metal Substrates

This note contains information related to procedures needed to determine the refractive index of metal substrates. The procedure is identical for metal films greater than ~35-50nm on other substrates, as these will effectively block the underlying material.

This information can then be used for subsequent analysis of coated samples using the same substrate.

Ellipsometer types	M-2000, RC2, alpha-SE
Software	CompleteEASE
Typical data required	Standard ellipsometric data at 2-3 angles between 50°-75°
Typical model required	Blank.mod
Considerations	Surface roughness & oxides

1. Measure sample or open saved data

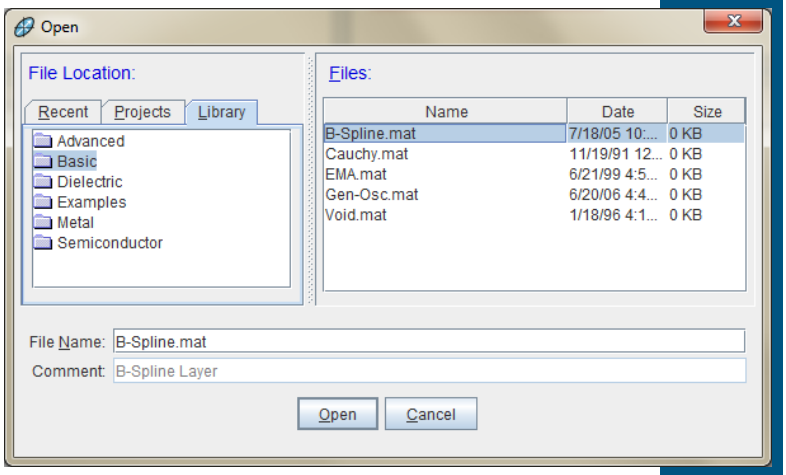


2. Open “Blank.mod” to start

(New versions of CompleteEASE automatically start with this model loaded. If needed, from the **Model** panel, click ‘Open’. Browse the Library tab, Basic folder to find Blank.mod. Click ‘Open’ to load the model structure into the Model panel.)

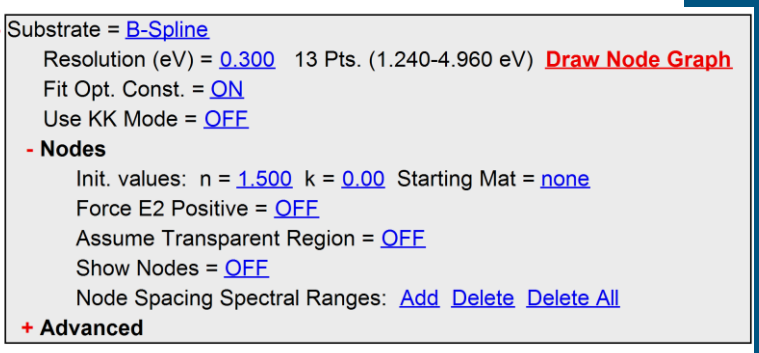
3. Click on “**none**” to open material file library

4. Browse Library tab, Basic folder to find B-Spline.mat



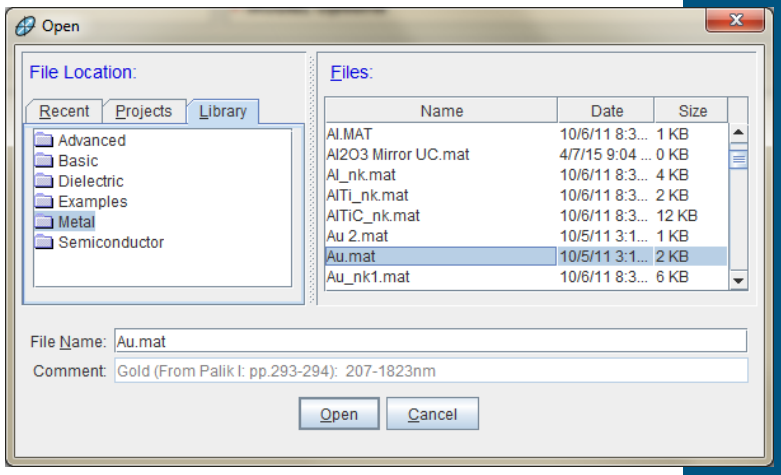
5. Click “Open” to add the material file to the model structure

6. Expand the +Substrate and +Nodes section within the B-Spline



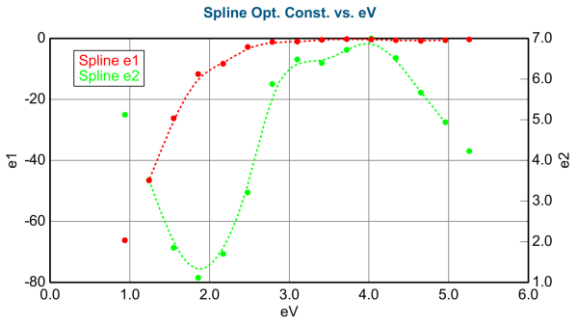
7. Click on (Starting Mat =) "**none**" to open material file library

8. Browse the Library tab, Metal folder to find a starting material file appropriate for your material



(Metal optical constants are highly variable. The .mat files in the software library are best used as starting values only. If your material is included in the library, choose any of the available options. If not, choose any similar material file.)

9. Click 'Open' to add the material file as a Starting Mat within the B-Spline model



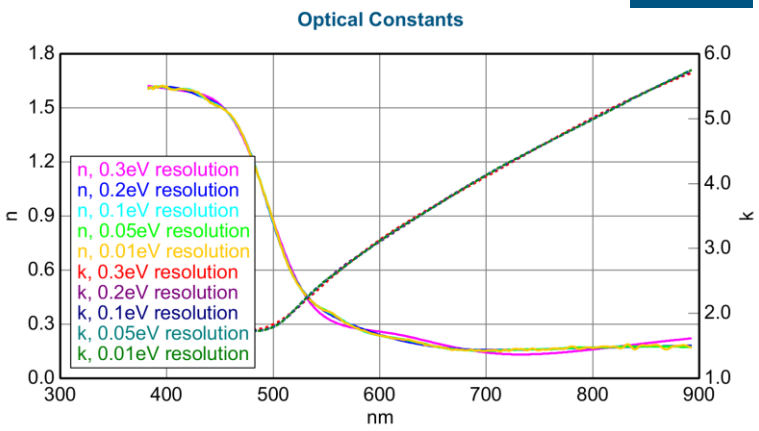
(The B-Spline layer will automatically adjust nodes to best match the Starting Mat)

10. From the Fit panel, click ‘Fit’

	MSE
0.3eV resolution	5.674
0.2eV resolution	2.51
0.1eV resolution	1.04
0.05eV resolution	0.724
0.01eV resolution	0.0393

11. Optimize the B-Spline node resolution

- Default B-Spline node resolution is 0.3eV
- Try slightly higher or lower node resolution (0.2, 0.4) and refit.
- Slowly increase or decrease to minimize MSE and visually match experimental data
- Stop when visual match to the data is achieved to avoid oversampling the data.
- 0.1-0.4eV is typically good for most metals.



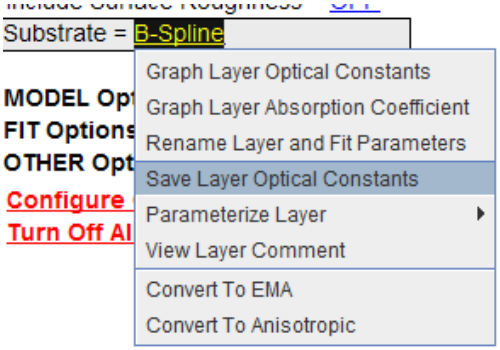
12. Evaluate result by considering:

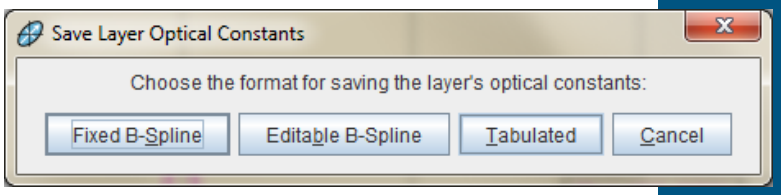
- Do the model generated curves visually match the experimental curves?
- What is the MSE value?
- Do the optical constants appear physically reasonable?

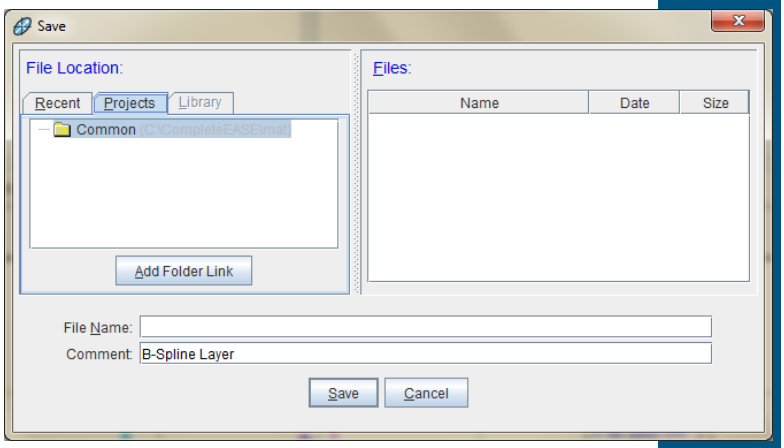
Metals should have increasing k towards IR wavelengths due to free carrier absorption.

11. If the result is acceptable, save the material file with a unique name for subsequent analysis of coatings on same or similar substrates

(Right-click on “B-Spline and click ‘Save Layer Optical Constants’. For metals, tabulated format is usually best. Use Recent or Projects tab to locate desired folder.)







Surface Roughness & Oxides

It is usually not possible to independently determine surface roughness or native oxide thickness on metal substrates. These effects are included in the optical properties of the results from this procedure. To see how the presence of roughness or oxide could affect the result, add one or the other to the model as a fixed quantity and refit the data.