



*Thin Film Measurement solution
Software, sensors, custom development
and integration*

Updated: September 2017

MProbe : QUICK SETUP

The Purpose:

This document describes the setup of a new MProbe system and taking the first measurement. It is intended as a quick introduction.

Please refer to the “System test” document supplied with your system for more details on configuration and measurement specific to your system.

The following instructions assume that the MProbe system, cables and accessories have been unpacked and that you have a computer with Windows OS (Vista/Windows7/Windows10). Minimum 2GHz CPU, 2GB RAM and 100GB free HD space are recommended.

Estimated time: 10-15 min

Tools: No tools required

Power requirements: MProbe system uses universal power supply that is working with 220V/50Hz and 110V/60Hz. MProbe Vis consumes <20W, MProbe UVVis/UVVisNIR requires <60W.

In depth description of software functionality, measurement procedure options and application examples are presented separately and are not part of this document.

Fiberoptics

MProbe is using fiberoptics reflectance probe for illumination and “reading” of reflected intensity from the sample. Our standard reflectance probe is using 400 μm core silica fibers. Probe ends are marked “Illumination” (this end is connected to the light source connector) and “read” (this end is connected to the spectrometer input), the common end is connected to the focusing lens. Reflectance probes are color coded: yellow boot – for visible/NIR light probe, green boot- for UV probe. Mixed probes (UV/NIR) have both UV and NIR ends (color coded).

I. Setting – up the system.

1. Install TFCompanion software from CD and update it to the latest version (installation and update instructions are on CD). DO NOT CONNECT USB CABLE TO MPROBE BEFORE SOFTWARE IS INSTALLED.
Note. If computer was included with your system – software is already installed and configured – please skip this step.
2. Connect MProbe to computer using USB cable (USB socket located on the back panel of the instrument). Plug USB socket fully and switch on the power. Windows should detect USB device drivers and automatically install them. MProbe unit may include one or two spectrometers (depending on the model) and a separate microprocessor. Microprocessor driver is installed automatically on Windows 7/10. On earlier Windows versions a microprocessor driver installation is required (instructions and driver are in the /cdcdriver directory on the memory stick)

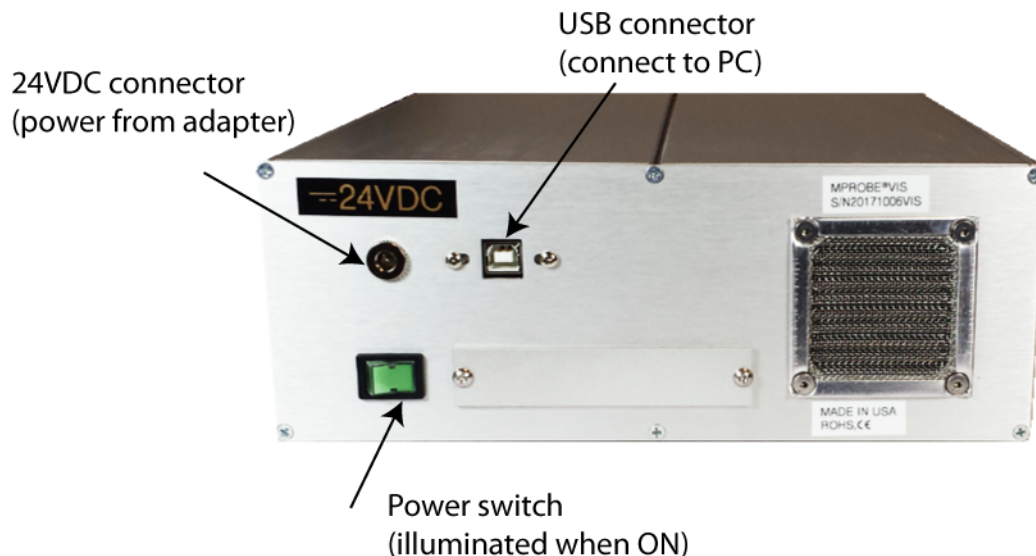


Fig. 1. Back panel of MProbe system (all systems except UVVisF)

3. When power is switched ON (on the back panel), microprocessor is activated in all system
 - a). For MProbe Vis,NIR, VisNIR and UVVisNIR – the 5W TH light source is activated. The initial intensity is programmed in the microprocessor during testing. The light will shine from the SMA adapter marked “Illumination”.
 - b). For MProbe UVVisSR, UVVisNIR systems the light is switched on only when corresponding buttons on the front panel are switched ON.
 - c). In case of the flash lamp, the strobes need to be started from the software. The front panel button can be used to switched on/off lamp after is was activated by the software.
4. Plug-in USB dongle (hardware license) in one of the USB ports on the computer



Warning! Never look directly in the incoming light. This is especially dangerous if UV light is switched on. Permanent eye damage and blindness can occur.



Fig. 2 The front panel of the MProbe Vis (or VisNIR) system

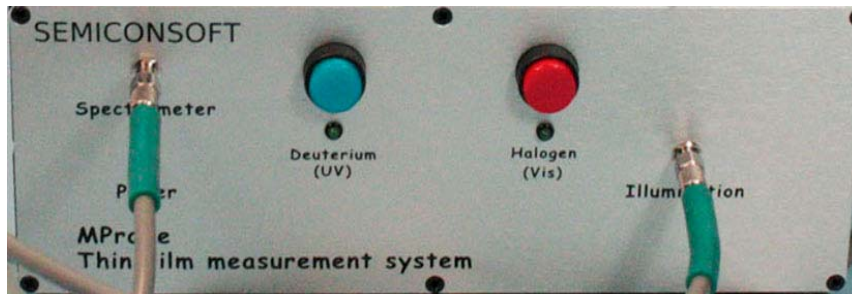


Fig. 3 The front panel of MProbe UVVis system

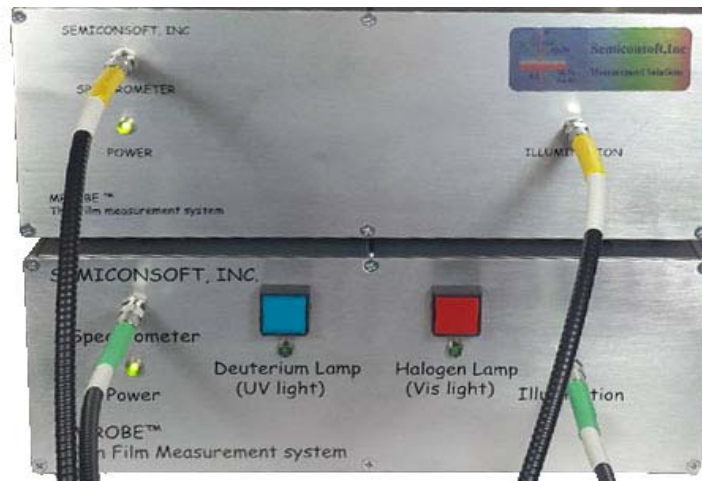


Fig. 4 The front panel of MProbe UVVisNIR system. Notice two separate spectrometer inputs: use Yellow coded end of reflectance probe for IR channel (Green for UVVis channel)

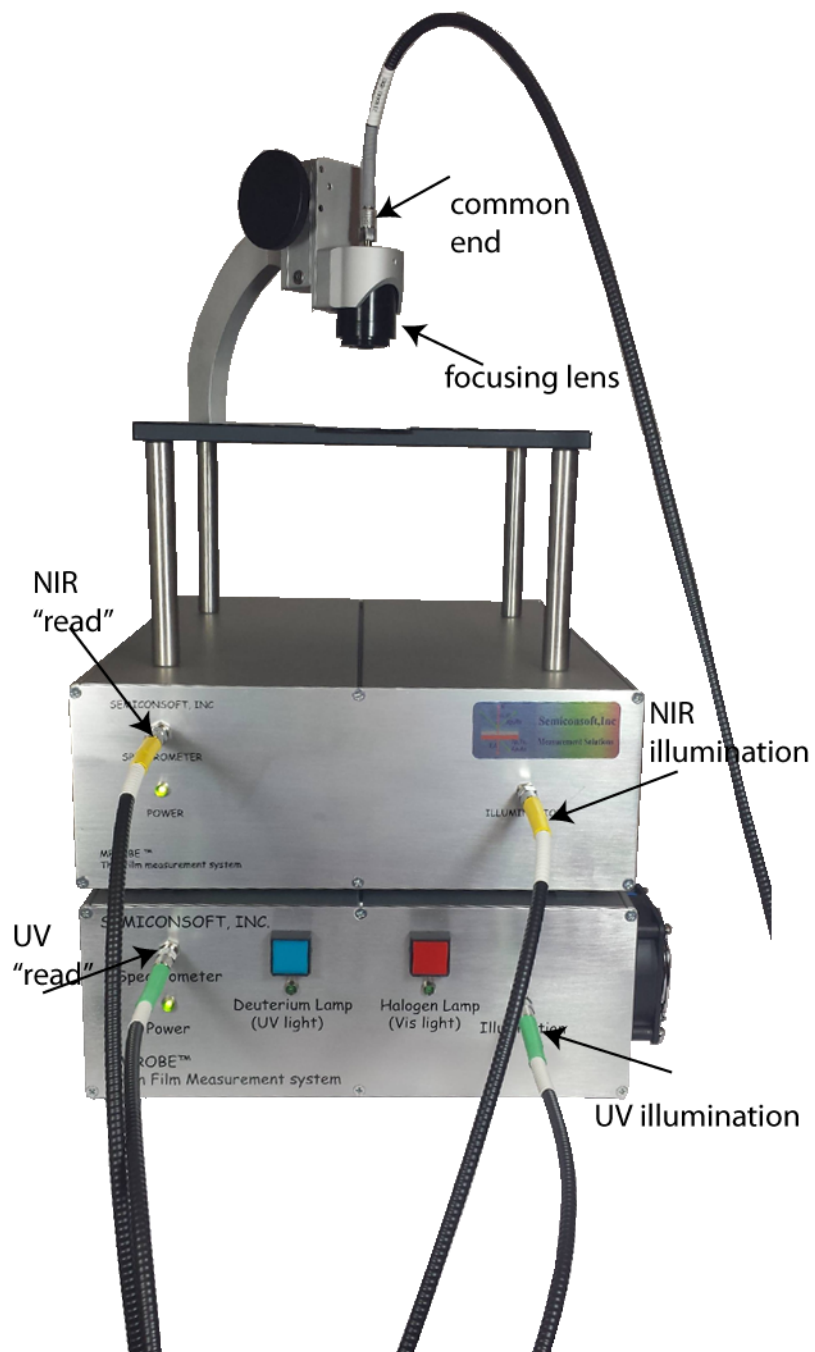


Fig. 5 UVVisNIR system fiberoptic connections.



Fig. 6 The front panel of MProbe UVVisF (with Xe flash lamp)

5. Remove the dust covers from SMA adapters on the front panel (there are two SMA adapters: “Illumination” and “Spectrometer”)
6. Connect Reflectance Probe SMA terminated legs to SMA adapters on the front panel of the instrument. “Spectrometer” end of the reflectance probe is marked as “Read”.

Note. In case of in-situ system with oblique incidence configuration – two separate fiber optics cable are used instead of reflectance probe.

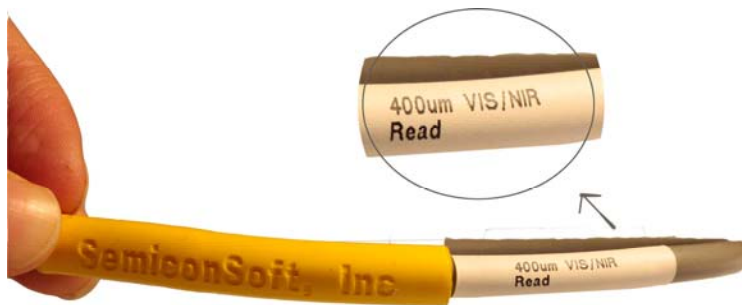


Fig. 7 Reflectance probe’s leg connected to spectrometer input SMA adapter.

Note. Fiber marking can be directly on the jacket sleeve or heats shrink (as shown)

7. Connect other leg of reflectance probe (marked illumination) to the SMA connector “Illumination” (light source)



Fig. 8. Illumination leg marking of reflectance probe

Note. Fiber marking can be directly on the jacket sleeve or a heat shrink (as shown)

8. Attached common end of the Reflectance probe to SMA connector of the focusing lens and put Si reference sample on the table.
Note. SH200A stage uses different lenses depending on the system configuration: VisACH lens for Vis, VisNIR and NIR system and UV quartz lens for UV or UVVisNIR systems.

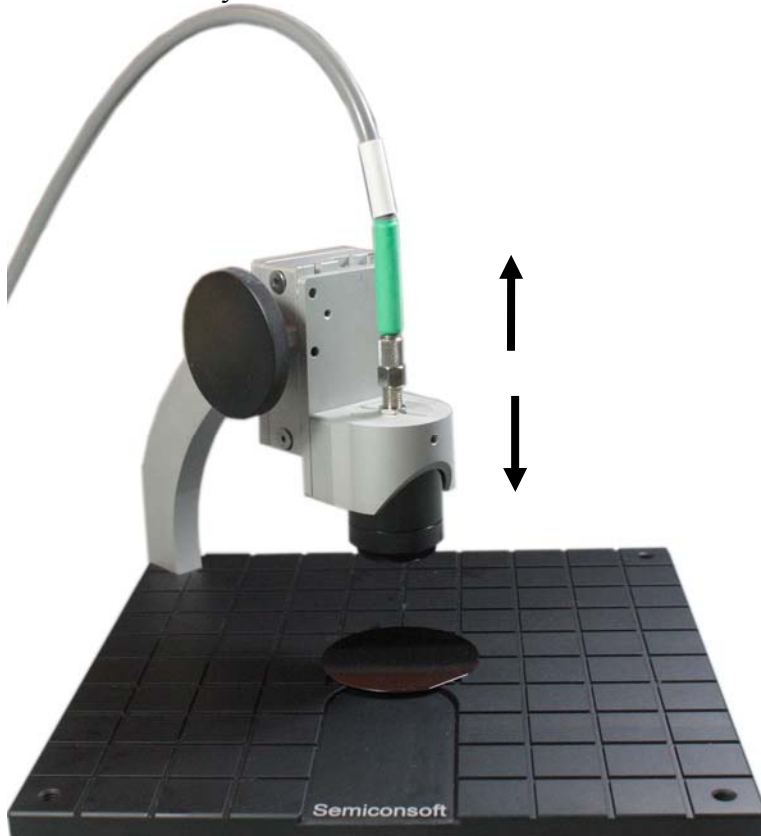


Fig. 9. SH200A stage (standard reflectance configuration)

9. Start TFCompanion software. Select “Admin_hdw” user, password: psw (You can create individual users/profiles later for each user with different privileges). During the first use, TFCompanion will configure the system based on information stored in the firmware, it will select and load a suitable measurement recipe for use with system.

After software is started – you should see signal monitor showing signal from spectrometer. Light intensity of TH lamps is controlled by the software – intensity slide is accessible in the Signal Monitor

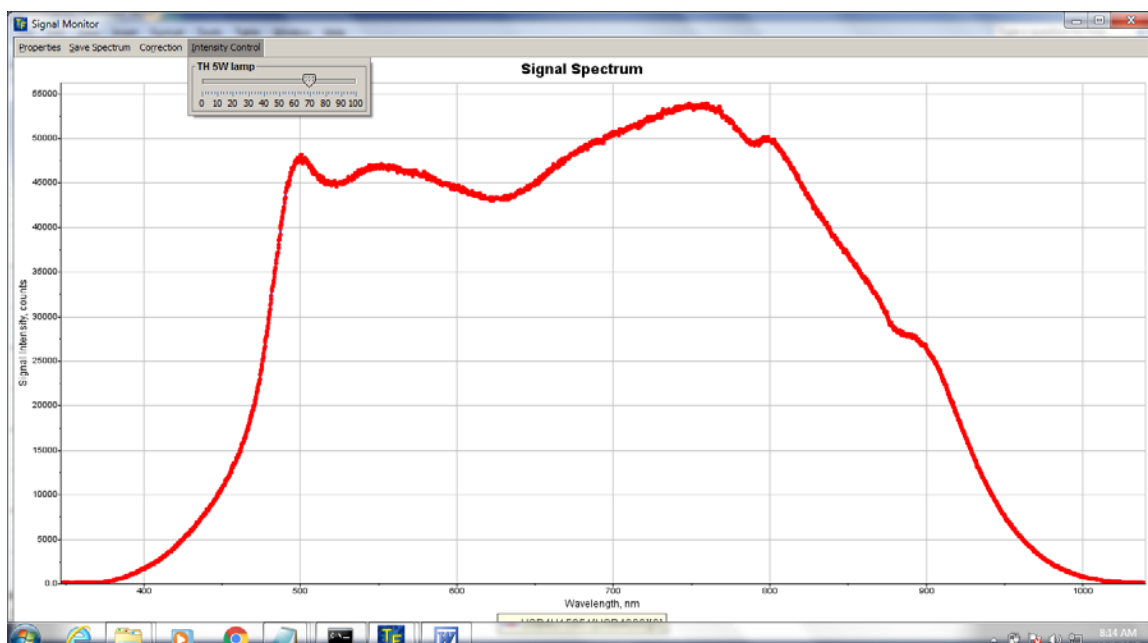


Fig. 10 Signal monitor displaying raw signal from Si (MProbe Vis system). Intensity slide for 5W lamp is shown.

See TFCompanion set-up tutorial for detailed instructions.

10. Adjust the distance between reflectance probe and the sample for a maximum signal. (VisACH lens has WD~ 65mm, UV lens has WD ~ 40mm). Integration time for MProbe Vis system is, typically, in 10ms -30ms range. For MProbe UVVis is, typically, in 20ms-50ms range. Note. Integration time is given for the full signal (16bits ~ 65000 counts) reflectance from Si sample.

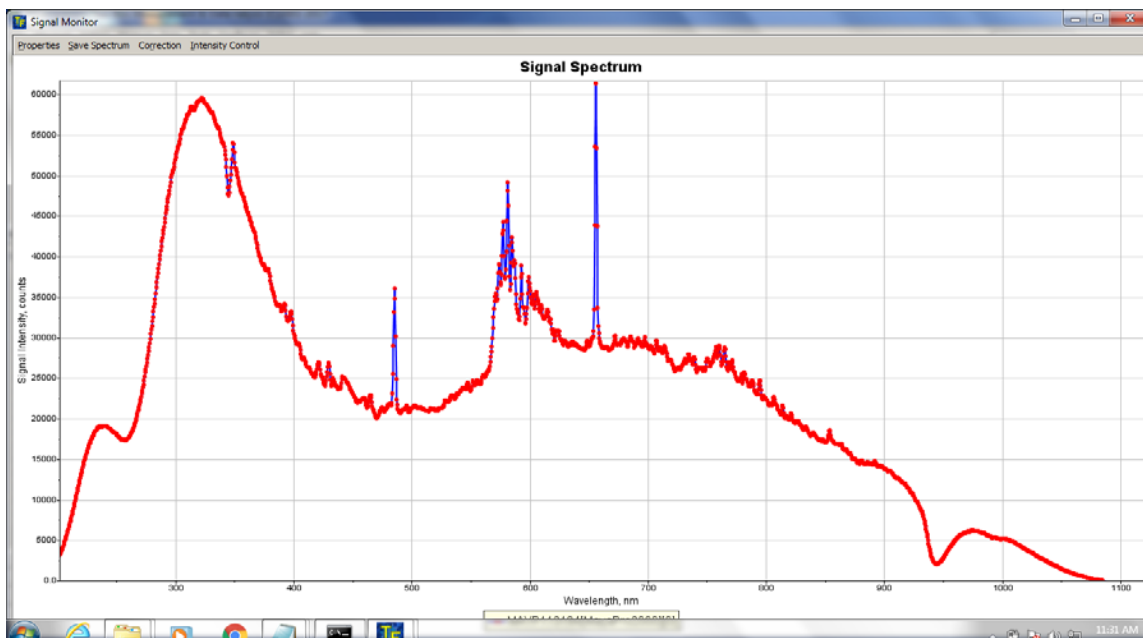


Fig. 11 MProbe UVVisSR: typical raw reflectance signal displayed by Signal Monitor (reflectance from Si wafer)

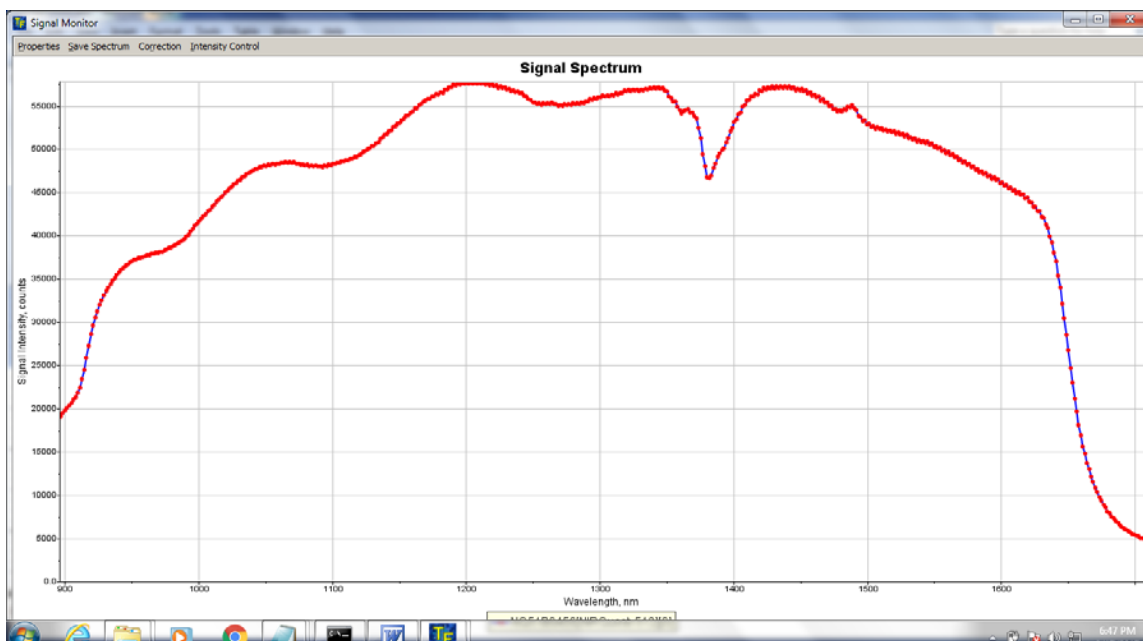


Fig. 12 MProbe NIR – raw reflectance from Al

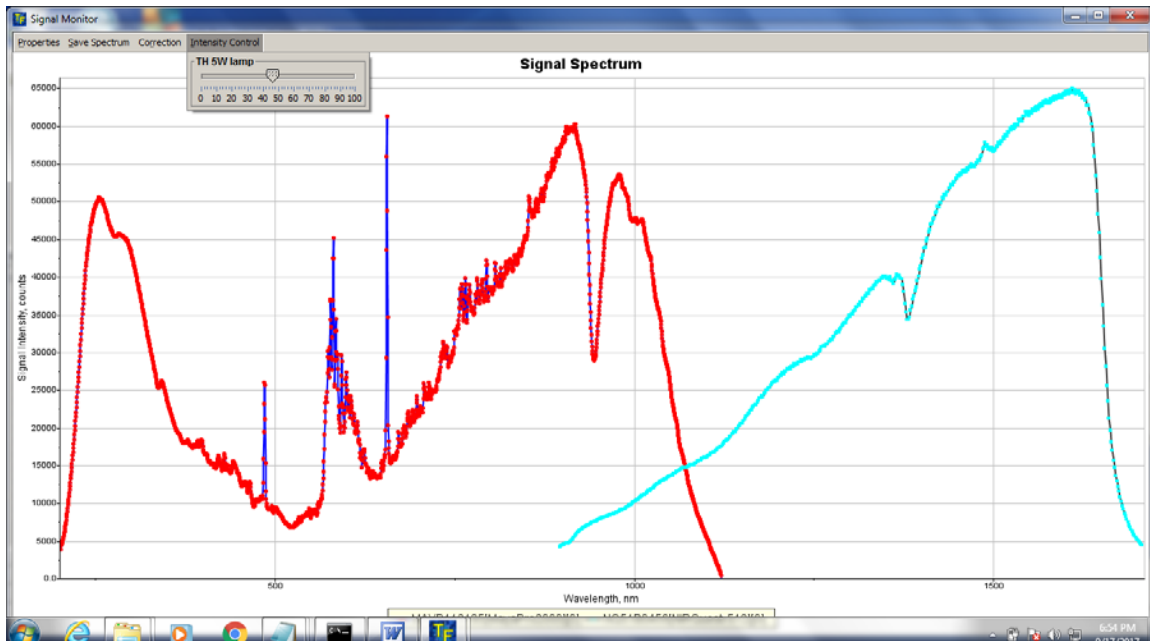


Fig. 13 MProbe UVVisNIR – raw reflectance from Al

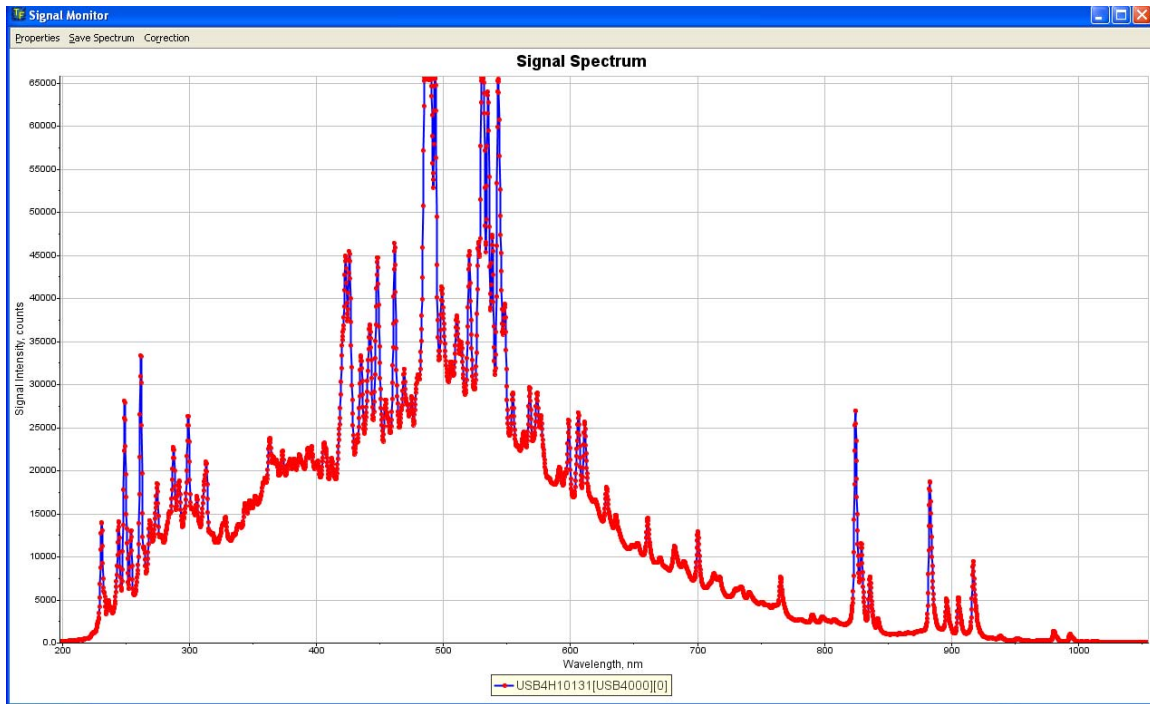


Fig. 14. MProbeUVVis (Xe Flash lamp) typical raw reflectance signal displayed by Signal Monitor (reflectance from Si wafer)

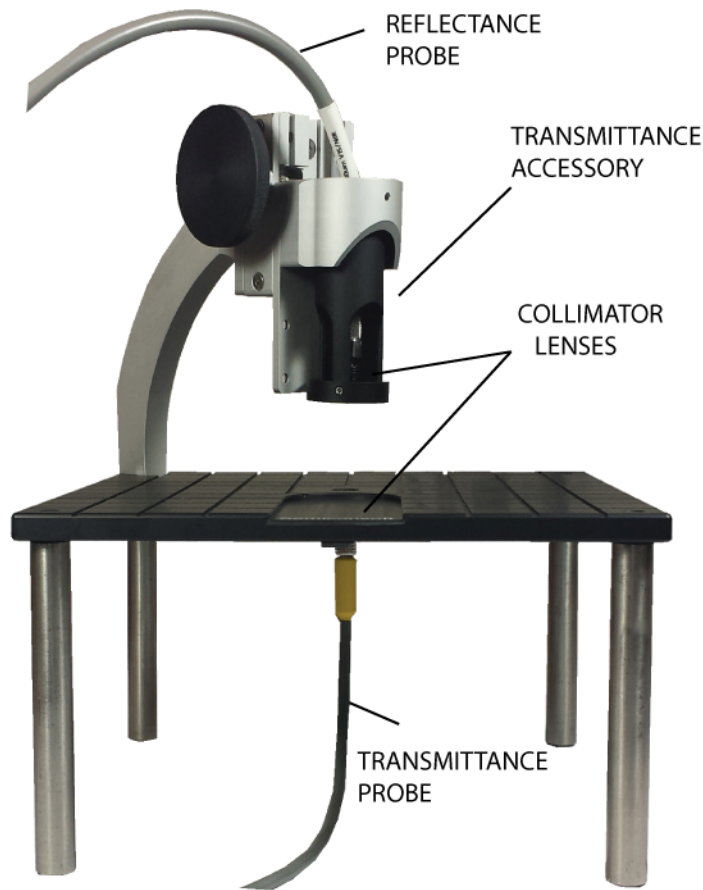


Fig. 15 SH200A sample in transmittance configuration.

Focusing lens is replaced with the transmittance accessory. It maybe necessary to align collimator lenses.

II. Sample Measurement

Measurement of the test sample. For MProbe Vis/ UVVisSR/UVVisF (also UVVis part of the UVVisNIR system) we use a 200nm SiO₂ sample. For NIR, typically, use Al or Quartz plate sample.

MProbe performs spectroscopic reflectance and/or transmittance measurement. Physical properties of the sample are determined/inferred from the fit of the filmstack model (representing the sample) to experimentally measured data or using FFT , in case of the thick films.

MProbe controls the measurement process using measurement recipes. During the first startup TFCompanion select and adjust a measurement recipe for the system. Typically, this recipe will be automatically loaded. You can also select/load a specific recipe from the list.. MProbe database includes several optimized recipes (see Appendix I) – it is recommended to use these recipes for best measurement precision.

Measurement, actually, includes two steps:

- a). taking spectroscopic measurement
- b). analyzing the data to determine physical properties of the sample (thicknesses and n, k values of the layers).

Note.. Measurement recipe with names ending “_raw” – measure just Reflectance or transmittance spectrum – without calculation step. Recipes with the name ending “_calc” do measurement and calculation.

Measurement recipe can handle both steps smoothly and transparent to the user.

Before taking measurement, instrument need to be calibrated. Reflectance calibrations is done using a sample with known reflectivity – the default calibration sample is bare Si (other samples like Al or Quartz plate can be used as well but it need to be set explicitly in software configuration). The purpose of the calibration is to match measured light intensity with the known reflectivity. It is important that calibration and measurement are done at the same conditions. This means that light intensity should not changed after calibration is done. And in particular, that the distance between the probe and calibration sample has to be the same as the distance between the probe and the measured sample. SH200A stage has a fine lens adjustment for cases when sample substrate is different from the calibration substrate

Place calibration sample (bare Si) on the table.

1. Select the measurement recipe (**Refl_Vis_Calc** or **Refl_UVVis_Calc**)
2. Select Baseline button
3. Follow the prompt to first calibration step : measurement of calibration sample
4. Follow the prompt to calibration step 2 (measurement of dark current/background). Remove the sample and place black pad on the table (for face-up configuration).
5. When calibration is completed – the results are displayed .
6. Place the oxide sample on the table and click ”Measure” to proceed.

You should see measurement results like on Fig. 16/17 below.

Note. We rely here on the fact that software loads a default filmstack oxide2000 (SiO₂/Si) at start-up. When you measure different type of the sample – you need to change to a corresponding filmstack. See details in the Measurement Guide: MProbeMeasurement101.

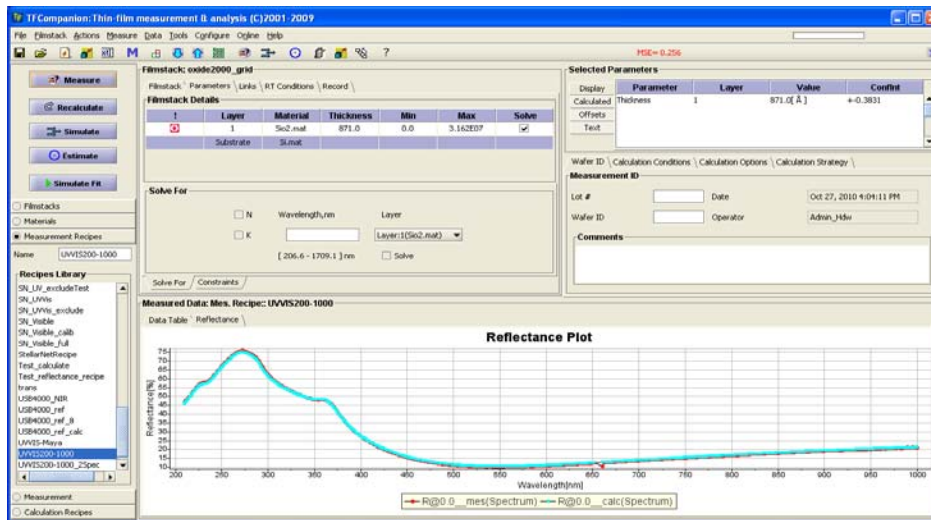


Fig. 16 MProbe UVVisSR measurement of SiO₂ (nominal thickness 100nm)

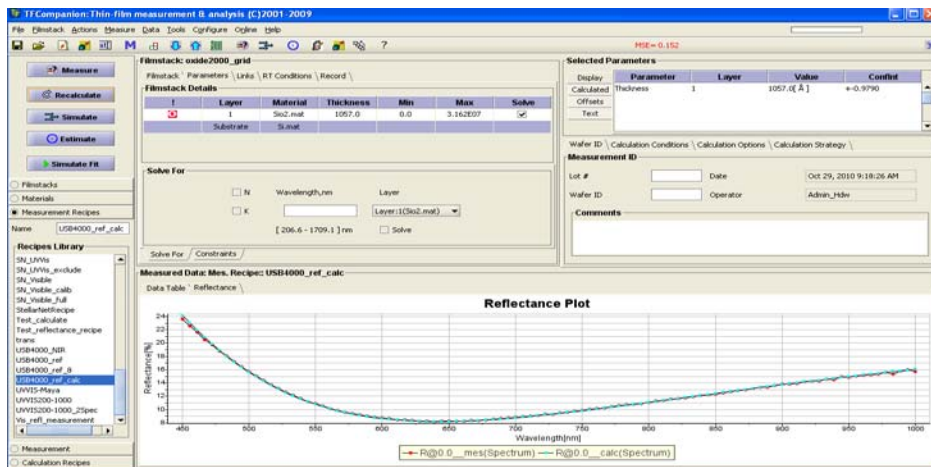


Fig. 17 MProbeVis measurement of SiO₂ (nominal thickness 100nm)

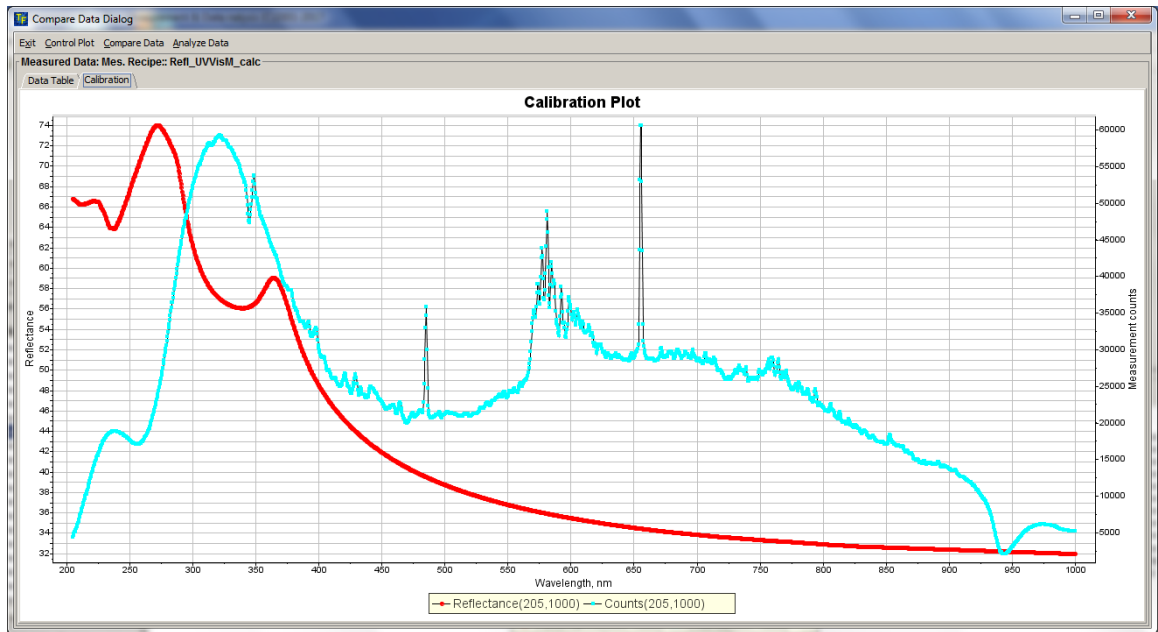


Fig.18 MProbeUVVis calibration chart. Blue actual intensity measurement, red – Si reflectivity

III Specifics of using UVVis system with the flash lamp.

1. Xe emits very short flashes of light that are triggered by the TTL pulses.
There are two operational modes that are supported in MProbe system:
 - a). Single strobe. In this case, the strobe is synchronized with the data acquisition cycle. The user can specify a delay of the strobe relative to the start of acquisition cycle (delay of 10 to 100 μ s is typically used)
 - b) Continuous strobe. In this case, used can specify the frequency of the strobes – there will be no synchronization with the acquisition cycle. Note. Maximum frequency with full intensity is < 50Hz. Decreasing the intensity allows higher frequency

For thickness measurement Single strobe mode is preferable.

2. Starting the lamp and selecting the mode.
Use Actions/FlashLampController (FlashLamp plug-in need to be installed to support this functionality)
Select “Enable Lamp” to start the lamp or deselect it – to stop the lamp.



Fig. 19. Flash lamp control

NOTE 1. When the “Single strobe” option is selected to enable the lamp, the strobe is synchronized with spectrometer data acquisition cycle. Spectrometer is typically in the free running mode with the integration time of ~ 20ms. Select “Measure/Intensity monitor” from the main menu and set the integration time to check synchronization of the pulses.

3. Measuring with the flash lamp.

Intensity of the lamp need to be adjusted in software (using slide in Intensity **Flash Xe** spectrum has few sharp peaks around 500nm. Unless these peaks are excluded in the software, dynamic range can be very limited. To exclude the peak one needs to remove small portion of the spectrum (few nm) so there is a trade-off. Normally, intensity is adjusted depending on the application and saturated (flat) portion of the peaks is defined to be excluded in the measurement recipe.

IV. GPIO input/output

In-situ systems typically have GPIO input/output. This provides 5 ports that can be programmed to create +5V TTL signal. It can input mode, they can accept +5V TTL external triggers, or output mode

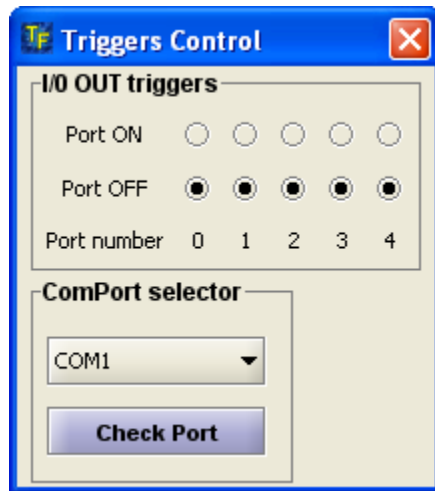


Fig. 20 Triggers can be tested/configured using Trigger control Panel (Configure/ConfigureGPIO). GPIO plugin need to be installed

Appendix I. Measurement recipes

MProbe measurement process is controlled by a measurement recipe. If no recipe is loaded – user is prompted to select a “default” recipe type and the recipe is created automatically. Default recipe is using the full range of the spectrometer and all pixels of the CCD. In many cases, the signal at the end points of spectrum is too weak and averaging/ smoothing several pixels works better as well.

Recipes database include several optimized measurement recipes that can be loaded and used for measurement.

Below is a list of included recipes with description.

“_Raw” recipes allow to collect reflectance or transmittance spectrum and perform data analysis separately. “_Calc” recipes integrate data collection and data analysis.

Recipe Name	Applicable system	Description
Refl_Vis_Calc	MProbe Vis	Reflectance measurement with automatic data analysis
Refl_Vis_Raw	MProbe Vis	Reflectance measurement :only reflectance spectrum – no automatic data analysis
Trans_Vis_Raw	MProbe Vis	Transmittance measurement :only transmittance spectrum – no automatic data analysis
Trans_Vis_Calc	MProbe Vis	Transmittance measurement with automatic data analysis.
Refl_UVVisM_Calc	MProbe UVVisSR	Reflectance measurement with automatic data analysis. Deuterium alpha line exclusion
Refl_UVVisM_Raw	MProbe UVVisSR	Reflectance measurement only: no automatic data analysis. Deuterium alpha line exclusion
Trans_UVVisM_Calc	MProbe UVVisSR	Transmittance measurement with automatic data analysis. Deuterium alpha line exclusion
Trans_UVVisM_Raw	MProbe UVVisSR	Transmittance measurement only: no automatic data analysis. Deuterium alpha line exclusion
Refl_VisNIR_Calc	MProbe VisNIR	Reflectance measurement with automatic data analysis.
Refl_VisNIR_Raw	MProbe VisNIR	Reflectance measurement only: no automatic data analysis.
Trans_VisNIR_Calc	MProbe VisNIR	Transmittance measurement with automatic data analysis.
Trans_VisNIR_Raw	MProbe VisNIR	Transmittance measurement only: no automatic data analysis.
Refl_UVVisNIR_Calc	MProbe	Reflectance measurement with

	UVVisNIR	automatic data analysis.
Refl_UVVisNIR_Raw	MProbe UVVisNIR	Reflectance measurement only: no automatic data analysis.
Trans_UVVis- NIR_Calc	MProbe UVVisNIR	Transmittance measurement with automatic data analysis.
Trans_UVVis- NIR_Raw	MProbe UVVisNIR	Transmittance measurement only: no automatic data analysis.
Refl_UVVisF_Raw	MProbe UVVisF	Version for flash lamp. Exclusion ranges need to be customized based on application.

Appendix II. MProbe Troubleshooting

	Problem	Reason	Solution
1.	TFCompanion software shows message. "Your software is not registered. Starting in Evaluation mode"	Software requires USB dongle (hardware license key). Software cannot find the license key.	Check that USB dongle is plugged in the USB port. LED at the end of the dongle should be lit-up. Try to remove the dongle and plug it in again. If the problem persists – try another USB port.
2.	The error message after software loaded is displayed: " No spectrometers are connected"	Software cannot find spectrometers. USB cable maybe disconnected or USB connection timed-out because computer was in stand-by or sleep mode	Exit the software. Unplug MProbe USB cable from the computer and plug it in again. Start TFCompanion software. If the problem persist, unplug USB cable again and try another port. Please note that some systems (e.g. VisNIR) require USB2.0. If you use USB1.0 or USB1.1 spectrometer driver may not install and function properly
3	No light is coming when the unit is switched on	In Vis and VisNIR system the light is switched on by the power switch on the back panel. In UVVis system the button on the front panel need to switched in addition to power switch on the back panel.	If you followed instruction to switched the light but there is no light: a). Check if you have potentiometer/ intensity regulator on the back panel. Try to turn it and check if it solves the problem b). You bulb may need replacement
4	TFCompanion software does not exit.	It maybe waits for spectrometer or other hardware to close. Typically, the message indicating wait time is displayed	Disconnect MProbe USB cable from the computer and try exit again. In unlikely case that problem persists -use Windows Task Manager to "kill" TFCompanion process and report the problem.

5	TFCompanion software becomes sluggish and does not respond	There maybe several different issues: a). Low-memory (see 6) b). Spectrometer integration time increased too much (see 7)	
6	Software memory problem	If software becomes sluggish this maybe because of low allocated memory	Check the memory use (Help/Memory Monitor). If you see 90% or more memory used – you need to increase the memory allocation. Use Configure/Configure Launcher to set memory allocation. You need to restart the software to new memory allocation to take effect
7	Spectrometer integration time problem	Integration time in spectrometer is adjusted automatically for the best precision depending on the light intensity. If your signal is very low - typically, one may click measurement when there is no sample, etc.- integration time may increase significantly (limited in the measurement recipe)	Select Measure/Signal monitor and select Measurement Conditions to set lower integration time. If it takes a long to wait for spectrometer to respond, you can disconnect the USB cable and restart the software.
8	Measurement recipe does not match calibration	Calibration need to match recipe condition exactly – if you change a recipe, you need to recalibrate!	Select Measure/Clear Calibration. You will prompted to perform calibration when you try to do measurement