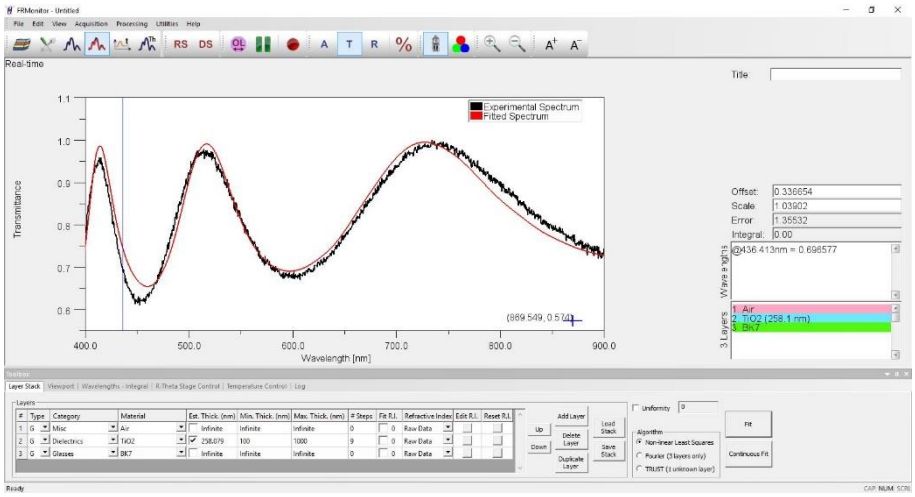
TRANSMITTANCE MEASUREMENTS

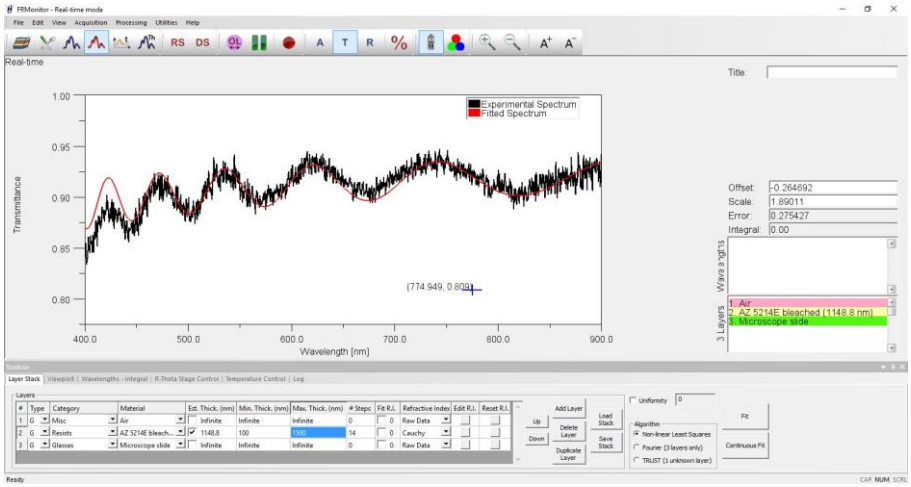
With FR-tools, transmittance measurements of semi-transparent and transparent samples can be performed as well as, of supported and un-supported (suspended) films.

If the absorption in the film and the substrate is very small or even negligible, film thickness may also be determined from transmittance. Such measurements are shown below.

MEASUREMENT OF THE THICKNESS OF SUPPORTED FILMS



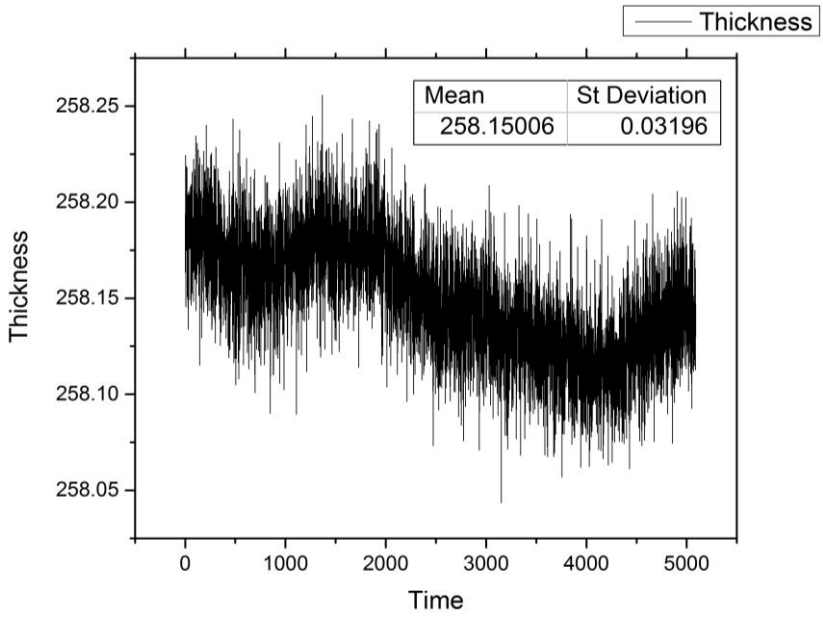
TiO_2 on BK7 glass. TiO_2 film thickness: 258.1 nm.



AZ5214 resist on microscope slide. AZ5214 film thickness: 1.1 µm.

PRECISION, MEASUREMENT STABILITY ON THICKNESS MEASUREMENT

Measurement stability has been tested for a 258.1nm TiO_2 thin film on BK7 glass. In the following plots the precision and measurement stability are illustrated. All measurements were performed during at an exhibition on a standard table without any precautions on environmental light and temperature stability.



TiO_2 film thickness measurement over a period of 2hours (x-axis is in seconds).

ACCURACY ON TRANSMITTANCE SIGNAL

Transmittance measurements of colour filters.

Transmittance measurements on #01 (Light Bastard Amber) and #04 (Medium Bastard Amber) colour filters made by Rosco Laboratories were performed using a FR-pOrtable, operating in 370-1020nm spectral range. Additional transmittance measurements were taken on both samples using a Perkin Elmer Lambda 40 spectrometer, a high precision table spectrometer. The obtained results were compared with the Spectral Energy Distribution (SED) curves given by the manufacturer.

Results:

The measurements of transmittance (%) as a function of wavelength (nm) for colour filters #01 and #04 are summarized in the following figures, left and right, respectively. It should be noted that the reference values (Rosco Label) were obtained after digitization of manufacturer's SED curves, in order to acquire data that are more accurate.

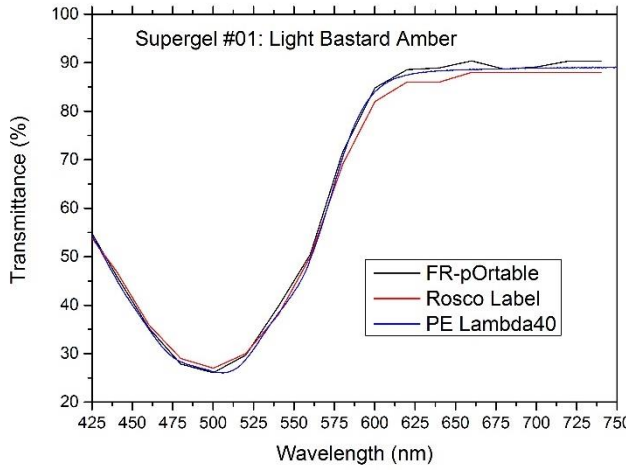


Figure 1

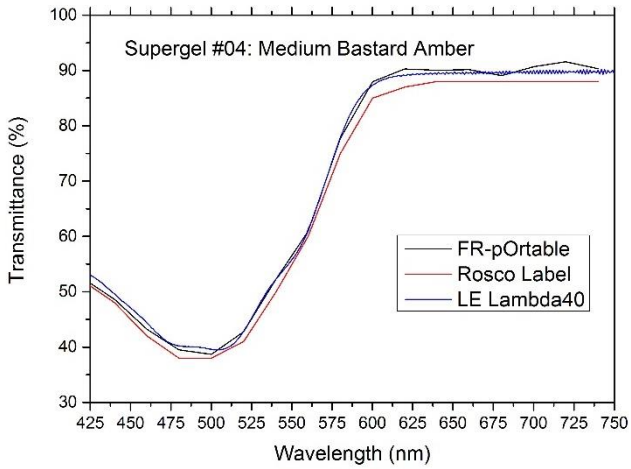
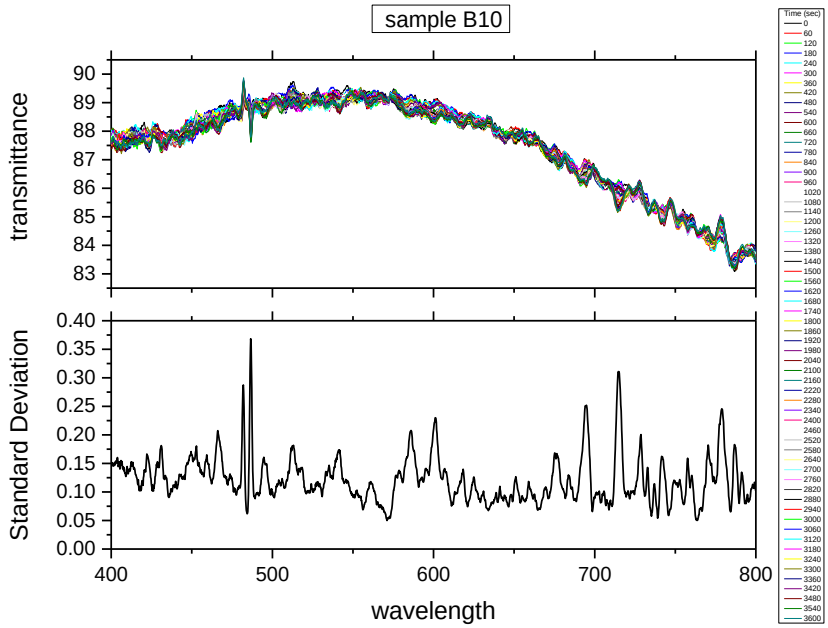


Figure 2

PRECICION, STABILITY ON TRANSMITTANCE SIGNAL

Stability over an hour

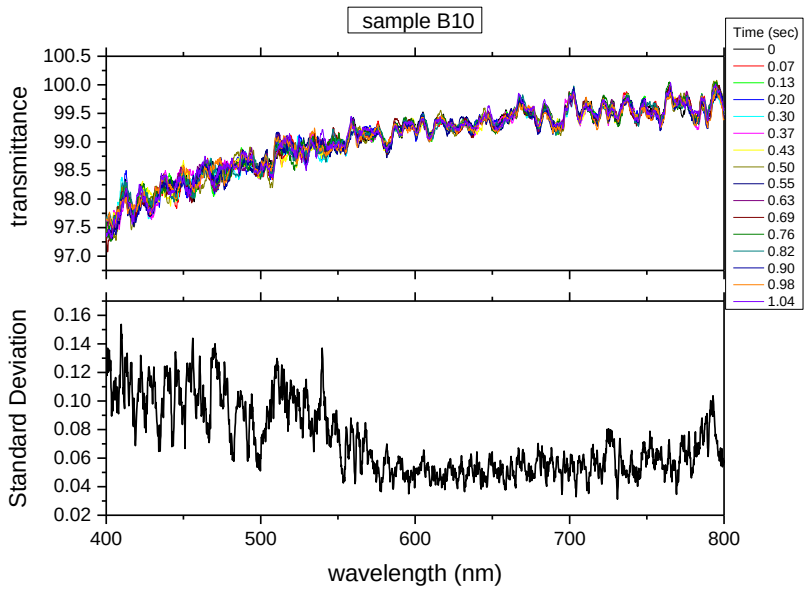
The stability of transmittance measurements (following figure– top) was tested by taking measurements of a glass sample coated (named B10) with AR coating for one hour, with a rate of 1min. The standard deviation (following figure - bottom) of the transmission values acquired for each pixel of the spectrometer for each measurement, express the noise of the system, and was found to be 0.10%. High noise values found only in wavelengths related with the high peaks of Deuterium lamp (e.g. 486nm, 656nm), which can be avoided in case there is no requirement of measurements in the UV region, using an hybrid LED - Halogen light source.



Transmittance values (%) acquired in 1hour and standard deviation obtained on sample B10.

Stability of 15 measurements over a second

Stability measurements were also performed for the condition of 15 measurements per second. The examined sample was again a glass with AR coating by taking as reference a sample of the same glass without the AR coating. The transmittance data and the standard deviation for each case are shown in the following plots.

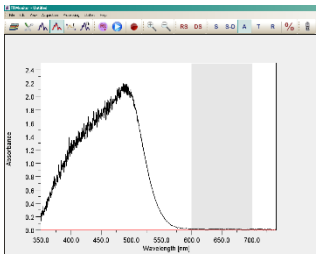


Transmittance values (%) and standard deviation of 16measurements/sec on sample B10.

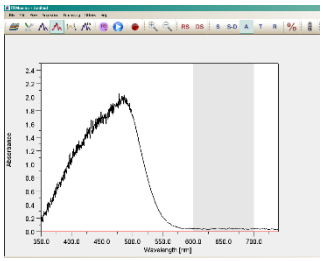
DETERMNINATION OF SUBSTANCE CONCENTRATION IN SOLUTIONS

FR-pRo, offers a wide range of accessories to be used for numerous applications. For example, FR-pRo is combined with the FR-Film/Cuvette holder operate as a standard spectrometer for the measurement of the absorption of solutions in standard quartz/glass/plastic cuvettes. In the following graphs such measurements in the VIS/NIR spectral range (recorded by an FR-pRoc VIS/NIR) are illustrated. Methyl orange and Methylene blue aqueous solutions were examined.

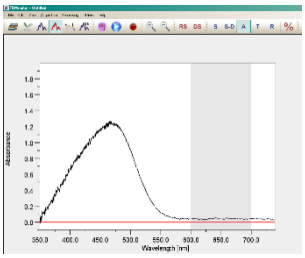
Methyl orange is a pH indicator and has a pKa of 3.47 in water at 25°C. The absorption spectra as they recorded through FR-Monitor are illustrated in the figure below for four different concentrations. As the hydrogen ion is lost or gained there is a shift in the exact nature of the delocalisation in the molecule, and that causes a shift in the wavelength of light absorbed resulting in a colour change. Dilution in deionized water, where equal amounts of the red and yellow forms are present and so methyl orange looks orange, doesn't affect its initial chromophore. The examined concentration range, below 10^{-3}M, is following the Beer-Lambert Law where Absorbance is a linear function of the molar concentration (A=εbC). Thus, calculation of the molar absorptivity (or molar absorption coefficient, ε) of the examined chemical compound is attainable. The measurements are performed at 507nm according to Sigma-Aldrich specifications and the results are in good agreement with the literature.



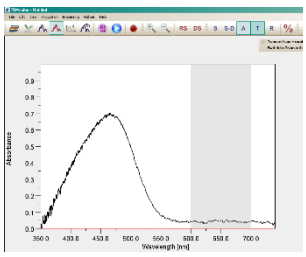
50mg/L≈0.15mM



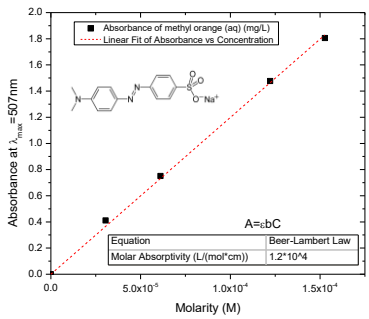
40mg/L≈0.12 mM



20mg/L≈0.06 mM

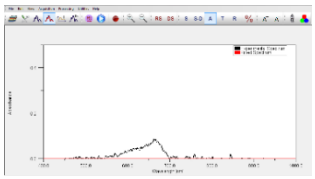


10mg/L≈0.03 mM

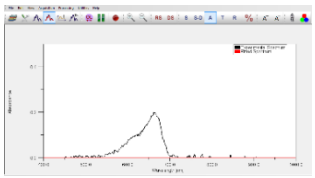


Absorbance calibration curve of methyl orange at 507nm at 25°C.

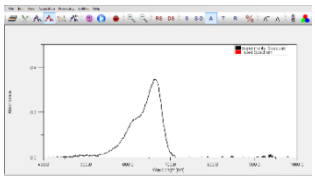
Methylene blue aqueous solutions show absorbance in visible region due to involving of π-π*and n-π* transitions present in molecules. The concentration range is following the Beer-Lambert law where Absorbance is a linear function of the molar concentration (A=εbC). Thus, calculation of the molar absorptivity (or molar absorption coefficient, ε) of the examined chemical compound is attainable. The absorption measurements are performed at 668nm according to bibliography and the results are in very good agreement with the literature.



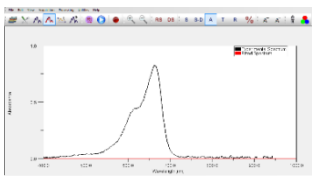
1.56*10^{-6}M



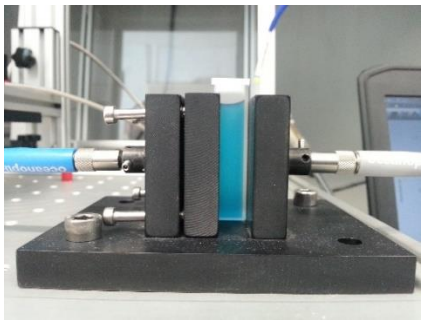
3.12*10^{-6}M



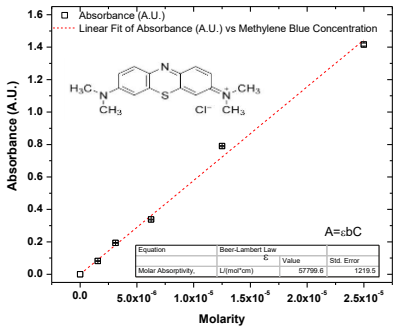
6.25*10^{-6}M



1.25*10^{-5}M



Measurement Set-up



Absorbance calibration curve of Methylene Blue at 668nm at 25°C.