

FilmEllipse™ is an easy to use production oriented software tool for the analysis and acquisition of ellipsometric data. FilmEllipse™ enables solutions to a wide range of applications not typically covered by the software bundled with commercially available ellipsometers. In particular, FilmEllipse™:

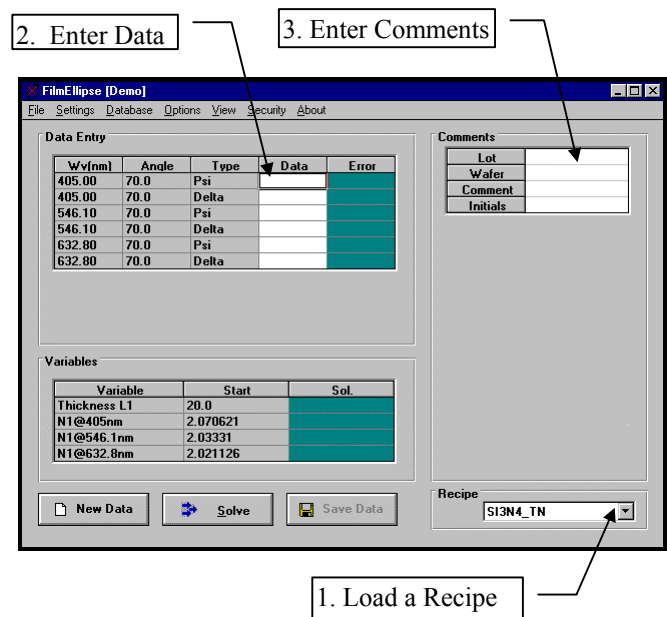
- ❑ Simultaneously solves for complex indices ( $n+ik$ ) and thicknesses of multi-layer film structures.
- ❑ Allows the user to enter ellipsometric and spectrophotometric data collected at multiple wavelengths and angles of incidence.
- ❑ May be operated in either an engineering or manufacturing mode. The manufacturing mode requires little or no experience in personal computers or thin film optics.
- ❑ Gives unique self-consistent layer thickness solutions. Most commercially available three wavelength ellipsometers treat each wavelength independently which results in three different thickness solutions (one for each wavelength). FilmEllipse™ uses the fact there can physically only be one thickness value and calculates a thickness that consistently fits all three wavelengths.
- ❑ Global Solution/Optimization methods are used to obtain the best solutions, avoiding local minimas and minimizing sensitivity to measurements errors.
- ❑ Maximum and minimum bounds may be placed on any unknown thickness or index of refraction.
- ❑ Gives the user flexibility in customizing FilmEllipse™ for entry and storage of user-defined fields.
- ❑ Automatically saves and groups experimental data, instrument parameter settings, layer structures, and comments in a user-defined database for later analysis. This feature is important in performing statistical process control and instrument calibration.
- ❑ Optional advanced features, including :
  1. Direct data acquisition
  2. Wafer mapping capability

### Ease of Use:

FilmEllipse™ is designed to be operated in either an engineering or manufacturing mode.

### Manufacturing Mode

The manufacturing mode is specifically designed such that little or no experience in personal computers, thin film optics, or ellipsometric techniques is required. In this mode the user interacts with a single window (shown below) to open pre-defined recipes that automatically load all instrument parameters and layer settings. The user need only enter the experimental data and fill in the user-defined fields.

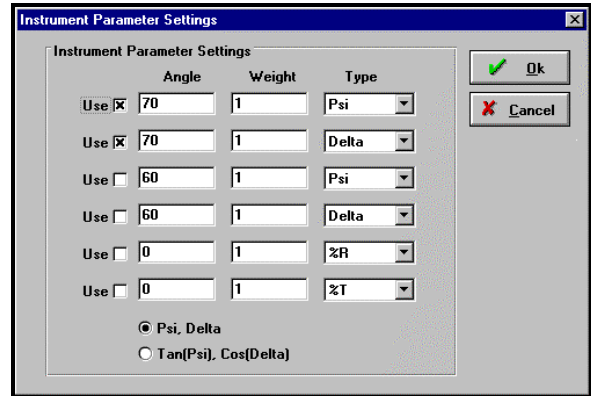


### Engineering Mode

In the engineering mode the engineer specifies the recipe settings. Each recipe contains the layer and material settings, instrument/ellipsometer parameters settings, and the required user-defined fields needed such as lot number, wafer number, etc. These recipes may be protected with an optional password and saved for later use by other users.

## Instrument Parameter Settings

FilmEllipse™ allows the user to enter ellipsometric data  $\psi, \Delta$  [Tan( $\psi$ ), or Cos( $\Delta$ )] by itself or in conjunction with spectrophotometric data (*i.e.*, transmittance and/or reflectance). This is particularly valuable to users who also employ spectrophotometers (*e.g.*, Nanospecs) for film thickness measurements. Measured data may be collected at multiple wavelengths and incident angles.



The dialog box 'Instrument Parameter Settings' contains a table with columns 'Angle', 'Weight', and 'Type'. It has five rows, each with a 'Use' checkbox and a 'Weight' field set to '1'. The 'Type' column has dropdown menus for 'Psi', 'Delta', and '%R'. At the bottom, there are radio buttons for 'Psi, Delta' (selected) and 'Tan(Psi), Cos(Delta)'. 'Ok' and 'Cancel' buttons are on the right.

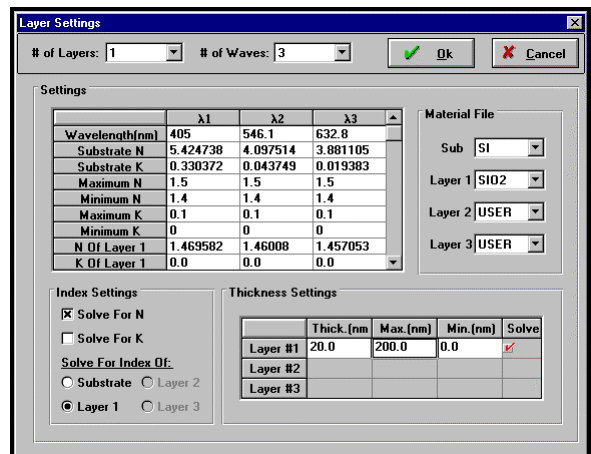
Use	Angle	Weight	Type
<input checked="" type="checkbox"/>	70	1	Psi
<input checked="" type="checkbox"/>	70	1	Delta
<input type="checkbox"/>	60	1	Psi
<input type="checkbox"/>	60	1	Delta
<input type="checkbox"/>	0	1	%R
<input type="checkbox"/>	0	1	%T

Instrument Parameter Setting Dialog Box

## Layer Settings

Up to three layers may be specified in the film stack. Films may be dielectric, semiconductors, or metallic (absorbing). The optical properties of the various films and substrates are stored as tables of complex refractive index ( $n+ik$ ) versus wavelength. FilmEllipse™ comes with a large database of optical constants ( $nk$ ) which may be edited.

Up to three different wavelengths can be used in a single recipe with multiple angles of incidence. Maximum and minimum bounds may be placed on any unknown thickness or index of refraction.



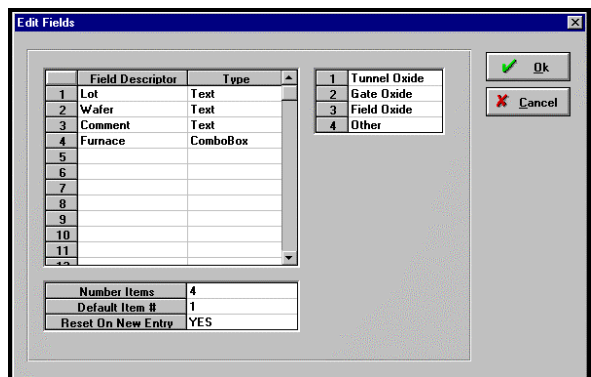
The 'Layer Settings' dialog box shows '# of Layers: 1' and '# of Waves: 3'. It features a table for 'Settings' with columns for wavelength and refractive index components. Below are sections for 'Index Settings' and 'Thickness Settings'.

Wavelength(nm)	$\lambda_1$	$\lambda_2$	$\lambda_3$
405	546.1	632.8	
Substrate N	5.424738	4.097514	3.881105
Substrate K	0.330372	0.043749	0.019383
Maximum N	1.5	1.5	1.5
Minimum N	1.4	1.4	1.4
Maximum K	0.1	0.1	0.1
Minimum K	0	0	0
N Of Layer 1	1.469582	1.46008	1.457053
K Of Layer 1	0.0	0.0	0.0

Layer Setting Dialog Box

## Database

One of the most attractive FilmEllipse™ features is the flexibility it gives the user in customizing FilmEllipse™ for entry and storage of user-defined fields. The engineer can specify up to 100 fields. The allowed field types include ComboBoxes, Yes/No, Text, Integer, Long, Single, Double, and Dates. In this way process dependent data can be stored along with the solutions in tab delimited files. The data files FilmEllipse™ generates can be readily imported into Microsoft Excel or Microsoft Access.



The 'Edit Fields' dialog box shows a table for defining fields. It includes a 'Number Items' field set to 4 and a 'Reset On New Entry' checkbox checked.

Field Descriptor	Type
1 Lot	Text
2 Wafer	Text
3 Comment	Text
4 Furnace	ComboBox
5	
6	
7	
8	
9	
10	
11	

Database setup