

Plasmon06

This document is a manual for check-up and adjustment of the Plasmon 6 device running under Plasmon06 control software and can serve as an operation manual. While the control software and the standard measurement procedures using this device are expounded in the document **Program package Plasmon06**, this document refers to the device itself and auxiliary operations. This document covers models Plasmon 6 and Biosuplar 6.

Содержание

Device description.....	5
Delivery set	5
Turning on the device and installing program package	6
Design	7
Optical arrangement.....	8
Thermally stabilized cell.....	10
Pumps.....	11
Turning on measurement channels	12
Checking the device.....	12
Adjusting the device.....	13
Changing the prism	14
Calibration.....	14
Connection and cables	16
 Program package Plasmon06.....	 18
System requirements	18
Measurement modes	19
Device Calibration	19
Single measurement	20
Multiple measurement.....	20
Track mode	22
Slope	24
Pause	26
Stop	27
Restart	27
Adjustment mode	27
Subsidiary channel	28
Subsidiary channel calibration	29
Main window	30
Buttons	31
Operational program change	32

Clearing the SPR1 window	33
Kinetics Start.....	33
Save&Exit	33
Menu of the Professional program.....	34
Menu of the Express program.....	35
Status bar.....	36
Data presentation.....	39
SPR1 window.....	40
SPR2 window.....	42
Subsidiary window.....	44
Notes window	46
View window	46
Monitor window.....	47
Set Options.....	48
Set options of Professional program	48
Set main options.....	48
Advanced options.....	51
Data Processing options	52
Graphics options	55
Color options.....	57
Sound options.....	57
Device options.....	58
Monitor options.....	59
Set options of Express program	60
Multiple Options	60
Track options.....	61
Slope options.....	63
Single options.....	64
Service options.....	65
Advanced options.....	66
Work with data.....	67
Open File.....	67
Viewing the automatically saved files	68
Save File.....	69

Automatic data saving.....	70
Data files format.....	72
Copy Clipboard.....	74
Print graphic.....	74
Data processing.....	75
Pop-up menus.....	80
Managing Channel.....	85
Device information.....	86
Command line.....	86
Pump control.....	87
Pumps programming.....	88
Monitoring and stabilization of the temperature.....	89

Device description

Delivery set

Device

Power source (220 V AC or 100...220 V AC)

PC connection cable

Connection cable for subsidiary channel signal

Installation diskettes (CD)

Spare parts (variable set on customer's demand)

Typical set includes:

- F1-65 prism – 1 piece;
- K8-50 prism – 1 piece;
- Rubber gaskets – 5 pieces;
- Sensor chips – 20 pieces;
- Cell – 2 pieces;
- Immersion liquid – 1 ml.

Additional components that can be included into the set:

If the device is completed with plunger pumps, the following components are included in the set:

- Plunger pump – 2 pieces;
- Syringe – 2 pieces;
- Cable.

If the device has a sample thermostabilization system, then one of the included cells is thermally stabilized.

Attention: Program components provided on the installation diskette are individual for your device exemplar.

Turning on the device and installing program package

To turn on the device, connect it to free COM port of the computer and to the power source. If the facility is completed with plunger pumps, it is necessary to connect pumps to the device. Turn on the computer and the power source.

To install the program:

Insert the first diskette. Start the Setup.exe program. During the installation enter the factory device number into the “**Serial number**” field (factory number is marked on the lower surface of the load-bearing slab of the device and specified on the installation diskettes).

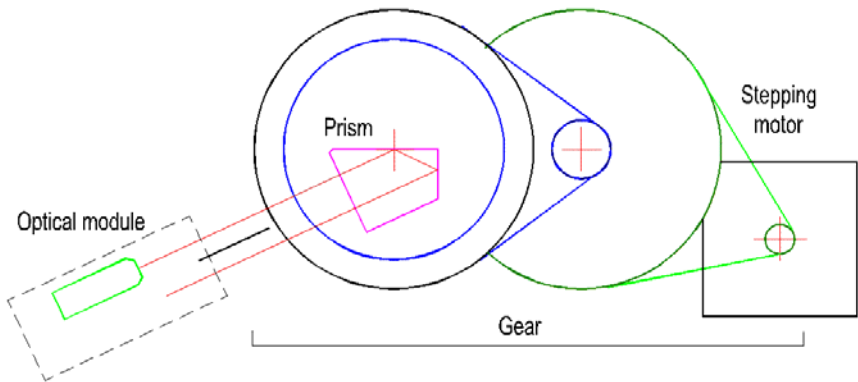
While starting the program first time, the **Set Device** window will appear. It is necessary to select the following options in this window:

- The port the device is connected to.
- The prism installed on the device.

Different device modifications require different set-up; to tune up, Enable the required channels.

The device is ready for operation.

Design



The device is built in Kretschmann geometry. The main element of the device is the retroreflecting measurement prism, which is installed on the rotating table. The right (on the figure) prism face is made reflecting, and top right angle of the prism equals to 90 degrees. During the device operation the sensor chip (a glass slide with deposited thin Au layer) is installed on the top prism face using the immersion liquid. Properly, the SPR (surface plasmon resonance) phenomenon is observed in the sensor chip. A cell intended for injection of the investigated probe is pressed to the layer. To observe the SPR phenomenon, the intensity of the polarized light reflected by the Au layer is investigated as a function of angle of incidence of light on this layer (further – angle of incidence).

The table with prism is made rotating to change the angle of incidence. The rotation is carried out on the axis, which approximately coincides with the glass slide surface. The rotation can be realized manually using the preset ring or programmatically by the controlled precision rotation system. Precision rotation system consists of stepping motor and double-stage reducer, which outlet axis the table with prism is installed in via the friction clutch.

important for ensuring of accuracy of the SPR curve measurement.

The second channel arrangement differs from the first channel arrangement by absence of plate 4 and photodiodes 1 and 3.

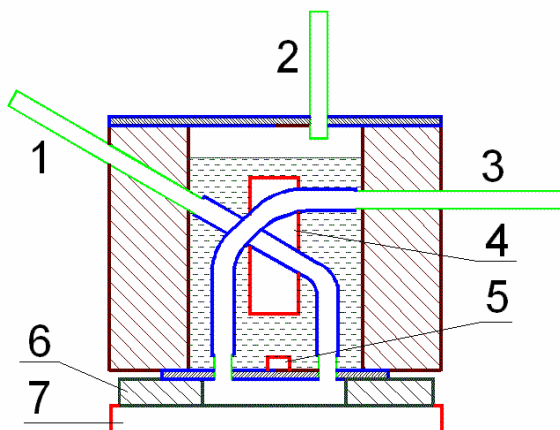
The device allows to calculate absolute values of angle of incidence. Note that under normal incidence of light on the input prism face (the autocollimation position) angle of incidence equals to prism angle. Therefore, it is necessary to know the device autocollimation position for determination of the absolute values of angle of incidence. Photodiode 1, which the light reflected by the front prism face can fall in after reflecting from the glass plate 4, is used for determination of the autocollimation position. Maximum signal of the photodiode 1 (the calibration signal) is observed at the value of the angle near to the autocollimation. Difference of this value from the precise value (the correction) is measured by the manufacturer for every device exemplar and is stored in the file, which is included in the installation system supplied along with the device. Here positive value of the correction, e.g. 15, means that maximum calibration signal is observed when the beam reflected by the front prism face is deflected downward by 15 angular minutes relative to the autocollimation position.

The device can be completed with the following measurement prisms:

- K8-50 prism (made of K8 glass, with operating angle (angle at the top) of 50 degrees);
- F1-65 prism (made of F1 glass, with operating angle of 65 degrees).

Note: It is possible to find information about prisms by selecting the menu items sequentially: **Options/Options/Device**.

Thermally stabilized cell



Thermally stabilized cell represents an oil-filled plastic housing with bedplate made of stainless steel. The bedplate of the cell is pressed to the perforated silicon gasket 6 that, in turn, is pressed to the sensor chip 7. Properly, perforation in the silicon gasket forms the cuvette. Investigated probe gets to the cuvette region via the input connection 1 and silicon pipe inside the housing through the hole in the bedplate. The probe is evacuated through the connection 3. Temperature sensor 5 is attached to the cuvette bedplate. Signal from the temperature sensor controls the resistive heater 4, which is situated in the oil-filled volume of the cell, using the proportional-integral-differential algorithm. Heater and temperature sensor are automatically connected to the circuit when the cell is introduced.

Since the silicon rubber is partially transparent for gases dissolved in the probe, part of these gases evolves into the oil and accumulates in the top part of the cell volume. Connection 2 is intended to pump out these gases. Probability of bubble nucleation in the active region of the cuvette decreases and reliability of

obtained results increases upon decreasing the amount of dissolved gases in the probe.

Pumps

The device can be completed with two PUMP3 plunger pumps or two rotary pumps.

Plunger pump is assembled on the basis of medical syringe (Bogmark™ 11 ml); inner part of the syringe can be moved by the stepping motor. The pump is made as a separate product; it can be connected to the device using a cable. It is possible to connect 2 pumps to the device. The pumps are controlled programmatically and independently. These pumps can operate both in injection and exhaust modes. The operation mode is the exhaust mode. Pumps can operate in the rate range of 1...10000 ul/min. Modes of rapid passage are also provided. Maximum pump volume that can be used – 10 ml.

Pumps from Rietschle Thomas (Rotary Vane Pump model G12/01) are used as rotary pumps. These pumps are installed directly on the device. It is possible to install 1 or 2 pumps. The pumps are controlled programmatically and independently. These pumps can operate both in injection and exhaust modes. The operation mode is the exhaust mode. Pumps can operate in the rate range of 500...100000 ul/min. Modes of rapid passage are also provided.

Operating the device

Turning on measurement channels

Each device contains two optical measurement channels, which are processed by channels #1 and #2 of the electronic module, and subsidiary measurement channel, which is processed by channel #5 of the electronic module.

It is only possible to receive and process signals from the measurement channels when the corresponding channel of the electronic module is turned on. To turn on/off necessary channels, press the **Set options** button (or select the **Options/Options** menu item). In the opened window select the **Advanced Options** page and switch on/off corresponding channels (a set “flag” means that this channel is turned on).

Checking the device.

To check the device, install the selected prism and the sensor chip, and do not forget to use immersion liquid. If you work with liquids, install the cell and fill it with the required solution. Start the program and turn on the **Adjustment** mode by pressing the **Adjustment** button (or by selecting the **Tools/Adjustment** menu item). Laser beam intensity will increase and signals of all device channels will visualize in the arisen window as horizontal colour lines (even signals of the channels, unused in the current device realization). Length of the lines is proportional to corresponding signal values.

Observe the light spot on the working layer through the cell while turning table with the prism using the angle preset ring.

Brightness of the spot increases noticeably at certain rotation angle that corresponds to the SPR angle. The spot must be situated inside the cuvette not far from the center (usually it is situated between the center and right edge), and it must not go out of the cuvette borders during the rotation. The beam that came out of the prism must fall on the rotary mirror 5. Observe the position of the spot of the beam that came out of the prism on the rotary mirror 5 surface while turning table with the prism using angle preset ring (see Optical arrangement). The spot position has to be changed insignificantly.

If you have found the position corresponding to the SPR angle, decrease the angle of incidence by turning the preset ring clockwise on several degrees. Start the measurement by pressing the **Single measurement** button (or by selecting the **Measurement/Single** menu item). The measurements will start. Measurement results will be represented by the curve in the opened window entitled SPR1. You have to see part of the SPR curve; moreover, maximum signal must be above the window half height, but it must not exceed its boundaries.

If all of the above mentioned is fulfilled, the device is ready for operation.

Adjusting the device.

If after Checking the device you are sure that device adjustment is wrong, you can try to rectify the situation. To do this, loosen the left screw of the optical block mount to the device plate and reach the adjustment position described in the Checking the device section by slightly turning the block. If all is set up correctly, but the signal is absent or very weak, it is possible that the working beam does not fall on the photodetector 2. In this case it is necessary to take off the lid by unfastening two screws at the bottom of the optical block and visually check whether the beam

falls on the photodetector or not. The beam must fall into the center of the photodetector 2 after reflection from rotary mirror 5. If it is necessary, one can turn the support with the mirror 5 in the required direction.

Note: Displacement of any optical block elements (except the mirror 5) leads to impairment of the measurement of absolute angle values accuracy.

Changing the prism

To change the prism, turn off the fixation screw of the prism table and pull out the prism (along with the table).

Install and fix the table with a new prism. Check the device as described in the Ckecking and adjusting the device section.

Note: After you change the prism or change its position you have to carry out the device Calibration before starting the measurements.

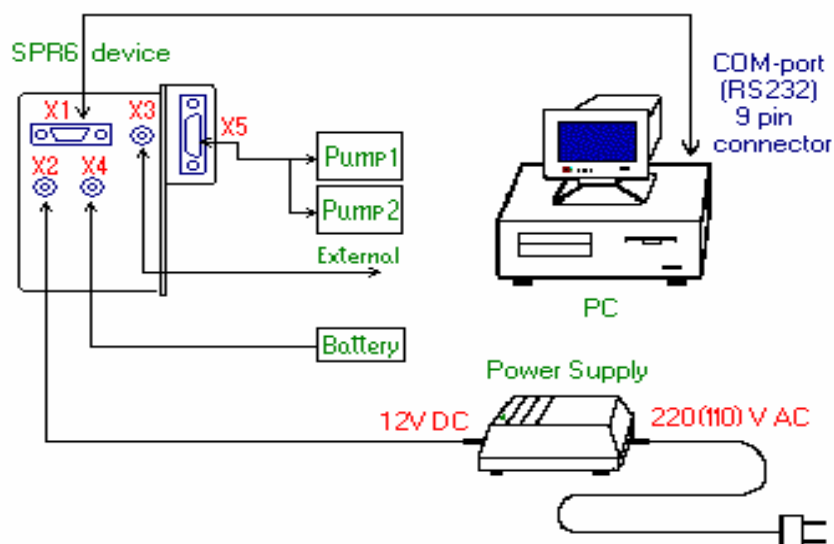
Calibration

Calibration is the process of associating the angular sweep of the device to the built-in calibration reference point. Angular position of the reference point is located near from the position of normal incidence of light on the input prism face and it is known precisely. Calibration allows calculating absolute values of angles of incidence to a high accuracy.

Calibration should be carried out after changing the prism or any modification of its position or simply before starting important measurements.

Set the prism in the position required by the terms of the experiment by turning the angle preset ring. Press the **Calibration** button (or select the **Tools/Calibration** menu item). The angle scanning will begin (for more detail see **Device description. Design**). During the calibration the special mode for measurement of the reference point signal is established and the system position in the moment of the maximum reference point signal is determined. The reference point signal is drawn in the SPR1 window, and the calculated position of its maximum is shown by the vertical line and the text is outputted, e.g. Zero”=607 a.m., in the same place. It means that the angle of incidence of light on the input prism face equals to zero when the prism rotation angle equals to 607 angular minutes. The passport correction for true angular reference point position is taken into account automatically.

Connection and cables



Cable RS232

X1 (DB9)		COM-port (DB9)
2 RXD		2 RXD
3 TXD		3 TXD
5 GND		5 GND
1,4,6,7,8,9 - NC		1,4,6,7,8,9 - NC

Power Connector

X2
1 GND
2 +12V DC (central contact)

External Signal (to Subsidiary channel)

X3	
1	GND
2	external + (central contact)

Program package Plasmon06

System requirements

Supported operating systems: Windows 95/98/Me/XP.

PC configuration for normal device and program operation:

CPU frequency – no less than 500 MHz (for Windows XP – no less than 600 MHz).

Standard COM port or USB (depends on device modification).

30 MB of free disk space.

Mouse.

Note: Device will work at lower CPU frequencies but operation stability decreases. If it is necessary to work on low-power PC, you can follow these instructions to reduce CPU load:

- Increase curve drawing speed by adjusting the **Drawing accelerat.** element (highest possible value – 9) on the Graphics page in the **Options** window of the *Professional* program.
- Increase measurements period in the Multiple mode by adjusting the **Period, s** element on the Set Options or Multiple pages in the **Options** window.

Measurement modes

Device Calibration

It is necessary to know absolute values of the angle of incidence of light for some calculations. There is a built-in reference point in the instrument for the determination of the absolute angles. Angular position of the reference point is near to the position of normal incidence of light on the prism and it is precisely determined as an instrumental calibration correction during the adjustment made by the manufacturer.

The system calibration consists in associating the rotation system with the built-in reference point. This operation is to be repeated after each prism replacing or changing its preset position (for instance, by turning the preset ring).

The calibration mode can be switched on by selecting the **Tools/Calibration** menu item.

This mode can be also switched on by pressing the **Device calibration** button in the main window of the *Professional* program.

During the calibration, the special mode of the reference signal measurement is turned on and the system position is defined when the reference signal is maximal. The reference signal and the calculated position of its maximum in the form of the vertical line and in the form of the inscription are displayed in the **SPR1** window. For instance, the “0”=607 a.m. inscription means that the angle of incidence of light on the input prism face equals to zero, if the rotation angle of the instrument equals to 607 angular minutes. Here, correction for the real angular position of the reference point (instrumental calibration correction) is taken into account automatically.

The determined calibration value is stored by the system and used for angles of incidence calculation in the **Absolute angle** mode (see Data processing, Data presentation). The value of the last calibration can be shown by choosing the **Help/Device** item in the Menu. If the instrument calibration has not been carried out, the system will use the old calibration value without any warning.

Note: An instrumental calibration correction is saved to the “DeviceDat.dat” file, which the instrument is supplied with.

Single measurement

Single measurement of the SPR curves within the angular range specified by the **Max angle, degree** option and in the angular coordinates specified by the **Absolute angle-Angle in air-Angle in glass** options. The results are processed (see Data processing) and displayed in the window entitled **SPR1**, which is opened automatically if necessary (see Data presentation). Positions of the curves minima are also marked with vertical markers and displayed in the top right corner of the window. If the curve minimum cannot be found, the corresponding message is displayed instead of the angular value.

The results can be saved to file in text or graphical format (see Save file), copied to clipboard (Copy Clipboard) or printed (Print graphic).

Multiple measurement

Periodic measurement of the SPR curves (in the same way as in the Single measurement mode). Data obtained in each

measurement are processed and displayed similarly to the Single measurement mode, then for every enabled measurement channel the angular position of the minimum is found (see Data processing). If the minimum is found, its position is displayed on the plot in the window entitled **SPR2** (see Data presentation). If the minimum is not found, a corresponding message is displayed in the **SPR1** window, and a corresponding point is omitted in the **SPR2** window.

If the prescribed value of the **Period, s** element is less than the time required for the single measurement, then the measurements will be performed continuously.

Kinetic data displayed in the **SPR2** window can be processed mathematically (see Data processing).

Kinetic measurements can be carried out in two modes:

1) If the flag of the **Time auto increase** element *is set* (see Set options), the measurement is performed during the time specified by the **Operat. time, min** element with period of **Period, s** (see Set options). The measurement can be interrupted by the **Stop** command, which can be sent from the main menu or by pressing the **Stop** button.

2) If the flag of the **Time auto increase** element *is not set*, a request for prolongation of the measurement time is displayed after the lapse of the measurement time specified by the **Operat. time, min** element. If user answers negatively, the measurement interrupts. If user answers positively, the measurement time increases by the originally prescribed value of the **Operat. time, min** element. The final measurement time value obtained as a result of prolongations is stored in the **Operat. time, min** element and used in subsequent measurements.

The results can be saved to file in text or graphic format (see Save file), copied to clipboard (Copy Clipboard) or printed (Print graphic).

Additionally, SPR curves can be saved in text files directly in the course of the measurement when the Automatic data saving mode is switched on.

The measurement process can be interrupted by sending the Pause command or terminated by pressing the Stop button. In the latter case, the last measured point data may be lost.

Maximal continuous measurement time depends on several parameters; first of all, on the angular scan range (**Max angle, degree**). With increase of the angular scan range the measurement time increases. The maximum continuous measurement time for the angular scan range of 5 degrees is 8 hours.

Track mode

Operation in this mode is similar to the operation in the Multiple measurement mode, but it is much faster because the smaller angular range is scanned. The measurement is carried out in the following way. On starting this mode, the first measurement is performed in the same way, as in the Single measurement mode. Then, for the multi-channel instrument, the Managing Channel window is opened for selection of the managing channel. After the selection of the required channel configuration, the instrument is positioned at the angle of **Deviation, degree/2** (see Set options) to the left of the SPR curve minimum in the managing channel and the scan is performed in the angular range of **Deviation, degree**. For every enabled channel the angular position of the minimum is found (see Data processing) and if the minimum is found, its position is displayed on the plot in the window entitled **SPR2**. If the minimum is lost in the course of the measurement (for example during fast

processes), the program will switch to the mode of full SPR curve measurement and after finding of the minimum it will return to the Track mode.

Note: The minimum in one of the channels cannot be found in some cases for the multi-channel instrument. In this case the correspondent data point will be omitted.

Kinetic measurements can be carried out in two modes:

1) If the flag of the **Time auto increase** element *is set*, the measurement is performed during the time specified by the **Operat. time, min** element with period of **Period, s** (see Set options). The measurement can be interrupted by the **Stop** command, which can be sent from the main menu or by pressing the **Stop** button.

2) If the flag of the **Time auto increase** element *is not set*, a request for prolongation of the measurement time is displayed after the lapse of the measurement time specified by the **Operat. time, min** element. If user answers negatively, the measurement interrupts. If user answers positively, the measurement time increases by the originally prescribed value of the **Operat. time, min** element. The final measurement time value obtained as a result of prolongations is stored in the **Operat. time, min** element and used in subsequent measurements.

The results can be saved to file in text or graphic format (see Save file), copied to clipboard (Copy Clipboard) or printed (Print graphic).

The measurement process can be interrupted by sending the Pause command or terminated by pressing the Stop button or by sending the corresponding command from the main menu. In the latter case, the last measured point data may be lost.

Maximal continuous measurement time depends on several parameters; first of all, on the angular scan range (**Deviation, degree**). With increase of the angular scan range the measurement time increases. The maximum continuous measurement time for the angular scan range of 2 degrees is 3.5 hours.

Slope

In this mode measurements are carried out without mechanical rotation of the measurement prism and are characterized by high speed of operation and low noise level.

If the **Rel.units** (see below) representation mode is selected, then the «Set Former angle of measurements? [Yes] [No]» question is displayed. In the case of positive answer, measurement prism is set in the position which it was in during the last measurement session and the measurement begins. This allows continuing the measurements, interrupted for some reason.

If the other mode is selected or in the case of negative answer, the first measurement is performed in the same way, as in the Single measurement mode and the Managing Channel window for selection of the managing channel is opened for the multi-channel instrument. Then, if the **50 %** element (Options) is selected, the measurement prism is positioned at the angle which the signal corresponds to the half of the height of the SPR curve left slope at, and the measurement begins. If the **Pointer** element is selected, user can select the point on the curve by dragging the marker that appears in the **SPR1** window with the left mouse button pressed. Then the measurement prism is positioned corresponding to selected point and the measurement begins.

The measurement consists in reading the signals in the enabled channels, processing these signals and displaying them

in the window entitled **SPR2** when the prism position is fixed. Then the instrument waits for the time specified by the **Delay, s** element and the process is repeated.

Processing of signals and their representation depends on the representation mode, selected in the Options window. Three choices are possible; they are selected by the corresponding element: **Rel.units**, **Grad.corr** or **Degree**. If the **Rel.units** element is selected, signal levels (in ADC code units) are used as the kinetics points. If the **Grad.corr** element is selected, values of the signals are multiplied by the gradients of the corresponding SPR curves. This allows to compare signals from two channels more correctly. If the **Degree** element is selected, values of the signals are converted into the effective angle change and kinetics is displayed in degrees. The kinetic data obtained can be additionally processed depending on the **Peak-filter** and **Averaging** options.

Kinetic measurements can be carried out in two modes:

1) If the flag of the **Time auto increase** element *is set*, the measurement is performed during the time specified by the **Operat. time, min** element with period of **Period, s** (see Set options). The measurement can be interrupted by the **Stop** command, which can be sent from the main menu or by pressing the **Stop** button.

2) If the flag of the **Time auto increase** element *is not set*, a request for prolongation of the measurement time is displayed after the lapse of the measurement time specified by the **Operat. time, min** element. If user answers negatively, the measurement interrupts. If user answers positively, the measurement time increases by the originally prescribed value of the **Operat. time, min** element. The final measurement time value obtained as a result of prolongations is stored in the **Operat. time, min** element and used in subsequent measurements.

The results can be saved to file in text or graphic format (see Save file), copied to clipboard (Copy Clipboard) or printed (Print graphic).

The measurement process can be interrupted by sending the Pause command or terminated by pressing the Stop button. In this case, the last measured point data may be lost.

Maximal continuous measurement time depends on the **Delay, 0,1s** option and for delay of 0.1 s it equals 2 hours, and for delay of 10 s – 200 hours. Maximal continuous measurement time is calculated and indicated before the beginning of the measurement in the **Reminder** window.

Pause

The pause is switched on/off by pressing the **Pause** button or the “Ctrl” + “P” keys in the keyboard. This mode is intended for the temporary measurement interruption. It is useful when the examination of data already obtained is desired, to switch to another application and so on.

Switching on the Pause mode is indicated by change of the button image color.

It is recommended to use this mode also when making some commutations, changing options etc.

Note: If the Pause mode is switched on during the kinetics measurement, then program operation interrupts but the measurement time count continues.

Stop

Kinetics measurements can be stopped automatically or by user depending on the selected options. They can be interrupted at any time by pressing the button or by sending the **Stop** command from the main menu. After pressing the button, the interruption may not occur immediately because the system may need some time to stop the operation correctly.

Information about the last measured point may be lost when the **Stop** command is used.

Restart

Sets the instrument mechanical system to its initial position. This operation is performed automatically on starting the program and before the beginning of the measurements in any mode. It can be repeated using the **Restart** command at any time when the instrument is not carrying out the measurement. It is recommended to execute this operation if the fault in the mechanical system of the instrument is suspected.

Note: In some versions the Restart operation is available in the Multiple measurement and Track modes.

Adjustment mode

To switch to the Adjustment mode, press the “**Adjustment**” button or choose the **Tools/Adjustment** menu item of the *Professional* program. In this mode the signal intensities in all measurement channels are monitored periodically and their values are displayed as a color bar chart diagram in the main window.

This process lasts for several minutes and then switches off automatically. It can be also terminated by pressing the Stop button or by pressing the “**Adjustment**” button again.

Note: The indication is carried out for all channels, even for those that are not used in the current device model.

This mode is convenient for adjustment and testing purposes.

Subsidiary channel

Subsidiary channel is intended for measurement and representation of the user's external signal voltage. The measured range is -5V...+5V.

The subsidiary channel can be operated in two different modes: in the independent mode and in the synchronous mode. During operation in the first mode, the measurement is performed periodically after a period of time specified by the timer. In this mode the measurement starts immediately after the window is opened. In the second mode the measurement in the subsidiary channel is performed simultaneously with the SPR kinetics measurement. It means that the measurement is performed when the next kinetics point is determined (the minimum position in the Multiple measurement and Track modes or the signal measurement in the Slope mode).

Note: The independent measurement mode is available only during the stand-alone operation of the subsidiary channel. If any mode of kinetics measurement is switched on, the synchronous mode will be automatically switched on.

Attention! If the 5 channel is turned off, the external signal measurement mode is unavailable.

It is possible to control the window and the Subsidiary mode via the Pop-up menu and from the **Subsidiary** panel on the **Data processing** and **Advanced Options** pages in the Options window.

These panels contain the following elements:

- **Averaging** – switches on/off the mode of measurement averaging.

- **Number of points** – defines the number of points that are used for averaging.

- **Independence** – switches on/off the independent operation mode.

- **Period, 0,1s** – this element is active only if the independent mode is switched on; it allows to specify the measurement period in this mode.

Note: Inaccuracy of the measurement of the internal signal can be reduced by executing the accurate Subsidiary channel calibration

Subsidiary channel calibration

Calibration of the subsidiary channel consists in determination of precise values of amplification factor and position of the zero line of the channel. The subsidiary channel calibration can be carried out in the *Professional* version of the program only.

To perform the calibration, proceed as follows:

1. Switch the channel on in the independent mode by pressing the button “Subsidiary” in the main window.

2. Short-circuit the wires corresponding to the input signal of the subsidiary channel and wait for some time while the zero line

is drawn.

3. Connect the constant-current source with known voltage to the channel input and wait for some time while the line corresponding to this voltage is drawn.

4. Interrupt the measurement by selecting the **Independence** item in the pop-up menu. Changing the curve scale, determine the applied voltage value as a difference between the signal and zero line levels. Divide the real applied voltage by this value and obtain the **k1** coefficient.

5. Open the **Options** window on the **Advanced Options** page, read the amplification coefficient value **k** from the **Amplification** window and replace it with a new value calculated as the $k \cdot k1$.

6. Short-circuit the wires corresponding to the input signal of the subsidiary channel and wait for some time while the zero line is drawn.

7. Determine the precise **p1** value, which corresponds to the “0” input voltage.

8. Open the **Options** window on the **Advanced Options** page, read the pedestal value **p** from the **Pedestal, V** window and replace it with a new value calculated as $p - p1$.

Main window

When the program starts, it detects and initializes the instrument and after that opens up the Main window of the program.

The Main window contains main Menu, control Buttons below the menu and Status bar at the bottom of the window.

Middle part of the window is empty just after start of the program. Windows with plots of the measurement results will be located here.

Menu and control buttons have standard appearance, structure and functioning unlike **Status bar** which serves as active control element.

Most of available functions are duplicated by menu items and control buttons. Some of them are also duplicated by the status bar active fields.

Note: The main window current size and position are stored by the system. You can resize or drag the main window to any desirable position, and this size and position will be reproduced when you run the program next time.

Buttons

Open file	Reading text files	
Save file	Saving data as a text file	
AutoSave	Automatic data saving in a text file	
Copy	Copy data to system	For <i>Professional</i>
Clipboard.	Clipboard	program only
Print graphic		For <i>Professional</i> program only
Change	Switch between program	
Single measurement	Single measurement of the SPR curve	
Multiple measurement	Start cyclical spectrum acquisition with simultaneous representation	For <i>Professional</i> program only
Track mode	Start continuous measurement of the angular position of the resonance dip	For <i>Professional</i> program only
Slope	Start continuous measurement of signal intensity on the left or right slope of the resonance dip	For <i>Professional</i> program only
Kinetics measurement	Run and choice of kinetic measurements	For <i>Express</i> program only

Subsidiary	On/Off measurement of the user's external signal	
Stop	Termination of current measurement	
ClearSPR1	Clear SPR1 data presentation window	For <i>Professional</i> program only
Calibration	Autocalibration of the instrument for absolute angle-of incidence measurements	For <i>Professional</i> program only
Restart	Initialization of the instrument mechanics	For <i>Professional</i> program only
Pause		
Kinetics Start	Resstarting kinetics measurement	
Set options	Selection of measurement options	For <i>Professional</i> program only
Adjustment	Instrument adjustment	For <i>Professional</i> program only
Pumps	Control of pumps	
Mnitor	Monitoring of the cell temperature and power supply voltage	
Save&Exit	Measurement interrupt and close of program	
Help	Opening the Help file	

Operational program change

The device software includes two programs that differ manly by their user interface: **Plasmon06_Professional** and **Plasmon06_Express**. It is possible to switch between them quickly by pressing the button “**Change**”.

Clearing the SPR1 window

The SPR1 window can operate in two different modes: 1) all measured curves are plotted in the same window or 2) a new window is opened for every curve. Representation mode can be switched via the pop-up menu (SPR1 in New Window) or via the main menu (Window/SPR1 in New Window). Window clearing is intended for removing the old curves when operating in the 1 mode.

If the **Auto Clear SPR1** mode is switched off when operating in the 1 mode, then all measured curves are plotted in the SPR1 window. If the clearing mode is switched on, then not more than 16 lately measured curves will be displayed in the window.

It is possible to switch this mode on/off on the **Graphics** page in the Set Options window or via the Status bar

Kinetics Start

This button is active only when the kinetics measurement mode is switched on (Multiple measurement, Track or Slope modes). This button is intended to begin the kinetics measurement after some preparatory stage. Pressing this button is equivalent to switching off and then switching on the kinetics measurement mode.

If this button is pressed, the kinetics measurement timer is zeroed and the SPR2 and Subsidiary windows are cleared. The previously measured kinetics data will be lost.

Save&Exit

To finish the work with the instrument, press the **Close** button, select the **File/Close** item or press the **F4** key in the keyboard.

The system will request:

- “Save SPR2?” if the SPR2 window was opened but was not saved;
- “Delete AutoConserved files?” if the Automatic data saving mode was switched on;
- “Save SPR1?” and then close the program.

The program can be also closed by pressing the system close button in the top right corner of the main window; in this case no data saving requests will be displayed and certain option settings which were defined during the operation will not be stored.

Menu of the Professional program

Almost all menu functions are duplicated by the main window buttons or by the pop-up menu commands; these functions are described in their descriptions, with the exception of the following ones:

Tools/Stabilize Cell – switches the monitoring and cell temperature stabilization modes on.

Tools/Stabilize t2 – switches the monitoring and additional channel temperature stabilization modes on.

Tools/Monitor – switches the monitoring mode on.

Tools/Decimation – “decimation” of the text data file which corresponds to the SPR curve. This operation may be useful when the file is transferred “manually” to another computer or

program environment. When this operation is carried out, the program reads the file selected by user, determines the number of experimental points contained in this file, asks for the number of points to be left and saves the resulting file with the name specified by user. Data points for the new file are selected uniformly as far as possible.

Tools/Set device – records instrument data contained in the “deviceDat.dat” file to the system registry and allows to reinstall the port the instrument is connected to.

Window/Notes – calls and opens/closes the Notes window.

Window/View – calls and opens the View review window.

Window/SPR1 in New Windows – if this element is selected, each measured SPR curve is plotted in a separate window.

Window/Align – window arrangement control.

Help/Help Hardware – connects the instrument (hardware) HELP-file.

Help/Help Software – connects this HELP-file (it is connected by default).

Menu of the Express program

Nearly all menu functions are duplicated by main window buttons or pop-up menu commands; these functions are described in their descriptions, with the exception of the following ones:

Tools/Calibration – Calibration – calibration of the absolute angles measurement system.

Tools/Adjustment mode – Adjustment mode. Signals from all channels of the device are measured and their values are visualized periodically in this mode.

Tools/Set device – records instrument data contained in the

“deviceDat.dat” file to the system registry and allows to reinstall the port the instrument is connected to.

Window/Notes – calls and opens/closes the Notes window.

Window/View – calls and opens the View review window.

Window/SPR1 in New Windows – if this element is selected, each measured SPR curve is plotted in a separate window.

Window/Align – window arrangement control.

Help/Help Hardware – connects the HELP-file with device specification.

Help/Help Software – connects this HELP-file (it is connected by default).

Status bar

The Status bar is an active control element. It is intended not only to inform about the operation modes that are currently set, but also to set up and modify some of them. That partially duplicates controls in the Set options window.

The Status bar consists of 8 fields, first and eighth of which are intended for indication only, while the rest of them are used for both indication and modification of corresponding modes. To switch between the different modes, click on corresponding field in the status bar. At that, the inscription in the string field will change, and the appearance of the field may change. Status bar fields and their destinations are listed below.

1. This field indicates the current operation mode.
2. Indicates and modifies the angle-of-incidence calculation and presentation method:

Relative angles – angle displayed corresponds to the turning angle of the prism table with reference to its initial position;

Absolute angles – angle displayed corresponds to the absolute angle of incidence of light. In order for this mode to operate correctly, the Angle calibration is to be carried out first.

See also Data processing.

3. Specifies absolute angles calculation method:

in glass – angles indicated in the data plots correspond to the angles of incidence of light on the top prism face (in glass);

in air – angles indicated in the data plots correspond to the angles of incidence of light on the input face of the prism. When the beam reflected from the input prism face appears to lie above the incident beam, the angles are considered negative; in the opposite case they are considered positive. See also Data processing.

4. Enables/disables automatic erasing of the SPR curves in the SPR1 plot. Available only when the **SPR1** in **New Windows** mode is turned off:

n_Clear – all measured SPR curves are displayed;

Clear – on plotting every sixteenth SPR curve the window is cleared, and then the next 16 curves are plotted and so on.

The window can be also cleared at any time by pressing the **Clear SPR1** button.

5. Indicates and controls processing of kinetics curve data (SPR2) for the Multiple measurement, Track and Slope operation modes. Options for data processing modes can be adjusted in the Set options\Data processing window.

None – data processing is switched off;

Peak – single spike filter (peak-filter) mode is switched on;

Peak+Aver – peak-filter and averaging modes are switched on;

Aver x. – averaging mode is switched on, averaging is executed by x points.

6. Indicates and controls the plot scale of the OY axis for kinetic measurement in the SPR2 window:

Full – full window in initially preset scale is shown;

Link – OY axis scale in SPR2 window is dependent on SPR1 window scale so that with changing of the plot scale in the SPR1 window the OY axis scale in the SPR2 window is changed automatically;

Fix – previously adjusted OY axis scale (e.g. in **Link** mode) is kept.

7. Indicates and controls the method of determination of the SPR curve minimum:

Abs – determination of the absolute minimum of the SPR curve;

Aver – determination of the minimum of the SPR curve by averaging midpoints of several segments connecting two points which are located at grade on different slopes of the SPR curve. This method is implemented in some versions of the program only;

Parab – method of approximating the SPR curve by the second-order polynomial; minimum position is then calculated for this polynomial;

Cubic – method of approximating the SPR curve by the third-order polynomial; minimum position is then calculated for this polynomial. This method is implemented in some versions of the program only.

See also Data processing.

8. This field is used by the automatic data saving to the files. It displays the name of the last data file saved.

All operation modes displayed and accessible for changing in the status bar can be also switched on/off using control elements in the “Set options” window that can be activated by the Set options button or from the **Tools** and **Options** menu items. Some modes can be managed from the Pop-up menu

Data presentation

Presentation of the data measured or opened from the files takes place in five types of **windows**, entitled as **SPR1**, **SPR2**, **Subsidiary**, **Notes** and **View**. Many windows of the **SPR1**, **SPR2** and **Subsidiary** type can be opened simultaneously, but only one window of each type contains data which can be processed. Window arrangement can be controlled via the main menu or via the pop-up menus of these windows themselves. Only one instance of the **Notes** and **View** windows can exist.

The **SPR1 window** opens in all measurement modes except the stand-alone operating with the subsidiary channel. It is intended for direct display of the SPR curves being measured.

The **SPR2 window** opens in all measurement modes except the Single measurement mode and stand-alone operating with the subsidiary channel. It is intended for presentation of kinetic plots of the processes.

The **Subsidiary window** opens when the Subsidiary mode is switched on. It is intended for displaying the signal measured in the subsidiary measurement channel.

The **Notes window** is intended for the user’s comments to the measurement process.

The **View window** is intended for simultaneous representation of several previously obtained kinetic curves.

The **Monitor window** is intended for representation of measured cell and laser temperatures and source voltage.

The **Timer window** is opened as a separate window if one makes a mouse double-click on the timer indication in the top right corner of the **SPR2** window. If one makes a mouse double-click on the timer window field, the window will disappear and timer indication will return to the **SPR2** window.

Information displayed in the *SPR1*, *SPR2* and *Subsidiary* windows can be saved to file in text and graphic formats (see Data saving). Additionally, the window can be copied to clipboard (Copy Clipboard) or printed (Print graphic).

Information displayed in the *Subsidiary* and *Notes* windows is saved automatically when saving information displayed in the *SPR2* window in any text format.

Information displayed in the *View* windows can be saved to file in graphic format *.bmp or *.wmf, copied to clipboard or printed.

The **SPR1**, **SPR2**, **Subsidiary**, **View** and **Notes** windows can display the information previously saved in the text format (see Open file and Command Line).

SPR1 window

Windows of this type open automatically when it is necessary.

The **SPR1 window** is used in all measurement modes except the stand-alone operating with the subsidiary channel. It is

intended for presentation of measured SPR curves. If the **SPR1 in New Windows** mode is selected (this mode can be selected via the pop-up menu or main menu), then each new curve is plotted in a separate window. The curve number is displayed in the window title. Otherwise, all curves are plotted in the same window. In this case the **Auto Clear SPR1** mode can be switched on, then not more than 16 last curves will be shown simultaneously in the window.

Data plots read from the file are always displayed in a separate window.

On the OX axis the angle, degrees is laid off:

with the **Absolute angle** mode off – the prism turning angle,

with the **Absolute angle** mode on – the angle of incidence of light on the input face of the prism when the **in Air** mode is selected, or the angle of incidence of light on the top face of the prism when the **in Glass** mode is selected. These modes can be set via the Status bar, in the dialog box brought up by pressing the “Set Options” button or from the menu (see Data processing).

Signal magnitudes measured in the enabled channels are laid off along the vertical axis OY in arbitrary units.

In this window the measured SPR curves are plotted and positions of their minima are displayed if they have been found successfully. The minimum of the curve that corresponds to the first channel is displayed in red color, and the minimum of the curve that corresponds to the second channel is displayed in blue color.

If the flag of the **SPR1 legend** element in the pop-up menu (or in the Graphics window of the *Professional* program) is set, then the table with curves marks is displayed to the right of the plots.

With the cursor positioned within the window, the pop-up menu can be brought up by pressing the right mouse button. This

menu contains control elements for the main functions of the window.

The window can be also controlled via the main menu and the Set options window.

In the right top corner of the window the following information is displayed:

- The value of the last angle calibration;
- The last value that corresponds to the minimum of the curve measured in the first channel. It is displayed in red color;
- The last value that corresponds to the minimum of the curve measured in the second channel (for a two-channel device) and the number of the measured point (when the kinetics measurement is carried out). It is displayed in blue color.

SPR2 window

Windows of this type open automatically when it is necessary.

The **SPR2 window** is used in all measurement modes except the Single measurement mode and stand-alone operating with the subsidiary channel. It is intended for presentation of kinetic plots of the process under study.

Plots displayed in this window represent the kinetics of the angular position of the SPR curves minima (in the Multiple measurement and Track modes) or the signal magnitudes measured by enabled channels (in the Slope mode). For the two-channel instrument all information related to the first and to the second channel is displayed in red and blue color, respectively.

It is possible to operate in the mode when the difference of the signals measured in the first and the second channels is

displayed. Switching of the presentation modes can be made from the pop-up menu.

With the cursor positioned within the window, the pop-up menu can be brought up by pressing the right mouse button. This menu contains control elements for the main functions of the window.

The window can be also controlled via the main menu and the Set options window.

The horizontal scale (time scale) is set automatically.

The vertical scale is initially set equal to the horizontal scale of the SPR1 window (in the Multiple and Track modes) and the vertical scale of the SPR1 window in the Slope mode. In the course of the measurements vertical scale of the window can be changed in the following way:

- switch the **Full Graphic** mode to the **Link Graphics** mode. This can be done via the pop-up menu or via the status bar.
- change the **SPR1 window** scale to zoom into the region of interest. The **SPR2 window** scale will be changed automatically.
- switch the **Link Graphics** mode to the **Fix Left Axis** mode. The chosen vertical scale will be fixed.

In the right top corner of the window the following information is displayed:

- Current timer value. Clicking on the timer brings up a separate timer window, which can be dragged to any desirable position in the screen. To hide this window, click on it.
- The measurement time for the last data point.
- The slope ratio of the curve measured in the first channel.
- The slope ratio of the curve measured in the second channel (for a two-channel instrument).

It is possible to switch the curve points markers and the curve marking table (legend) on/off from the pop-up menu or in the Graphics page of the Set options window of the *Professional* program.

The following determination service possibilities are provided for processing of the data that are represented in the window:

- Mouse pointer coordinates determination.
- Determination of the distance between two points along the X and Y coordinates.
- Determination of the distances along the Y coordinates.
- Curve gradient determination.

These service possibilities are available from the pop-up menu. Operation results are displayed in two panels located in the bottom left corner of the window.

Service possibilities are more fully described in the Data processing section.

Subsidiary window

Windows of this type can be opened from the main menu: **Window/Subsidiary On**, or by pressing the button “**Subsidiary**” in the main window of the program.

The **Subsidiary window** is intended for displaying the signal measured in the subsidiary measurement channel.

It is possible to work with subsidiary channel only if this channel is enabled. To enable this channel, select the **5 (subsidiary)** element on the right panel of the **Advanced Options** page in the Set Options window of the *Professional* program.

Information displayed in this window can be saved in the graphic format and is always saved automatically when saving information displayed in the **SPR2** window in text format (see Data saving). The window can be also copied to clipboard (Copy Clipboard) or printed (Print graphic).

It is possible to switch the curve points markers and the curve marking table (legend) on/off from the pop-up menu, in the Graphics page of the Set options window of the *Professional* program or in the Advanced page of the *Express* program.

The following determination service possibilities are provided for processing of the data that are represented in the window:

- Mouse pointer coordinates determination.
- Curve gradient determination.

These service possibilities are available from the pop-up menu. Operation results are displayed in two panels located in the bottom left corner of the window.

Service possibilities are more fully described in the Data processing section.

For more detailed information about this window and the subsidiary channel see Subsidiary Channel.

Information displayed in this window is saved automatically when saving information displayed in the **SPR2** window in text format (see Data saving).

The **Subsidiary** windows can display the information previously saved in the text format (see Open file and Command Line).

Notes window

Windows of this type can be opened from the main menu:
Window/Notes.

The **Notes window** is intended for typing any user's comments to the measurement process.

Additionally, the following information is put into the window as a separate line:

- Current date and time upon the mouse click on the date or time representation fields in the **Notes** window;
- Results of service measurements (distance between two points, distance along the Y coordinates, curve gradient) in the **SPR2 window** upon the mouse click on this results representation fields in the **SPR2** window;
- Current experiment time upon the mouse click on the current time timer.

Information displayed in this window is saved automatically when saving information displayed in the **SPR2** window in text format (see Data saving).

The **Notes** windows can display the information previously saved in the text format (see Open file and Command Line)

View window

This window can be opened from the main menu:
Window/View.

The **View window** is intended for simultaneous representation of previously obtained results. This window can represent either SPR curves or kinetic curves. Type of the curves represented is

defined by the type of the curve which was loaded first in the window.

The curves for representation can be read from previously saved *.sp1, *.sp2 and *.spr files.

The time axis scale of the image is selected automatically according to the most long-duration kinetic curve loaded when representing kinetic curves. The OY axis scale is selected according to the **Axis Auto** option, which can be set in the **Viewing** panel on the Graphics page in the **Options** window. If this option is set, the scale is selected automatically in such a way that all displayed information is visible. Otherwise, the maximal value is set equal to the maximal OY scale value of all kinetic curves loaded, and minimal value is set equal to the minimal OY scale value of all kinetic curves loaded.

The contents of this window can be saved to file in graphic format *.bmp or *.wmf, copied to clipboard or printed. To do this, select **Save file**, **Copy clipboard** or **Print** items in the pop-up menu of the window, correspondingly.

Monitor window

This window can be opened from the main menu: **Tools/Monitor**.

The **Monitor window** is intended for:

- displaying the power supply voltage and warning upon its decrease lower than the specified value.
- displaying and specifying the cell temperature.
- displaying and specifying the temperature of the additional channel of the laser temperature stabilization.

The page contains 3 similar strings:

The **Cell t, C** string contains elements corresponding to the cell temperature: elements that indicate measured (at the left) and specified (at the right) temperature and an indicator button for switching the temperature stabilization mode on/off.

The **Temp2, C** string is similar to the previous string but it corresponds to the laser temperature. This string is not used in this device model.

The **Battery, V** string contains elements for displaying the power supply voltage (at the left) and specifying the power supply voltage at which the power supply emergency warning window is displayed (at the right).

Set Options

Set options of Professional program

Setting of options is executed in the “Options” dialog window. This window is activated by the “**Set Options**” button or the “**Options/Options**” menu item.

The “Options” window elements are located on eight pages.

Set main options

The **Set Options** page contains 5 panels with control elements:

The **General** panel contains the following elements:

Max angle, degree – specifies the angular prism rotation range when operating in the Single measurement and Multiple measurement modes and when searching for the operating point before measurement in the Track and Slope modes.

Operat. time, min – specifies the measurement time for all of the measurement modes except the Single measurement mode.

Time auto increase – when this flag *is set*, then after a lapse of the measurement time specified by the **Operat. time, min** control, the measurement time is prolonged automatically. If this flag *is not set*, the measurement time is fixed and after a lapse of the measurement time the system displays a request for prolongation of the measurement. This flag has an effect on all of the measurement modes except the Single measurement mode.

Full file name – this element is used when reading the previously saved files. When the flag *is not set*, the file name only is indicated, and when the flag *is set*, the full name (file name + path) is shown.

The **Multiple** panel contains the following elements:

Period, s – specifies the measurement period in the Multiple measurement mode. If the period specified is less than the time required for the measurement of one point, the measurement will be executed continuously.

Device initialization – when this flag *is set*, then before each SPR curve measurement the mechanical system of the instrument is returned to its initial position which is defined by the end sensor (device initialization). If this flag *is not set*, then device initialization is carried out once before the first SPR curve measurement.

The **Track** panel contains the **Deviation, degree** control element that specifies the angular scanning range in the Track mode. Maximum deviation of the prism from the angular position of the minimum equals to the half of the **Deviation, degree** value.

The **Slope** panel is intended for specifying Slope mode parameters and contains the following elements:

These three elements determine the method of calculation and presentation of the kinetics:

Rel.units – kinetics is displayed in ADC code units (relative units);

Grad.corr – kinetics is displayed in ADC code units but the values are corrected during the calculation by taking into consideration the SPR curve slope at the measurement point;

Degree – during the calculation ADC code values are recalculated into the effective angle change and kinetics is displayed in degrees.

These two elements determine the point on the SPR curve at which the measurement is executed:

50 % – before the start of the measurement mechanical system of the instrument is automatically set into position corresponding to a half of the altitude of the SPR curve left slope;

Pointer – program allows the user to select the position of the mechanical system by dragging the marker in the SPR1 window to prescribed position (when the left mouse button is pressed).

Delay, 0,1s – specifies the interval between the measurements.

The **AutoSave** panel is intended for managing automatic saving of experimental data during the operation. The **SPR 1** element switches on/off the Automatic data saving mode for SPR1 window, and the **SPR 2** element switches on/off kinetics autosaving (for SPR2 and Subsidiary windows). If one switches the SPR2 autosaving on, then the **Period, min** element is activated. This element specifies the autosave period for the SPR2 and Subsidiary windows. On default the kinetics (the SPR2 window) is saved to the “SPR2.sp2” file. The file name can be modified after pressing the **File** button.

Advanced options

The **Advanced Options** page contains 3 panels with control elements:

The first panel contains the following elements:

COM port – specifies PC COM port which the instrument is connected to. If this option is set to **Auto**, then the program will try to determine the port automatically.

Position control – switches on/off the mode of program tracking of allowable position of mechanical system of the instrument. It is not recommended to turn on this option.

Data repair automatically – activates (when the flag *is set*) or deactivates (when the flag *is not set*) the procedure of automatic repair of the data that program receives from the instrument. It is not recommended to turn off this option.

Laser control – activates/deactivates the automatic accounting of laser radiation instability.

Control elements in the **Channel On** panel allow to switch measurement channels of the instrument on (the flag is set) or off (the flag is not set). Elements that correspond to channels that are absent in the present instrument are unavailable to user.

The mode of measurement of external signal (Subsidiary) is unavailable when the 5-channel is turned off.

Pedestal, V and Amplification, mV/ru control elements in the **Subsidiary** panel are intended for set-up of amplification factor and position of the base line for the subsidiary channel (see Subsidiary channel calibration).

Independence – switches on/off the independent operation mode.

Period, 0.1s – this control element is active only when the independent mode is switched on; it allows to specify the measurement period for subsidiary channel in this mode.

Data Processing options

The **Data processing** page contains control elements for kinetics and SPR curve processing modes, which are more fully described in the Data processing section.

Mathematical data processing is controlled by the control elements which are set in 3 panels of the page.

The **SPR 1** panel contains control elements for the SPR curve processing:

The first element allows to select the method of the SPR curve minimum determination.

Absolute minimum – position of the minimum is calculated as the angular position of the absolute minimum of the curve when this element is selected.

Parabolic approximation – the SPR curve is approximated to the second-order polynomial and the minimum of this polynomial is calculated. It is possible to determine the SPR curve minimum even if the minimum point is out of the measurement range (e.g. during operation in the Track mode with narrow capture band (**Deviation, degree** = 1..2 degrees)) when operating in this mode. The further from the minimum the verified section is, the smaller the precision of the minimum determination is.

Average value – position of the minimum is calculated as the mean value of the centres of several line segments which connect two points that are located at grade on different slopes of the SPR curve. This method is supported in some versions of the program only.

Cubical approximation – the SPR curve is approximated to the third-order polynomial and the minimum of this polynomial is calculated. This method is supported in some versions of the program only.

Center of mass – this method is supported in some versions of the program only.

The minimum determination method can be also selected from the Status bar.

The SPR1 panel contains 3 control elements for managing the calculation of angles of incidence of light:

Absolute angle – if this flag is not set, then the SPR curve is determined according to the rotation angle of the prism table in the relative coordinates. If this flag is set, then the real (physical) angles of incidence of light are calculated.

Angle in Air – if this element is selected, then the SPR curve is determined according to the angle of incidence of light on the input prism face. When the beam reflected from the input prism face appears to lie above the incident beam, the angle of incidence is considered negative; in the opposite case it is considered positive.

Angle in Glass – if this element is selected, then the SPR curve is determined according to the angle of incidence of light on the top prism face (in glass).

One can also manage the calculation of angles of incidence of light via the Status bar.

Averaging – switches on/off the SPR curve averaging mode; if the averaging is switched on, then **n** measured points of the SPR curve are averaged into one point (**n** is the value that is specified in the **Number of points** window which is activated only if the **Averaging** element is marked). The averaging is made immediately during the measurement and all subsequent operations (such as minimum search, saving data to file etc.) are executed with averaged values. Thus number of points of the SPR curve is reduced by a factor of **n**. This mode is available during the single-channel instrument operation only.

Decimation – switches on/off the mode of the SPR curve “decimation”; if this mode is switched on and a value of **n** is set in the **Number of points** window, then saving SPR curve to file results in saving only **n** points that are uniformly picked from the measured array of points.

The **SPR 2** panel contains control elements for managing kinetics curve filters:

Peak-filter – switches on/off the single peak filtration mode for the kinetics curve;

Averaging – switches on/off the data averaging mode. The number of points averaged is determined by **For Slope, s** and **For non Slope, points** elements;

For non Slope, points – determines the number of points averaged in the Multiple measurement and Track modes;

For Slope, s – determines the time interval of the measurement during which the obtained points are averaged. In any case the averaging is executed using the “running window” method.

Switching of the modes on is indicated in the Status bar in the main window and it can be changed via the Status bar.

The **Subsidiary** panel includes control elements for managing the subsidiary channel window:

Averaging – switches on/off the measurements averaging mode;

Number of points – specifies the number of points that are averaged.

Graphics options

This page is intended for management of graphical information representation.

The **Graphics** page contains 5 panels with control elements:

The **SPR 1** panel contains the following elements:

Auto Clear SPR1 – allows/forbids automatic curves clearing in the SPR1 window. It works only if the **SPR1 in New Windows** mode is turned off. No more than 16 curves will be output into the plot if the **Auto Clear SPR1** mode is turned on.

It is also possible to switch this mode on/off via the Status bar.

Refresh Minimum – if this flag *is set*, the last values of the minima will be marked on the plots in the SPR1 window and the previous ones will be cleared. If this flag is *not set*, all old values will remain.

SPR1 legend – controls the representation of the curves marking table that is to the right of the plots.

The **Drawing acceleration** element allows to control the speed of the SPR1 curve representation. Increase in speed is achieved by plotting not all of the measured points (but all of the measured points are taken into account during the data processing and saving the data to a file).

The **SPR 2** panel contains the following elements:

SPR2 Marks – switches on/off point markers in the plots which are represented in the SPR2 window. Change of this mode is sent to the program immediately.

The following 3 elements specify the units of measurement which the kinetics is measured in. These elements are available

in the Multiple measurement, Track modes and in the Slope mode when the data is converted to the angular units.

Axis SPR2 – degree – sets the OY axis unit of measurement to degrees.

Axis SPR2 – angle minute – sets the OY axis unit of measurement to angular minutes.

Axis SPR2 – angle sec. – sets the OY axis unit of measurement to angular seconds.

Axis SPR2 – refr.index – sets the OY axis unit of measurement to refractive index.

SPR2 legend – controls the representation of the curves marking table that is right of the plots.

The **Subsidiary** panel contains the following elements:

Subsidiary Marks – switches on/off point markers in the plots which are represented in the Subsidiary window. Change of this mode is sent to the program immediately.

Subsidiary legend – controls the representation of the curves marking table that is right of the plots.

The **Adjustment** panel contains one element:

Adjustment legend – controls the representation of the curves marking table that is right of the plots.

The **Viewing** panel contains the following elements:

Axis Auto – if this element is turned on, the scale of the OY axis in the View window is selected automatically in such a way that all curves located in this window are visible; if this element is turned off, the scale is inherited from the curves that are called into the window.

The **Line width** element specifies the width of the lines which are used for plotting.

Color options

The **Set Color** page contains control elements that allow to specify color appearance of the SPR1, SPR2, Subsidiary and View windows. The window, which colors are being specified for, is selected by the left element.

It is possible to specify the following options for the first three windows:

- The color of the passive window.
- The color of the top part of the active window (Start Color).
- The color of the bottom part of the active window (End Color).

The window will have a gradient color if Start Color and End Color do not coincide.

All changes made are sent to the program immediately.

It is possible to select the color of the passive window only for the **View** window. This window will always have the selected color.

Sound options

The **Sound** page contains control elements for managing sound signals that accompany the program operation.

The **Sound On** element switches on/off all sound signals.

The **Start** string contains the following elements:

Control element for switching on/off the sound that accompanies the measurement beginning. If this element is selected, then the button is activated. A sound file can be selected

if one clicks on this button. The name of the selected file is displayed in the text field which is located in the middle of the string.

End of point, **End** and **Error** strings are similar and correspond to the end of the measurement of one kinetics point, the end of the measurement and the measurement error, respectively.

The sound that is defined by the **Ring** string is used upon the pumps control.

Device options

The **Device** page contains 2 panels with control elements:

The top panel contains the following elements:

Prism type – specifies the type of the used prism.

Refract. Index – specifies the refractive index of the prism material. The refractive index value is set automatically on selecting the prism type.

Angle, degree – specifies the working angle of the selected prism. The working angle is set automatically on selecting the prism type.

Correction, a.m. – specifies the correction for the working angle of the prism in angular minutes. This element can be changed by user. The last entered correction is stored by the system and used as a default value.

The lower panel contains the following elements:

Immers. Refr. Index – specifies the refractive index of the immersion.

Glass Refr. Index – specifies the refractive index of the glass carrying the active layer.

The program contains the built-in database which contains the following preset parameters:

- four prism types with correspondent refractive indices and working angles,
- two refractive indices for immersion,
- two refractive indices for glass.

If user introduces new values of refractive indices for the immersion or the glass material, these values are added to the database. It is possible to add 3 values of each parameter in such a way. The prism types are predefined and cannot be changed by user.

In addition, this page displays the instrument serial number and zero angle position obtained during the last Angle calibration.

If user has changed some parameters in this page, then on pressing the “**Ok**” button the program calculates and displays the utmost attainable angle of incidence of light from glass onto the active layer.

Monitor options

The **Monitor** page contains 3 panels with control elements:

The **Cell temperature**, C panel contains elements for indication of the measured temperature (at the left) and for specifying the cell temperature (at the right).

The **Temperature**, C panel contains elements for indication of the measured temperature (at the left) and for specifying the laser temperature (at the right). This panel is not used in the current device model.

The **Battery** panel contains elements for indication of the power supply voltage (at the left) and for specifying the power supply voltage at which the power supply emergency warning window is displayed (at the right).

Set options of Express program

Setting of options is executed in the “Options” dialog window. This window is activated from the main menu – “Options/Options” or via the pop-up menus. The open window appearance depends on the way of opening. If the window is opened using the main menu command, then all pages of the window will be available. Otherwise pages that relate to the selected operation mode will be available only.

Multiple Options

The **Multiple** page of the Express program contains control elements applicable for the Multiple mode:

Max angle, degree – specifies the angular prism rotation range.

Period, s – specifies the curves measurement period. If the period specified is less than the time required for one measurement, the measurements will be executed continuously.

1 channel On and **2 channel On** – allow/forbid the first and second channel operation, respectively.

Line width – specifies the width of the lines which are used for plotting.

The **SPR 1** panel contains the following elements:

Refresh Minimum – if this flag *is set*, the last values of the minima will be marked on the plots in the SPR1 window and the previous ones will be cleared. If this flag is *not set*, all old values will remain.

Legend – controls the representation of the curves marking table that is to the right of the plots.

The **SPR 2** panel contains the following elements:

Peak-filter – switches on/off the single peak filtration mode for the kinetics curve;

Averaging – switches on/off the data averaging mode. The number of points averaged is determined by the **Number of points** element;

Number of points – determines the number of points averaged;

Legend – controls the representation of the curves marking table that is to the right of the plots.

The **AutoSave** panel is intended for managing the automatic saving of the results obtained during the operation.

The **SPR 1** element switches on/off the Automatic data saving mode for SPR1 window, and the **SPR 2** element switches on/off kinetics autosaving (for SPR2 and Subsidiary windows). If one switches the SPR2 autosaving on, then the **Period, min** element is activated. This element specifies the autosave period for the SPR2 and Subsidiary windows. On default the kinetics (the SPR2 window) is saved to the “SPR2.sp2” file.

The file name can be modified after pressing the **File** button.

Track options

The **Track** page of the Express program contains control elements applicable for the Track mode:

The **Deviation, degree** element that specifies the angular scanning range. Maximum deviation of the prism from the angular position of the minimum equals to the half of the **Deviation, degree** value.

1 channel On and **2 channel On** – allow/forbid the first and second channel operation, respectively.

Line width – specifies the width of the lines which are used for plotting.

The **SPR 1** panel contains the following elements:

Refresh Minimum – if this flag *is set*, the last values of the minima will be marked on the plots in the SPR1 window and the previous ones will be cleared. If this flag is *not set*, all old values will remain.

Legend – controls the representation of the curves marking table that is to the right of the plots.

The **SPR 2** panel contains the following elements:

Peak-filter – switches on/off the single peak filtration mode for the kinetics curve;

Averaging – switches on/off the data averaging mode. The number of points averaged is determined by the **Number of points** element;

Number of points – determines the number of points averaged;

Legend – controls the representation of the curves marking table that is to the right of the plots.

The **AutoSave** panel is intended for managing the automatic saving of the results obtained during the operation.

The **SPR 2** element switches on/off kinetics autosaving (for SPR2 and Subsidiary windows). If one switches the SPR2 autosaving on, then the **Period, min** element is activated. This element specifies the autosave period for the SPR2 and

Subsidiary windows. On default the kinetics (the SPR2 window) is saved to the “SPR2.sp2” file.

The file name can be modified after pressing the **File** button.

Slope options

The **Slope** page of the Express program contains control elements applicable for the Slope mode:

Delay, s – specifies the interval between the measurements.

1 channel On and **2 channel On** – allow/forbid the first and second channel operation, respectively.

Line width – specifies the width of the lines which are used for plotting.

The **SPR 2** panel contains the following elements:

Three elements that determine the method of calculation and presentation of the kinetics:

Axis in rel.units – kinetics is displayed in ADC code units (relative units);

Axis in grad.corr – kinetics is displayed in ADC code units but the values are corrected during the calculation by taking into consideration the SPR curve slope at the measurement point;

Axis in degree – during the calculation ADC code values are recalculated into the effective angle change and kinetics is displayed in degrees.

Peak-filter – switches on/off the single peak filtration mode for the kinetics curve;

Averaging – switches on/off the data averaging mode. The number of points averaged is determined by the **Number of points** element;

Number of points – determines the number of points averaged;

Legend – controls the representation of the curves marking table that is to the right of the plots.

The **AutoSave** panel is intended for managing the automatic saving of the results obtained during the operation.

The **SPR 2** element switches on/off kinetics autosaving (for SPR2 and Subsidiary windows). If one switches the SPR2 autosaving on, then the **Period, min** element is activated. This element specifies the autosave period for the SPR2 and Subsidiary windows. On default the kinetics (the SPR2 window) is saved to the “SPR2.sp2” file.

The file name can be modified after pressing the **File** button.

Single options

The **Single** page in the **Options** window of the Express program contains control elements applicable for the Single mode:

1 channel On and **2 channel On** – allow/forbid the first and second channel operation, respectively.

Averaging – switches on/off the SPR curve averaging mode; if the averaging is switched on, then **n** measured points of the SPR curve are averaged into one point (**n** is the value that is specified in the **Number of points** window which is activated only if the **Averaging** element is marked). The averaging is made immediately during the measurement and all subsequent operations (such as minimum search, saving data to file etc.) are executed with averaged values. Thus number of points of the SPR curve is reduced by a factor of **n**. This mode is available during the single-channel instrument operation only.

Line width – specifies the width of the lines which are used for plotting.

Service options

The **Service** page in the **Options** window of the Express program contains two panels.

The **Color** panel contains control elements for color appearance of the SPR1, SPR2, Subsidiary and View windows.

The window which colors are being adjusted for is selected by the left element.

It is possible to specify the following settings for the first three windows:

- The color of the passive window.
- The color of the top part of the active window (**Start Color**).
- The color of the bottom part of the active window (**End Color**).

The window will have a gradient color if Start Color and End Color do not coincide.

It is possible to select the color of the passive window only for the **View** window. This window will always have the selected color.

The **Default** button is intended for setting of colors that are preset by the manufacturer.

The **Sound** panel contains control elements for sound signals accompanying the program operation:

The following elements are located in the **Start** string:

Control element for switching on/off the sound that accompanies the measurement beginning. If this element is

selected, then the button is activated. A sound file can be selected if one clicks on this button. The name of the selected file is displayed in the text field which is located in the middle of the string.

End and **Error** strings are similar and correspond to the end of the measurement and the measurement error, respectively.

The **Sound On** element manages switching all the sound signals on/off.

Advanced options

The **Advanced** page in the **Options** window of the Express program contains 3 panels with control elements.

The **Optics** panel contains the following elements:

Prism type – specifies the type of the used prism.

Immers. Refr. Index – specifies the refractive index of the immersion.

Glass Refr. Index – specifies the refractive index of the material of the glass carrying the active layer.

The program contains the built-in database which contains the following preset parameters:

- four prism types with correspondent refractive indices and working angles,
- two refractive indices for immersion,
- two refractive indices for glass.

If user introduces new values of refractive indices for the immersion or the glass material, these values are added to the database. It is possible to add 3 values of each parameter in such a way. The prism types are predefined and cannot be changed by user.

The **Subsidiary** panel contains control elements for the subsidiary channel:

Independence Period, s – specifies the measurements period in the subsidiary channel during its stand-alone operation.

Averaging – switches on/off the mode of measurement averaging; if the averaging is switched on, then **n** measured points are averaged into one point (**n** is the value that is specified in the **Number of points** window which is activated only if the **Averaging** element is marked).

Legend – switches the representation of the curves marking table of the **Subsidiary** panel on/off.

The **Adjustment** panel contains the **Legend** element which switches the representation of the signals marking table of the **Adjustment** panel on/off.

Additionally, the device serial number is displayed in this page.

If user has changed some optical parameters in this page, then on pressing the “**Ok**” button the program calculates and displays the utmost attainable angle of incidence of light from glass onto the active layer.

Work with data

Open File

Reading data files, previously saved in the text format (*.SP1, *.SP2, *.SPR or *.SPD).

When this command is sent, the program requests a file name, opens corresponding windows for the selected file and

loads the data from the file in these windows. Working with these data has no difference from working with the obtained experimental data (see Data presentation).

It is possible to load data files in different ways. If the View window is opened, then the files are loaded into this window. If this window is not opened, then the file is loaded into the SPR1 or SPR2 window depending on the file type.

The following actions are carried out when loading the SPR2 data file:

- search for the Subsidiary window information in the file. When such information is found, then this window is opened.
- search for the file with Notes window information. When such file is found, then this window is opened.

If the Multiple measurement mode has been operated with the Automatic data saving mode switched on, then autosaved SPR curve files can be also viewed (see Viewing the automatically saved files).

Viewing the automatically saved files

Reading data files, previously saved automatically in the Automatic data saving.

If the Multiple measurement mode has been operated with the **Automatic data saving** mode switched on, then autosaved SPR curve files can be also viewed. To do this, proceed as follows:

- Use the Open file command to open the file containing the kinetics data (SPR2). The SPR2 window that contains the kinetics plot will be opened.

- Switch on the SPR2 Marks mode if it has not been set.
- With the CTRL keyboard key pressed, click on the point of interest on the kinetics curve with the left mouse button. If the SPR curve file that corresponds to this point is found, the SPR1 window will open and this file will be loaded in this window. In case the file is not found, the program will display a corresponding warning message.

Alternatively, the automatically saved SPR curve files can be viewed as usual files.

Save File

Data saving in a file.

To save data, press the **Save** button in the main window or select the **Save** command from the main menu or from the pop-up menu of any window.

If this command is sent from the main menu or using the button in the main window, then the program will suggest to save data in the currently active window (the active window is indicated by color); if this command is sent from the pop-up menu, then the program will save data contained in that window which pop-up menu the command has been sent from.

After sending the command the program requests the file name and opens it for writing. File format is determined by the file name extension the user has defined in response on the system request.

Information from the **SPR1**, **SPR2** and **Subsidiary** windows can be saved in text (*.SP1, *.SP2, *.SPD or *.CHD) or graphic format (*.BMP or *.WMF). Information from the **View** window can be saved in graphic format only (*.BMP or *.WMF).

Note: Data stored in the **SPR2** and **Subsidiary** windows are saved simultaneously in the same file. Information contained in the **Notes** window is stored in a separate file, which is saved simultaneously with the **SPR2** window.

It is recommended to keep all data files in the “Data” folder, which is created automatically during installation of the program.

Data saved in the text format can be read using the Open file command or on starting the application using the Command line. Previously saved files can be also loaded into the View review window.

For more detailed information about *.SP1, *.SP2 and *.SPD file formats see Data files format.

Note: If some files were not saved, then the program will suggest saving them on exit.

Automatic data saving

Automatic data saving mode is intended for automatic saving of SPR and kinetics curves to text files in the *.sp1 and *.sp2 formats, correspondingly. Automatic data saving of SPR curves is available only in the Multiple measurement mode while automatic saving of kinetics curves is available in any kinetics measurement mode.

To switch the automatic data saving mode on/off, select the options setting mode (Set Options) and select the **Set Options** page.

For automatic saving of SPR curves, mark the **SPR 1** element. If this mode is set, then after beginning of the measurement in the Multiple measurement mode a dialog window **AutoSave data as text** is opened. It is possible to select or introduce the base file name in this window. After the measurement of each SPR curve, the program will save data to the file with a name, received by addition of the file number to the base name.

If the automatic data saving mode is enabled, the AutoSave button in the main window becomes available. This button can be used for on the fly switching this mode on/off in the course of the measurements.

After each file is saved, its name appears in the rightmost field of the Status bar.

By default this mode is disabled, and can be enabled as described above or by opening the *.SP2 file previously saved with the enabled automatic data saving mode.

Note: Up to 999 files can be saved in this way. In case of need to save more data files, switch the automatic data saving mode off, introduce another base file name and switch it on again.

For automatic saving of kinetics curves, mark the **SPR 2** element. Switching on this mode activates the **Period, min** element that allows to specify the period of autosaving for SPR2 and Subsidiary windows data. Default file name for saving the kinetics data is “**SPR2.sp2**”. To change the file name, press the **File** button and introduce a new name.

After each file is saved, its name appears in the rightmost field of the Status bar.

The state of the SPR2 autosaving mode is stored when you exit the program and is used as a default setting at the next

program starting.

Data files format

Experimental data can be saved to files in the ***.sp1**, ***.sp2**, ***.spd**, ***.bmp** and ***.wmf** formats. The old files format ***.spr** is also supported.

The ***.sp1**, ***.sp2** and ***.spd** files are text files. Data, corresponding to the **SPR1** window, are saved to ***.sp1** files, and data, corresponding to the **SPR2** window, are saved to ***.sp2** files.

The ***.SP1** file has the following format:

The first string contains the following service information: window name (**spr1**), number of the points, initial and final OX axis values (in angular minutes), initial and final OY axis values (in relative units), information about the coordinates, which the data and correction value (in angular minutes) are recorded in.

Information about the coordinates, which the data is recorded in, can have the following values: **degree** or **a.m.** – information is recorded in the relative angles; **deg.(air)** or **a.m.(air)** – absolute values of angles of incidence of light on the prism; **deg.(glass)** or **a.m.(glass)** – absolute values of angles of departure of light from the prism.

The second string consists of the headers of data columns located below.

In the first data column angle values are recorded in tens of angular seconds (e.g. 120 means 1200 angular seconds or 20 angular minutes), in the rest of the columns signal values in the enabled channels are recorded in relative units. If the column is filled with zeros, the channel corresponding to this column is

disabled.

The *.SP2 file has the following format:

The first string contains the following service information: window name (spr2 or spr3), number of the points, initial and final OX axis values, initial and final OY axis values, information about the coordinates, which the information is recorded in.

Information about the coordinates, which the information is recorded in, can have the same values as for the **SPR1** window (see above).

The second string consists of the headers of data columns located below.

In the Multiple measurement and Track modes time in seconds is recorded in the first column, angle corresponding to the minimum of the 1 channel in tens of angular seconds is recorded in the second column, angle corresponding to the minimum of the 2 channel in tens of angular seconds is recorded in the third column, subsidiary external channel data is recorded in the fourth column.

In the Slope mode in the first column time is recorded in seconds, if the measurement delay exceeds 1 second (**Period, s** exceeds 1); otherwise, time is recorded in 0.1 s. Signal values in the 1 and 2 channels are recorded in the second and third columns, respectively, and subsidiary channel data is recorded in the fourth column.

*.SPD file format differs from the *.SPx file format in the following way:

- angular values are recorded in degrees (with three symbols after the decimal point), not in the tens of

angular seconds,

- every twentieth measured point is recorded to the file corresponding to the **SPR1** window, i.e. a Decimation procedure is carried out automatically while recording the file.

The *Subsidiary* window data are saved simultaneously with data contained in the **SPR2** window in the same file.

The *Notes* window information is saved simultaneously with data contained in the **SPR2** window in a separate file, which have the same name as the **SPR2** data file but with the *.txt extension.

Copy Clipboard

Copying the data from the **SPR1**, **SPR2**, **View** or **Subsidiary** window into the system Clipboard for further use in other applications.

If this command is sent using the Button or from the main Menu, the data displayed in the currently active window will be copied to Clipboard. The active window is indicated by the change of its color.

If this command is sent from the pop-up Menu, the data displayed in the window, which pop-up menu the command has been sent from, will be copied to Clipboard.

Print graphic

Printing out the plot displayed in the **SPR1**, **SPR2**, **View** or **Subsidiary** window on the printer selected through the print dialog.

If this command is sent using the Button or from the main Menu, the plot displayed in the currently active window will be printed out. The active window is indicated by the change of its color.

If this command is sent from the pop-up Menu, the plot displayed in the window, which pop-up menu the command has been sent from, will be printed out.

Data processing

This instrument is constructed according to the Kretschmann's configuration. Angular distribution of intensity of the reflected light is determined during the mechanical rotation of the measuring prism. Precision mechanical system and built-in fine position determining system allow to determine absolute angles of incidence of light.

The following information is used during the calculation of absolute angles of incidence:

- The result of angular positioning of the system with respect to the inner reference point (**Zero position**), which is carried out on pressing the Calibration button.
- Prism parameters specified by user in the **Device** window (see Device information). This window also displays the result of the last instrument calibration.
- Absolute angular position of the inner reference point defined by the manufacturer and stored in the `Devicedat.dat` file.

The angles are recalculated directly in the course of measurements and used for plotting the curves. The following information is used depending on the options setting:

turning angles of the prism table, if the **Relative angle** mode is set;

angles of incidence of light on the input prism face in the **Absolute Angle in Air** mode;

angles of incidence of light on the top prism face in the **Absolute Angle in Glass** mode.

The same angles will be saved in the data file created on pressing the Save file button or during the files autosave.

Data processing is executed both immediately during the device operation and when processing obtained results.

During the device operation the following information processing is executed.

The kinetics is determined as the change in the angular position of the minimum of the SPR curve during the kinetics measurements in the Multiple measurement and Track modes. Several methods are used to determine the angular position of the minimum:

Absolute minimum – position of the minimum is calculated as the angular position of the absolute minimum of the SPR curve. This method is the most reliable and stable, but not very precise.

Parabolic approximation – the SPR curve is approximated to the second-order polynomial and the minimum of this polynomial is calculated. It is possible to determine the SPR curve minimum even if the minimum point is out of the measurement range (e.g. during operation in the Track mode with narrow capture band (**Deviation, degree** = 1..2 degrees)) when operating in this mode. This is the most advanced method; it is characterized by the lowest noise of the kinetics curve. This method is defined as default.

Average value – position of the minimum is calculated as the mean value of the centres of several line segments which connect two points that are located at grade on different slopes of the SPR curve. These points are chosen in the vicinity of the minimum.

Cubical approximation – the SPR curve is approximated to the third-order polynomial and the minimum of this polynomial is

calculated. Unfortunately, calculation errors may be sometimes observed when using this method of the minimum determination.

Some versions of the program also use such a method of the determination of the SPR curve minimum as **Center of Mass**. Stability of this method is also lower than of Parabolic approximation method.

Note: The latter three methods are implemented in some program versions only.

Angular position of the SPR curve minimum can be converted to the equivalent value of refractive index of the medium under investigation during the measurement of absolute angles. These two methods differ only by the kinetics representation mode. Representation modes can be controlled via the pop-up menu of the SPR2 window or on the **SPR 2** panel in the Graphics page of the **Options** window of the *Professional* program.

During the kinetics measurement in the Slope mode the kinetics is determined as a change of a signal due to the SPR curve shift when the device mechanical system is fixed. The kinetic curve can be plotted either as a direct signals change (with or without taking into account the SPR curve steepness in the measurement point) or as a result of conversion of a signals value to the equivalent value of the SPR curve minimum shift. Kinetics representation modes, which are described in the previous paragraph, are available in the latter case. The kinetics presentation method can be controlled via the pop-up menu of the SPR2 window or by the elements on the **Slope** panel in the Options window:

Rel. units – kinetics is determined as the signals values that are changed due to the SPR curve shift.

grad. Corr. – kinetics is determined as the signals values that are changed due to the SPR curve shift, taking into account the SPR curve steepness in the measurement point.

degree – signals change is converted to the equivalent shift of the SPR curve minimum.

Two methods of the SPR curve processing are provided:

Averaging – the SPR curve averaging. After switching this mode on, it is possible to define the number of averaged points **n**. The averaging is made immediately during the measurement and all subsequent operations (such as minimum search, saving data to file etc.) are executed with the averaged values. Thus number of points of the SPR curve is reduced by a factor of **n**. This mode is available during the single-channel instrument operation only.

Decimation – this is the mode of SPR curve “decimation”. After switching this mode on, it is possible to define the number of points **n** that will be saved to file. In this mode only **n** points that are uniformly picked from the measured array of points will be saved to file. This mode affects only the SPR curve saving to file.

Both modes reduce the information quantity that is saved to file. The difference between these modes is that averaging additionally smoothes the SPR curve.

Two methods of the kinetics curve processing are provided.

Peak-filter – allows to filtrate sizeable single-point peaks on the kinetics curve.

Averaging – switches on/off the data averaging mode. The number of points averaged is determined by **For Slope, s** and **For non Slope, points** elements.

For non Slope, points – determines the number of points averaged in the Multiple measurement and Track modes;

For Slope, s – determines the time interval of the measurement during which the obtained points are averaged. In any case the averaging is executed using the “running window” method.

Switching of the modes on is indicated in the Status bar in the main window and it can be changed via the Status bar.

The subsequent information processing includes the following possibilities.

Service possibilities, which are provided for the data in the **SPR2** window, are described below. These possibilities can be turned on by selecting the corresponding **Tools** submenu item in the pop-up menu of the **SPR2** window. These possibilities can be also turned on from the **Tools/SPR2** window in the Main menu. Only one possibility can be turned on at the same time. The results are depicted in two panels located in the bottom left corner of the window. All results are presented in the same units the plot is represented in.

1) If the **Coordinate** element is selected, the mouse pointer coordinates determination takes place while the mouse pointer moves over the plot.

2) If the **Distance** element is selected, the distance between two sequentially specified plot points is determined. The distances along the X and Y coordinates are determined separately.

3) If the **Delta Y Line** element is selected, an **Assign first point.** prompt appears in the top left corner of the main window. Following the prompt, it is necessary to press the left mouse button and place the arisen dotted horizontal line at the selected level on the plot. An **Assign second point.** prompt will appear. Following this prompt, it is necessary to specify the second level in the same way as the first. The result will contain the distance between the marked levels along the Y coordinate.

4) If the **Delta Y Region** element is selected, the distance between the average values of the points which are included in two selected regions is determined. Each region is defined by two outermost points which are specified by user following the **Assign**

first point., **Assign second point.**, **Assign third point.** and **Assign fourth point.** prompts correspondingly.

5) If the **Gradient** element is selected, the curve gradient between two points, which are specified following the **Assign first point.** and **Assign second point.** prompts correspondingly, is determined.

Two service possibilities are provided for the data in the **Subsidiary** window. These possibilities can be turned on by selecting the corresponding **Tools** submenu item in the pop-up menu of the **Subsidiary** window. These possibilities can be also turned on from the **Tools/Subsidiary** window in the Main menu.

1) If the **Coordinate** element is selected, the mouse pointer coordinates determination takes place while the mouse pointer moves over the plot.

2) If the **Gradient** element is selected, the curve gradient between two points, which are specified following the **Assign first point.** and **Assign second point.** prompts correspondingly, is determined.

Pop-up menus

The **SPR1**, **SPR2**, **View** and **Subsidiary** windows are possessed of the pop-up menus. The pop-up menu is called by the mouse click on the correspondent window using the right mouse button. For the most of windows the pop-up menu contains the following items:

Align – in its turn, contains embedded menu that controls the window arrangement. All submenu items have standard meaning except the **Normalized** item. When this item is selected, the **SPR1** window is placed in the left third part of the screen and has the full screen height, and the **SPR2** window is placed on the right from the **SPR1** window. If the **Subsidiary** window is

opened, the SPR2 window height is halved and the Subsidiary window is placed underneath the SPR2 window.

Copy Clipboard – copies the contents of the window, which the pop-up menu was called from, to the system Clipboard.

Save Graphic – saves the information contained in the window, which the pop-up menu was called from, to the file (see Save file).

Print – prints out the plot contained in the window, which the pop-up menu was called from, using the system printer (see Print).

Delete Window – deletes the window, which the pop-up menu was called from.

Note: This is the only method to delete the already open windows.

Pop-up menu in each window contains specific items in addition to the common items.

Pop-up menu in the **SPR1 window** contains the following specific items:

Minimum Search – allows to find and to display the minimum of the last SPR curve measured or opened from the file. For example, it is possible to look how the found position of the minimum will change, if the method of minimum finding is changed (via the Status bar or from the main menu **Tools/Options**).

Clear SPR1 – clears the window by deleting all previously plotted curves. This menu item is duplicated by the similar button.

Auto Clear SPR1 – turns on the mode, during which not more than 16 curves are plotted in the window. After that the window is cleared, and the next 16 curves are plotted etc. This mode can be also controlled via the Status bar.

SPR1 in New Windows – when this item is selected, each measured SPR curve is plotted in a separate window. Otherwise,

all curves are displayed in the same window. This menu item is duplicated in the main menu.

Legend – controls the representation of the curves marking table that is to the right of the plots.

Pop-up menu in the **SPR2 window** contains the following specific items:

Difference – when this item is selected, the curve that presents the arithmetic difference of the curves correspondent to the 1 and the 2 channels is plotted in the **SPR2** window. Otherwise, kinetic curves are plotted for each channel. This element is available for two-channel instrument only.

The **Axis-units** submenu which contains elements that define measurement units for outputting the kinetics in the window. During operation in the Slope mode submenu elements are available, if the Degree mode is turned on. This mode can be turned on the **Set Options** page in the **Options** window. If the measurements are executed in this mode, the measured signal level is converted into the effective change of the angular position.

Angle degree – measurement units – degrees.

Angle minute – measurement units – angular minutes.

Angle second – measurement units – angular seconds.

Refr.Index – the measured kinetics is converted to the effective value of refractive index of the medium.

The **Tools** submenu which contains elements for turning on the service possibilities for processing of the data represented in the window.

Coordinate – turns on the mode of mouse pointer coordinates determination while it moves over the plot.

Distance – turns on the mode of determination of the distance between two sequentially specified plot points. The

distances along the X and Y coordinates are determined separately.

Delta Y Line – turns on the mode of determination of the distance between two sequentially specified levels along the Y coordinate.

Delta Y Region – turns on the mode of determination of the distance (along the Y coordinate) between the average values of points which are included in two selected regions.

Gradient – turns on the mode of determination of the curve gradient between two selected points.

It is also possible to turn on service possibilities from the Status bar.

The **Link mode** submenu which contains elements for scaling of the vertical axis of the plot displayed in the SPR2 window.

Full Graphic – the full window with the initially set scale.

Link Graphics – when the plot scale in the SPR1 window is changed, the OY axis scale of the plot in the SPR2 window changes automatically.

Fix Left Axis – breaks the link between the SPR1 and SPR2 windows and stores the OY axis scale previously specified in the **Link Graphics** mode.

These modes can be also switched from the Status bar or the **Graphics** page in the **Set options** window (see Graphics).

SPR2 marks – when this item is selected, the points on the curves displayed in the SPR2 window are marked with markers. This function is similar to the function of the **SPR2 marks** element in the Graphics window.

Legend – controls the representation of the curves marking table that is to the right of the plots.

Pop-up menu in the **Subsidiary window** contains the

following specific items:

Independence – when this item is selected, the independent operation mode is switched on. In this mode the measurement starts immediately after the window is opened and it is performed periodically after a period of time specified by the timer. Otherwise, the measurement is performed simultaneously with the SPR kinetics measurement. It means that the measurement is performed when the next kinetics point is determined (the minimum position in the Multiple measurement and Track modes or the signal measurement in the Slope mode).

Note: If any kinetics measurement is switched on, the instrument will automatically switch to the synchronous operation mode.

The **Tools** submenu which contains elements for turning on the service possibilities for processing of the data represented in the window.

Coordinate – turns on the mode of mouse pointer coordinates determination while it moves over the plot.

Gradient – turns on the mode of determination of the curve gradient between two selected points.

Subsidiary marks – when this item is selected, the points on the curves displayed in the **Subsidiary** window are marked with markers. This function is similar to the function of the **Subsidiary marks** element in the Graphics window.

Averaging – turns on/off the averaging mode. Number of points which are averaged is defined on the **Data processing** page in the Options window.

Pop-up menu in the **View window** contains the following specific items:

Add File – adds kinetic from the new file to the window.

Clear – clears the window.

Axis Auto – if this option is set, the scale is selected automatically in such a way that all displayed information is visible. Otherwise, the maximal value is set equal to the maximal OY scale value of all kinetic curves loaded, and minimal value is set equal to the minimal OY scale value of all kinetic curves loaded.

Legend – controls the representation of the curves marking table which is to the right of the plots.

Additionally, the Kinetics button in the *Express* program has its own pop-up menu.

Managing Channel

Concept of the managing channel makes sense only for the multi-channel instrument. Selection of the managing channel implies the selection of the channel in which the minimum is tracked in the Track mode or the channel, by the signal of which the system is positioned for the measurement in the Slope mode. It is possible to select the managing channel in the **Managing Channel** window, which is automatically opened after the initial measurement of the whole SPR curve in the modes indicated above.

The **Managing Channel** window is opened if more than one channel is enabled.

The managing channel selection is performed through the left panel of the window. In the right panel any measurement channel can be switched on/off, as well as through the **Channel On** panel in the Set options window.

Device information

It is possible to receive information about the available prisms, the device number and the value of the last device Calibration using the **Options/Options/Device** Main menu item of the *Professional* program or **Options/SetOptions/Advanced** command of the *Express* program.

Upon this the **Device (Advanced)** page in the **Options** window is opened, where one can:

- choose the working prism from the suggested list and, if necessary, introduce corrections for its parameters,
- choose (or introduce) information about the immersion liquid and the substrate glass,
- find out the device number and the last value of the Angle calibration.

If there is a theoretical limitation on the maximum angle of incidence of light on the active layer with the introduced parameters, it will be displayed on closing the **Device** window.

Command line

One parameter can be specified in the command line of the program call.

The program accepts two types of the parameters:

1. If the command line parameter represents a file name that has the **.SP1**, **.SP2** or **.SPD** extension, then the program will open this file in the same way as in the Open file mode.

2. On starting the program, it detects the instrument and checks some instrument parameters. If the instrument is not detected, the error messages are displayed. If the “debug”

command line parameter is specified, the program will be executed in a special mode, which allows operation without the instrument with some limitations.

Pump control

The device can be completed with rotary pumps from Thomas or plunger pumps based on disposable syringe from BogMark™ with 11 ml volume for support of probe pumping through the cells. Liquid probe pumping velocity range depends on the type of the pump used. Rotary pumps provide pumping velocity 500 ul/min..0,5 l/min, and plunger pumps – 1 ul/min..10 ml/min.

Pumps management is realized from the “Pump control” (or “Rotary Pump control”) window which is called from the main menu or by pressing the **Pump control** button in the main window. The window type is defined by the type of pumps supplied with the device. These windows are almost similar and provide the following possibilities:

1. Independent two pumps control.
2. Adjustment of the pumping velocity in the range indicated above.
3. Measurement of the pumped liquid volume.
4. Indicators of the position of the syringe plunger for plunger pumps.
5. Pumps operation programming.
6. Switching on/off the following modes:
 - Probe pump-out (Drain) mode; this is the operational mode.
 - Accelerated pump-out mode.
 - Pump mode.
 - Stop mode.

- Pause mode. *For plunger pump only.*
- Accelerated pump mode for syringe evacuation. *For plunger pump only.*

Note: It is recommended to carry out measurements with the device in the Drain mode.

Windows are divided into two similar panels; each of these panels contains control elements for “its” pump.

There is an element indicating the current probe volume being pumped in the bottom right corner of each panel. It is possible to zero the current value by clicking on this element with mouse.

A button that opens the pumps programming panel is located in the top right corner.

A button that switches the “on top of other windows” mode on is located in the top left corner.

As for the rest, the windows interface is intuitively obvious and self-explanatory.

Pumps programming

To program the pumps operation and operate them according to the program it is necessary to call the “Pump control” (or “Rotary Pump control”) window from the main menu or by pressing the **Pump control** button. There is a button that opens the pumps programming panels in the top right corner of this window. These panels contain 3 buttons each:

- “**Run script**” – switches on the operation according to the program.
- “**Stop script**” – stops the operation according to the program.
- “**New/Edit script**” – allows to develop or edit the program.

The **Edit script** window is opened upon switching on the development/editing mode.

New program development starts from choosing the required action (Action) by the selection element located in the top service string of the window. The following actions are provided:

- Fast drain – rapid pump-out.
- Drain – pump-out. This is the main operation mode which is generally used during the measurements.

- Fast pump – rapid pump. *For plunger pumps only.* This action is used for syringe evacuation.

- Pump – pump.
- Stop.
- Pause.

Elements allowing to specify time of operation (min), pumping velocity (ml/min), probe volume (ml) for the selected action are activated in the top service string of the window after selecting an action. After specifying required parameters it is possible to activate the next program string from the pop-up menu or by pressing the **Next line** button. It is possible to return to previous strings and edit them. To save created program, choose the **Save** button or corresponding pop-up menu item.

To edit previously created file, call it by pressing the **Open file** button and edit it.

Monitoring and stabilization of the temperature

The following additional possibilities are provided in the device:

- Monitoring and stabilization of the cell temperature.
- Additional monitoring channel and stabilization of the laser temperature.
- Monitoring of the power supply voltage.

Switching of the monitoring mode on is indicated by periodical red coloring of buttons/indicators in the “On” column of the window.

The monitoring mode is switched on upon the Monitor window call that can be called from the main menu: **Tools/Monitor** or **Tools/Stabilize Cell**. In the first case only the **Monitor** window is called and in the second case the **Monitor** window is called and the cell temperature stabilizing mode is switched on.

When the monitoring mode is on, the periodical measurements of power supply voltage and temperature of the cell and additional temperature channel are carried out and measured values are displayed in the **Monitor** window. A power supply emergency warning window is displayed upon power voltage decrease to the previously specified value.

The cell temperature stabilization is possible only if the special cell with built-in heater and thermometer is used. Temperature stabilization occurs by means of cell warming so the stabilizable temperature cannot be lower than the ambient temperature.

It is possible to switch the temperature stabilization of the cell and/or additional temperature channel on/off from the main menu by choosing **Tools/ Stabilize Cell** and **Tools/Stabilize t2** items correspondingly or from the **Monitor** window by clicking on the corresponding button/indicator located in the “On” column.

It is possible to specify the stabilization temperature and power monitoring actuation level from the Monitor page in the **Options** window or directly from the **Monitor** window using elements located in the “Set” column.