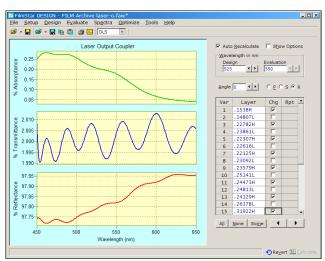# FILM★STAR *Optical Thin Film Software*

Introduction

FilmStar [tm] includes programs for designing, measuring and monitoring optical thin film coatings: DESIGN & INDEX, MEASURE, MONITOR and CRYSTAL.

Programs DESIGN & INDEX

Thin Film Design - Designs can contain virtually any number of layers defined by optical, physical or massive thickness. DESIGN supports evaluation and optimization in complex systems containing multiple substrates and spacers with films on some or all surfaces.

Capabilities include mathematical operations, Herpin replacement, optical to physical conversion, reverse design, inhomogeneous simulation, etc. Designs may contain up to 32K film materials. Design macros, with angle and wavelength matching, combine designs into filter assemblies. Program INDEX provides exceptionally convenient handling of filter glasses.

Film Indices - Indices are defined by constants, nk tables or dispersion functions. Built-in functions include Cauchy, Lorentz, Sellmeier, Maxwell-Garnet, Tauc-Lorentz, Bruggeman, etc. User-defined functions utilize up to three n,k tables and include angle/polarization effects. Using inverse synthesis, coefficients are determined from measured spectral data. Tables may be imported from Sopra and other sources.

DESIGN Interactor Screen

INDEX includes the following: 1. Calculate n,k from R&T for films of known thickness, 2. Calculate n,k from transmittance for slightly absorbing films, 3. Calculate filter glass dispersion from R&T data.
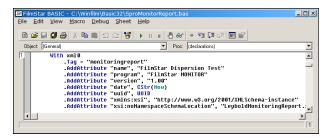
Calculated Quantities - Plot [%R, %T, OD, phase] vs. wavelength, angle or thickness. Modes include E-field, absorptance, ellipsometry, dispersion and color. An equation editor supports user-defined quantities. The Interactor lets users adjust all design parameters in a single screen. The FSPlot Module generates web and publication-quality graphs which may saved or printed in the Report Generator.

Optimization - Optimization and synthesis methods include DLS, LM, simplex, gradient, needle, flip-flop and genetic evolution. Targets at multiple wavelengths and angles include %R, %T, phase, Psi/Delta, etc. User-defined targets are supported.

Supplementing usual optimization targets, the FilmStar Workbook gives users unprecedented flexibility in meeting complex requirements. Examples: 1. AR coating where layers have specific ratios and total thickness requirements, 2. Satellite IR reflector meeting thermal constraints.

Optimization variables include layer thickness (optical, physical, massive), indices and tooling factors. Layer variables may be linked to preserve ratios. In inverse synthesis, targets are measured spectra; the starting design is the ideal design and the final design gives indices and thicknesses.

FilmStar BASIC - FilmStar goes beyond user-friendly menus and dialogs with VBA-like FilmStar BASIC. FilmStar is client-server compatible with *MS* Office and other popular programs. These capabilities offer powerful benefits.

FilmStar BASIC Development Environment

BASIC examples include OTFE (Optical Thin Film Exchange), cone-angle compensation, design export to Code V, FRED and Zemax, process export to Maxtek, spectra import from Shimadzu, Hitachi and Woollam, bandwidth plots, Excel and Word automation, etc. BASIC codes can be encrypted for security and assigned to macro keys.

For further information please visit www.ThinFilmSoftware.com

FTG Software Associates

FilmStar Workbook - The built-in Excel-compatible Workbook provides users with calculation and optimization facilities not available elsewhere.

This screen shot illustrates a beamsplitter optimized over an angle range and including a wavelength-dependent weighting function. P/S energy must be maximized. This is difficult, if not impossible, to set up with usual optimization targets.

Optimization in the FilmStar Workbook

FilmStar Free Version - Prospective users are invited to test the FilmStar DESIGN Free Version. The Free Version has restricted indices, but values are realistic and even include dispersive Ag and Al.

Program MEASURE

Optical films must be measured - not just designed. Optional program MEASURE controls and acquires data from spectrophotometers. It is highly integrated with DESIGN and provides an alternative to the unsuitable chemists' software supplied by instrument manufacturers. No other coating software directly controls spectrophotometers.

MEASURE Scan Method for PE 881

Supported instruments include PerkinElmer Lambda 2-1050 and Spectrum FTIR, PE 580B-983, Cary 1-7000 (UMA), Agilent/HP 8453, Hitachi U-3210/3410, Ocean Optics, StellarNet, and Nicolet FTIR. Please contact us about other instruments.

Program Modes - %T, OD, T^2 (variable angle accessory), %R (V, VW, URA). Wavelength units: Ångstroms to 1/cm. Data types: Sample, Baseline, Reference (*i.e.* empty sample compartment or known reflector), and Standard files. Spectral data can be utilized in DESIGN for inverse synthesis.

Scan Range - Scan Range is defined by minimum, maximum and interval wavelength or wavenumber. A Wave List can also be specified. This is useful when optics have differing characteristics in different bands, ie. blocking regions and transmission regions.

Additional Features - MEASURE includes FSPlot, the Workbook, FilmStar BASIC, and Report Generator. Users can automate QA procedures and measurements. MEASURE can control ancillary devices such as temperature controllers and PLCs via software or hardware (serial port) commands.

MEASURE supports the FilmStar Database (see Page 4). This link to the FileMaker Pro application provides means to store spectra in secure password-protected files. Records created by MEASURE can be retrieved and analyzed in DESIGN.

Program MONITOR

Coatings must be manufactured - not just designed. Optional program MONITOR converts designs to optical monitor recipes. MONITOR far exceeds the capabilities of monitoring curves typically provided in thin film design software (including our own).

Coating Chamber Parameters - These include tooling factors and spectral response. There are numerous options: vary wavelengths between chips or between layers on a chip; use previous turning points or previously coated chips; vary gain and offset for any layer. Wavelength calibration is included (critical when monitoring at widely separated wavelengths, but often neglected). As coating indices may differ from final values, two dispersive index files are utilized simultaneously.

Film Indices and Calculation Parameters appropriate for manual or automatic monitoring modes are stored as Parameters files. Typically each coating chamber has its own file. Film designs may be loaded from disk or pasted from the clipboard. Designs containing repeated layer groups, i.e. (.25H .25L)10 .25H, are converted to individual layers.

Witness Chip Manager - Users can assign or reassign any number of layers per chip. Different indices can be assigned for each witness chip.

MONITOR Witness Chip Manager

Calculated Monitor Quantities - MONITOR calculates signal changes as typically observed on a strip-chart. In effect each monitor witness chip or spot is treated as a unique thin film design.

Interactive Worksheet - The user starts by assigning default wavelengths. Wavelengths for each layer are then adjusted for optimum sensitivity and selectivity. Any layer can be changed in any order and new layers inserted without affecting prior settings. Colors indicate suitable wavelengths.
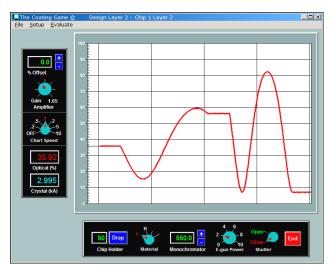
Settings for thin layers utilize turning points in previous layers. MONITOR supports optical monitors which allow re-use of previously coated witness spots.

Coating Run-Sheet - Once monitor wavelengths are determined, results are converted to printed run-sheets (manual monitoring) or machine settings (automatic monitoring). Run-sheets can be modified by user-defined local language templates. Automatic monitors include Balzers (Evatec) GSM-420, Eddy LMC, Leybold and Intellemetrics.

MONITOR Interactive Worksheet

Run-sheets may include design description, design file name, date, reflectance and transmittance values, etc. Run-sheets with helpful embedded strip-chart simulation plots are printed directly by MONITOR.
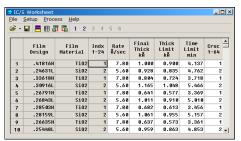

Coating Game Simulator

The Coating Game - Does the operator understand the run-sheet? This unique module provides means to train operators prior to actual coating runs.

Program CRYSTAL

Optional program FilmStar CRYSTAL converts thin film designs to deposition processes for Inficon controllers. CRYSTAL eliminates the tedious and error-prone input of layer thicknesses.

Parameters - Film indices and calculation parameters appropriate for the specified controller are stored as Parameters files. Typically each coating chamber has its own file. Film designs generated by FilmStar DESIGN may be loaded from disk or pasted from the Windows clipboard. An Extended Materials manager supports up to 100 film materials.

Layers Manager - This dialog displays the number of layers stored in each process as well as the total number of new layers that may be added. Unused film processes can be stored on disk and deleted from the controller's memory.

CRYSTAL Worksheet

Worksheets - Worksheets may be loaded from disk, calculated from a design, manually edited, uploaded to the deposition controller, downloaded from the controller, and stored. Worksheets can be modified with FilmStar BASIC or transferred to Excel. Users can, for example, automatically adjust thickness settings to compensate for systematic errors. *This is a secret for success with crystal thickness monitors!*

Advanced Features

FilmStar modules BASIC, the Workbook, FSPlot and Report Generator all work together. This provides unprecedented power and flexibility beyond the choices displayed in menus and dialog boxes.

FilmStar is highly integrated with other Windows applications via COM. Data and commands can be imported and exported. DESIGN and MEASURE can be embedded within users' programs.

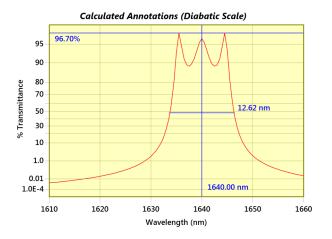## System Requirements

FilmStar runs under Windows XP and newer.

Further Information

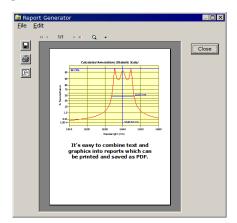More detailed and frequently updated information about FilmStar can be found on the FTG web site at

http://www.ftgsoftware.com

Additional Features

FSPlot Module - This powerful facility in DESIGN and MEASURE generates professional web and print graphics. As illustrated below, annotations are automatically calculated in FilmStar BASIC. A primary application is quality assurance where one can show performance and specifications on the same plot. The Schott *diabatic* scale deserves wider utilization.
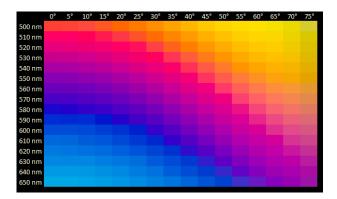

Report Generator - This module in DESIGN and MEASURE is useful for proposals, data sheets, catalogs, quality assurance, etc. Reports can be automated and include a logo, boilerplate text, etc. Reports can be saved as PDF files. The same technology is used to print run-sheets in MONITOR.
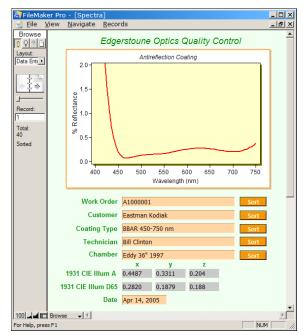

Compatibility with Popular Software - FilmStar combines thin film software with general purpose software such as Excel. The advantages are enormous!

FilmStar can automatically create or utilize Excel workbooks without the user running Excel. Advantages include accuracy and security.

As shown below, Excel also runs FilmStar. The code for this is freely available on our website and can even be utilized in the Free Version.

The screen shot below illustrates how popular database software provides means to securely store, track, sort and recall thousands of spectral curves. Data is automatically saved in MEASURE and immediately available to engineers using DESIGN.

Managing Coating QC with FileMaker Pro

To learn more about FilmStar we suggest an on-line presentation in the convenience of your own office.

To learn how this works and test your computer system for compatibility, please visit http://ftgsoftware.com/glance.htm.