User's Manual

Scanning Photo Current Microscope (SPCM01)

Sejong Scientific Instruments (Inc.)

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Name of equipment: Scanning Photocurrent microscope

Model: SPCM01

Product Information:

While the main function of this product is photocurrent mapping, it includes various convenient functions such as auto focusing, I-V curve measurement, and photocurrent change curve measurement over time. It is used as a useful tool to study the characteristics of solar devices as well as nano devices.

Hardware Description:

(Rear side of device) There are two BNC connectors on the back of the device for power switch and bias voltage input or photocurrent signal output. These two BNC connectors are connected to the header pins of the breadboard to connect to the device located on the front side. In other words, the BNC connector is used to connect to external equipment such as a sourcemeter or multimeter.

(Front of equipment) The front universal board header pin is used for direct connection to the sample device. To prevent static electricity damage for measurement of nano devices, extra sockets are provided so that the +/- terminals can be shorted using header pins.

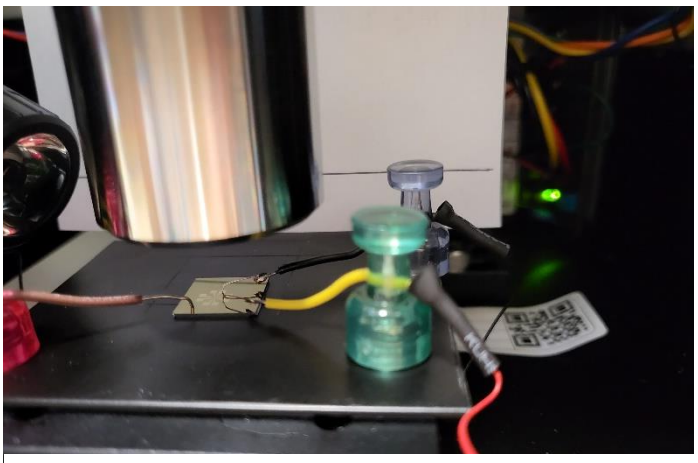

Figure 1 If there is no wire in the sample and only electrodes, connect the wires using a magnet holder

Mounting the sample device

Because the inside of the instrument is dark, the LED light is turned on by using the internal light switch on the left to mount the sample. This product is designed to measure a variety of general samples, including PN junction devices or photovoltaic devices, as a device for measuring devices on a 1-2 cm-sized substrate made for research. You can see a rectangle drawn over the sample

stage. Place the sample within this area so that the part to be scanned. Header sockets and pins are provided so that it can be used both when the sample element is connected with wires and when there are only electrodes on the board without wire. If there are wires, wrap the wires around the pin and insert it into the socket. If there is no wire, it can be connected to the electrode using three metal probes on the sample stage. The probes are fixed to a magnetic handle and the magnetic handle is designed for horizontal positioning.

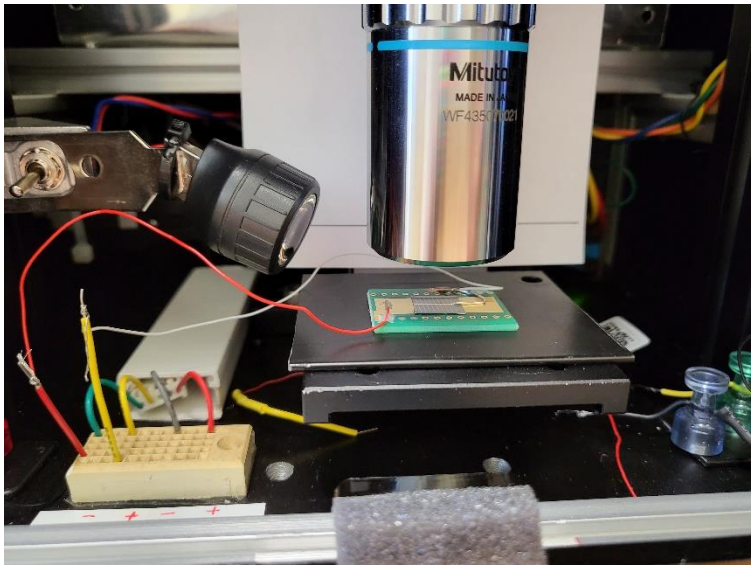

Figure 2 Header socket and pin connection photo for connecting the wire of the sample

Height of sample:

This product is designed to be able to adjust the sample height in a wide height range of 1 cm or more. The approximate height of focus can be estimate by placing the objective lens to be at the line on the white sheet at the back of the sample to roughly align the position of the sample surface. If the height of the sample is high, lower the Z value by that height.

XY positioning of sample:

To position the sample to be measured at the laser focus, first click the "illuminate" "On" button on the right menu of the app. When the Illuminator is turned on, you can see the white light coming down through the objective lens on the surface of the sample. Just place the area to be measured on the sample where this white light shines. Moving the sample is operated using the app's menu. (Refer to Displaying and Changing the Location and the Shortcut Button on the Right of the Main Screen)

At the bottom of the right menu are +X, -X, +Y, -Y, +Z, -Z buttons. You can move them in that direction by clicking or holding them. It moves by 10 um per click.

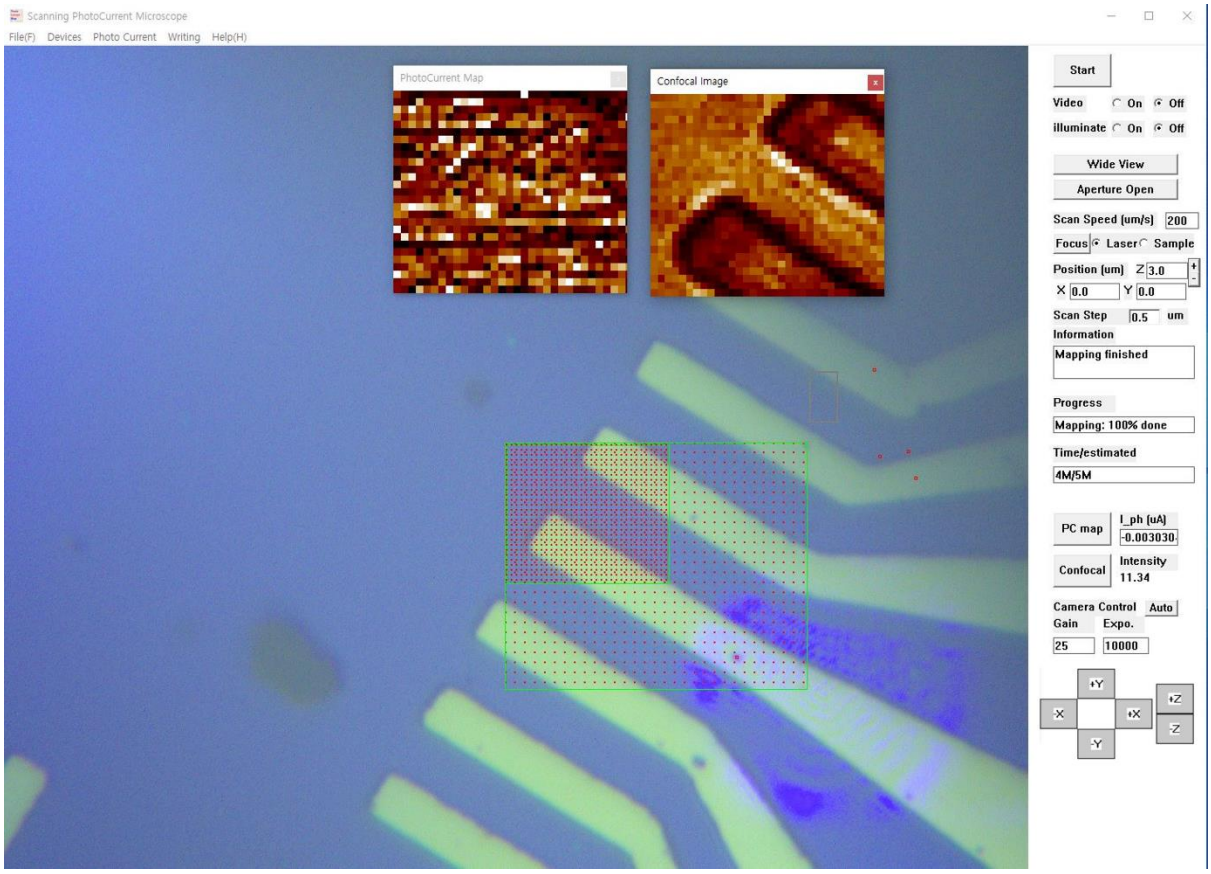

Figure 3 Screen image of Windows app "SPCM.exe"

Shortcut button on the right side of the main screen

(Start button) There are various input/output windows and operation buttons on the right side of the main window. (See Fig. 3) The "Start" button at the top is a button to start scanning. Pressing the button starts scanning. Before starting the scan, first set the area to be measured through mouse dragging. If you want to stop scanning, you can either click this button again or left-click anywhere in the main window. At this time, if a new message window appears, confirm once more and decide whether to stop or continue the scan. Map data is automatically saved even when scanning is finished or interrupted.

(Data saving folder) When a user starts a measurement, a folder marked with the current date and time is automatically created in the data folder on the desktop, and data is always automatically saved when the measurement is finished.

(Video button) If you press the "Video On" button, the video image grabbed by the camera mounted on the microscope is displayed on the main window in real time, and if the "Off" button is pressed, the video image output is stopped.

(Illumination button) When the "On" button is pressed, the LED light for sample observation connected to the objective lens turns on, allowing observation of the sample surface. Press the "Off" button to turn off the light.

(Laser button) Press the "On" button to turn the laser on, press the "Off" button to turn it off.

(Wide view button) Since the field of view may be narrow to observe the sample using a 50x objective lens, if you press this button to provide a wide field of view, 9 images taken from the surrounding area are patched and displayed on one screen.

(Motor speed) Enter a number in the input box next to "Scan Speed (um/s)" and press the Enter key to set the moving speed of the sample during the scanning process. However, the actual scanning time is greatly affected not only by this scan speed, but also by the interface between the confocal image and the photocurrent measuring device.

(Focus button) Press the "Focus" button to start the process of focusing automatically. In this process, you can check the process of adjusting the focus on the screen while the z-axis motor moves. The laser and sample radio buttons right next to the focus button are buttons to check the laser focus and sample position, respectively. Press the Laser button to turn off the illuminator and turn on the laser. By minimizing the exposure time and amplification factor of the camera, it makes it easy to check the focus of the laser. In this state, to fine-tune the position of the focus, place the mouse cursor over the focus and right-click to adjust the focus. Once the adjusted position is saved on the hard disk, the adjusted position is memorized even when the program is newly started. When the sample button is pressed, the laser is turned off, the illuminator is turned on, and the brightness of the camera is automatically adjusted so that the surface of the sample can be easily checked.

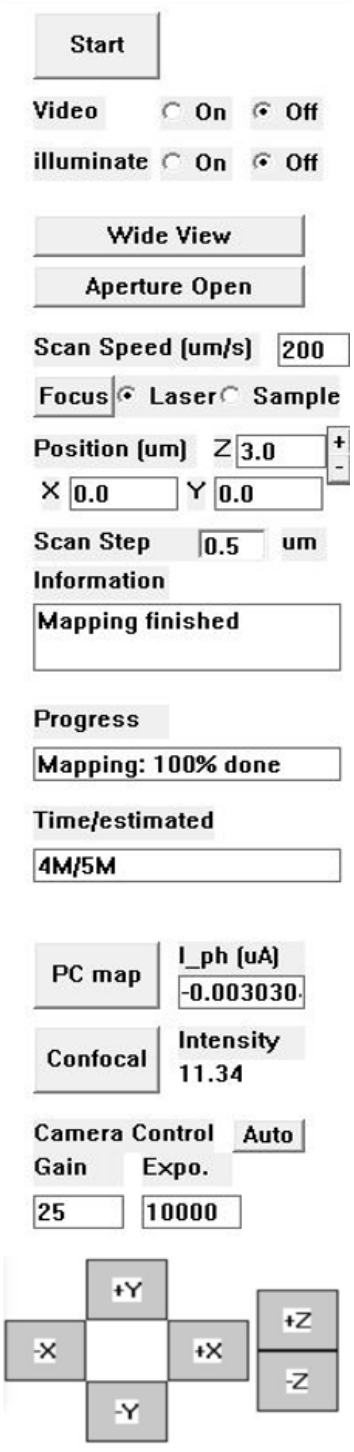

Figure 4 Menus at the right side of the Main window

(Position display and change) "Position(um)" shows the current motor position in each of X, Y. Z. Enter a number in the corresponding window and press Enter to move

the motor to the position corresponding to the number. The unit here is micrometers. However, when moving in the Z-axis direction, make sure that the distance from the objective lens is sufficient before moving. Press the arrow keys on your keyboard to move in 100 micrometer increments. For example, the right arrow key moves the sample to the right and you will see the image on the screen move to the right as well. Next to the Z display, there are "+" and "-" buttons. Small buttons move in 0.5 micrometer increments and large buttons move in 5 micrometer increments in the Z-axis direction. Also, if you press the page up and page down keys, it moves by 10 um in Z-direction, and if you keep pressing the key, it moves continuously.

(Scan step) The number in the "Scan step" input window determines the size of one pixel during the mapping process. If you enter a different number in the input box and hit enter, the pixel spacing is changed.

(Information window) The "Information" window displays the current app operating status.

(Progress indicator) The "Progress" window informs you of the progress when scanning or focusing.

(Time indicator) The "Time/estimated" window informs you of the time taken so far and the estimated total time taken during the scan process.

(Photocurrent map) Pressing the "PC map" button shows the measured photocurrent map data on the PC map window. The "I_ph (um)" window shows the currently measured photocurrent value in real time.

(Confocal map) If you press the "Confocal" button, the measured confocal image data is displayed in the confocal map window.

(RGB extraction) The "R", "G", and "B" windows show the RGB values of the detected pixels at the laser focus position, respectively.

(Camera adjustment) The "Auto" button of "Camera Control" is a button that automatically adjusts the exposure time and amplification factor of the camera and is mainly used when monitoring the surface of the sample. The "Gain" and "expo." windows mean the amplification factor and exposure time of the camera, respectively, and these values show the values applied when measuring the photocurrent by detecting the laser signal. Under normal operating conditions, these values are set to their minimum values. At the bottom of the right menu are +X, -X, +Y, -Y, +Z, -Z buttons. You can move them in that direction by clicking or holding them. It moves by 10 um per click.

menu description:

(Save measurement result data) It automatically saves data when new measurement data is acquired. A folder marked with the current date and time is automatically created in the data folder on the desktop, and data is always automatically saved when measurement is completed.

(Save screen image) If you want to save the microscope image of the sample separately, you can save it by selecting "Save Window Image" or "Save Camera Image" in the File menu. "Save Window Image" saves the image as the main window, while "Save Camera Image" saves the image in the memory received from the camera, but the result is the same image. However, to save a wide view image. You must select "Save Window Image".

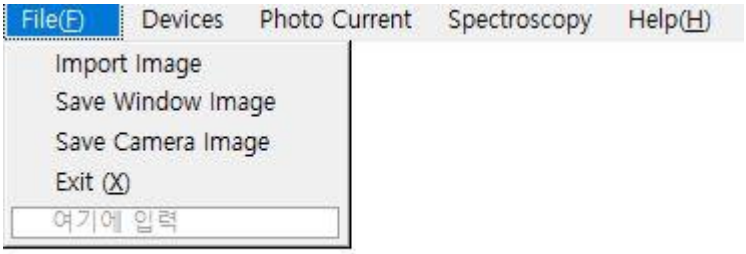

Figure 5 "Save Window Image" or "Save Camera Image" at the File menu to save optical images

(Settings) If you click the "Configuration" menu under the "Devices" menu, you can change the overall settings of this system. The "Current Equip" combo box appears at the top left corner. This is a menu to select an externally connected device via USB. You can connect to an external device by selecting the built-in Arduino device, NI-DAQ, GPIB-multimeter, GPIB-sourcemeter, USB-sourcemeter, etc. To connect other devices, please contact our technical support. If you click the "Initialize" button just below, you can initialize the connection status with the devices connected inside and outside the system. It is not necessary in normal cases as it is automatically initialized when starting the app, but if a specific device is turned off and on or a temporary error occurs, click the "Initialize" button to initialize and try to connect again.

(GPIB-Device Connection) When connecting a GPIB device, input the address in the address window and click the "Initialize" button to connect.

(Arduino connection) In order to connect the Arduino processor, you need to know the COM port number. Enter the port number correctly, which can be found in the Windows Device Manager and at the port section, and click the initialize button. Standa equipment is built-in as a motor. If the

Standa motor does not move temporarily, unplug and reconnect the USB cable and press the Standa initialize button to reconnect. If the camera temporarily fails, press the "Camera initialize" button to initialize the built-in camera and start over.

(Confocal Image) There is a check box with "Confocal Image" written on it in the upper right corner. If you scan with this box checked, the confocal image is also measured at the same time. If you uncheck it, it will not be measured. Because confocal image is measured simultaneously with photocurrent image, it is used to accurately confirm the location of the sample. However, please take into account that it takes more than double the scan time when measuring confocal images.

"Bias voltage" and "Current limit" are necessary settings when using the sourcemter. When measuring photocurrent, if a voltage value is entered in Bias voltage, it is possible to measure by applying the bias voltage. In order to avoid overcurrent damage to the device, the maximum allowable current can be entered in the Current limit.

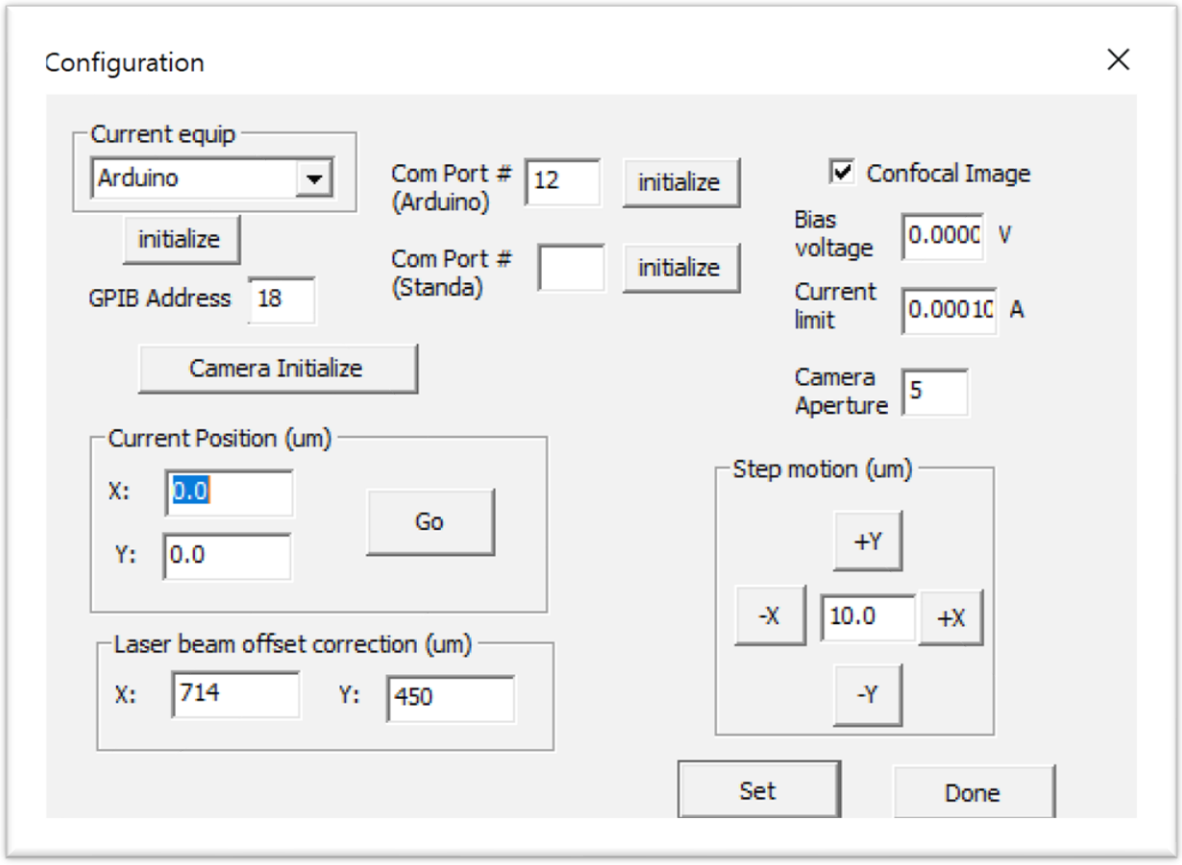

Figure 6 Configuration Dialog window

The "camera aperture" value determines the size of the aperture to obtain the confocal image and does not need to be changed by the user. In addition, the dialog boxes at the bottom are for setting

the position of the motor and the laser beam, and the general user does not need to change it.

(I-V curve measurement) If you look at the sub-menu of the spectroscopy menu, there are "IV measurement" and "TIME Evolution" submenus. The "IV measurement" function is only activated when the source meter is connected as an external measurement device like a sourcemeter. If you select this menu, a new window appears. If you input the range of voltage values and press the start button, the positive voltage gradually increases to reach the maximum voltage value, starting from 0, and the voltage value gradually decreases to the negative maximum value, and then it goes back to 0 by incrementing again. I-V data are saved by measuring the current value according to this voltage value. Data corresponding to this condition can be obtained by turning the laser on or off before starting the I-V measurement. By positioning the focus of the laser at a specific position and measuring this, the I-V data according to the position can be obtained.

(Time evolution measurement) Provides the ability to turn the laser light on or off and measure the change in photocurrent over time. In other words, this function can be used for experiments that can check how the photocurrent of the device changes with time, whether there is aging according to the laser exposure time, and how long it takes to recover. You can set the laser irradiation time (On time), the waiting time (Off time) to turn off the laser, and the number of times to repeat on-off can be set in the "repeat" window. When the start button is pressed, the measurement starts and when the measurement is finished, the data is automatically saved in the corresponding folder (data folder on the desktop). Real-time data of the measurement process is automatically graphed on the screen.

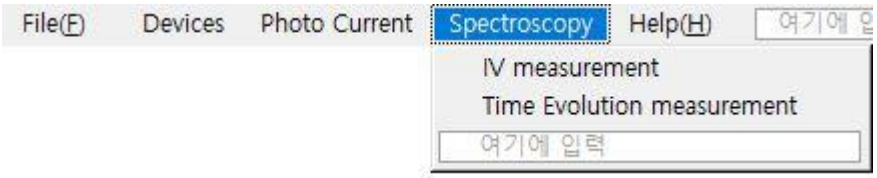

Figure 7 Supports IV curve measurement and change over time in the Spectroscopy menu

Mouse and Keyboard manupulation

(Mouse operation): Drag the mouse to mark a specific area of the camera image as a rectangle to set that area as the scan area. If you left-click a point with the mouse, a message window appears. Press "Yes" to move the point to the center of the screen, or click "No" to move the point to the laser focus position.

(Keyboard operation): Use the right and left arrow keys to move the sample in the x-axis direction. Each click moves 100 micrometers. Use the up and down arrow keys to move in the Y-axis direction.

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