Press Information: Sensor Instruments

November 2023

Inline color calibration with respect to plastic recyclate

### 11/03/2023 Sensor Instruments GmbH:

The Windows® Software SPECTRO3 MSM DOCAL Scope facilitates inline calibration of the color sensor system in different ways, which are explained below in further detail.

Calibration with RAL plastic color cards

The nonprofit organization RAL gGmbH, Bonn offers a collection of 300 different colored plastic cards calibrated according to the d/8° method. The corresponding L*a*b*-values are noted on every sleeve that is enclosed with the plastic color card.
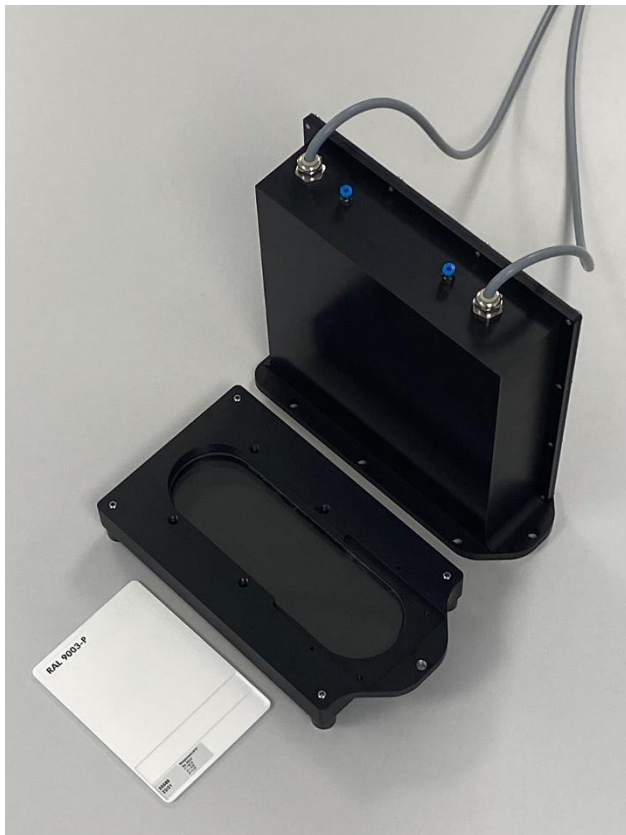
In addition, for the RAL plastic color cards, which can be obtained from Sensor Instruments GmbH, the respective L*a*b*-value, which is obtained from the 45°/0° measurement, is noted on both the RAL plastic color card as well as on the sleeve and in
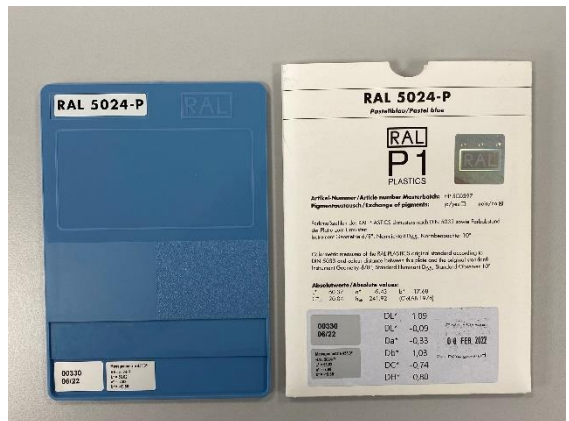
addition, assigned a 5-digit number. Sensor Instruments assigns and enters successive 5-digit numbers for new RAL plastic color cards to be calibrated, along with the L*a*b* color value that is calibrated on the RAL plastic color card, to a calibration file. Thus, during the calibration process, the sensor system only has to be presented the RAL plastic color cards to be calibrated and the matching 5-digit number input in the software. With this calibration mode, reference is made solely to the RAL plastic color cards, as a result of which a location-independent comparison of the measurement results is made possible, for example, for companies with several locations, since in such a case, manual color measuring instruments, the so-called manual colorimeters, can be dispensed with.

Calibration using injection molded color platelets and recyclates

But very often, it is exactly this relation to the manual or laboratory colorimeters already present in the facility that is desired, since it then becomes possible to better compare the measurement values between production and laboratory. This referencing to colorimeters that are already available in the facility through the SPECTRO3 MSM DOCAL Scope software is described in some more detail below. To do this, apart from the inline color measurement systems, Sensor Instruments also supplies laboratory equipment that work according to exactly the same process and whose sensor systems are identical. The systems that are available are both those that measure through an inspection glass as well as those which directly view the recyclate itself, of which measurements are to be taken.

Inline colorimetry using the SPECTRO-3-0°/45°-MSM-INLINE-ANA and the matching laboratory equipment SPECTRO-3-0°/45°-MSM-CMU

In both cases, calibration can be done directly with reference to the recyclate, while the L*a*b* reference values are determined using injection molded platelets, made from the same batch of the recyclate that is available to the devices to be calibrated. The L*a*b* reference values are determined using the injection molded platelets by means of the manual or laboratory colorimeters available in the respective facility.
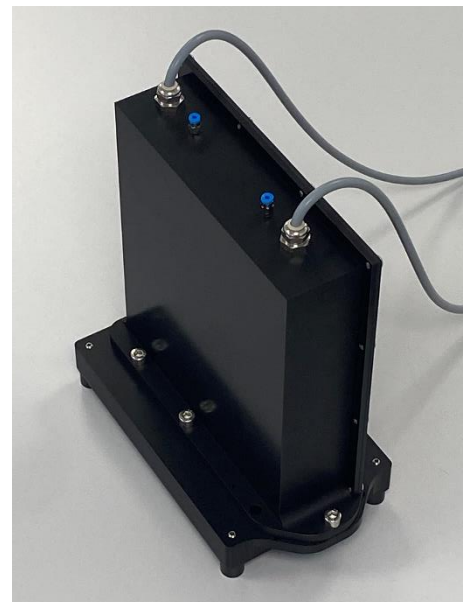
Inline colorimetry using a SPECTRO-3-FIO-MSM-ANA-DL in conjunction with a frontend KL-D-0°/45°-85-1200-D-S-A3.0-VIS and the matching SPECTRO-3-0°/45°-MST laboratory device

Here too, the injection molded platelets provide the L*a*b* reference values. The optical frontend is pointed directly at the recyclate at a distance of 85 mm. The recyclate that is available during the calibration is also used for making the injection molded platelets. Thus, the injection molded platelets and the recyclate originate from the same batch.
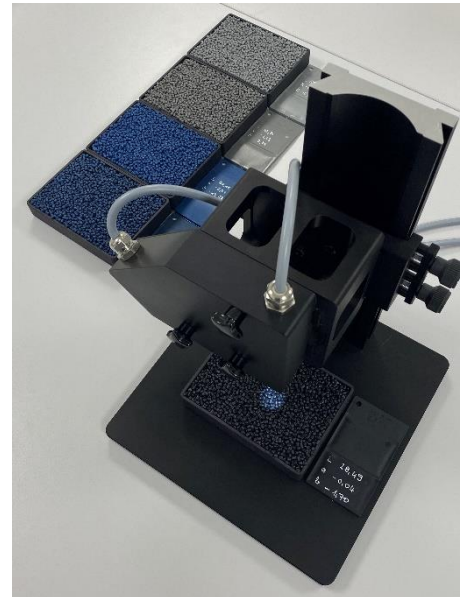
When calibrating using a SPECTRO-3-0°/45°-MST laboratory device, it is recommended that when recording the measurement value during the calibration process, the recyclate holding bowl should be moved in the x and y directions with the distance to the front end of the sensor being constant, so that the random position of the pellets can be compensated. Inline, this is done by transporting the pellets on a jolting conveyor. Here, the recyclate flow assumes a speed of typically 50mm/s to 100mm/s. During a calibration process with a duration of 30s, for example, the recyclate stream moves through 1.5m to 3m, i.e. an average is calculated across this measurement path during the calibration process. The measurement result is then correspondingly accurate and independent of the random position of the granulate grains. Even with vibrations that set the pellets in resonance and then cause them to "bounce", this can achieve significant compensation during the measurement process with a duration of a few seconds. What is decisive here is the large light spot size of approximately 20 mm diameter, as a result of which, even at standstill, optical averaging takes place across a large number of pellets.
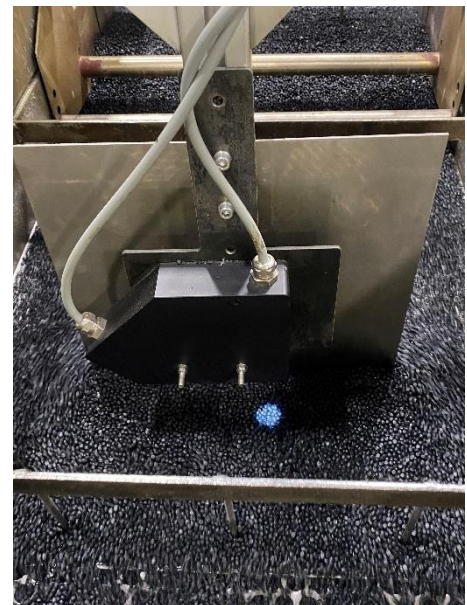
The typical procedure during the calibration directly with reference to the recyclate and using injection molded platelets is explained below with an example.

Selection of a suitable white reference (for example, RAL 9003-P)
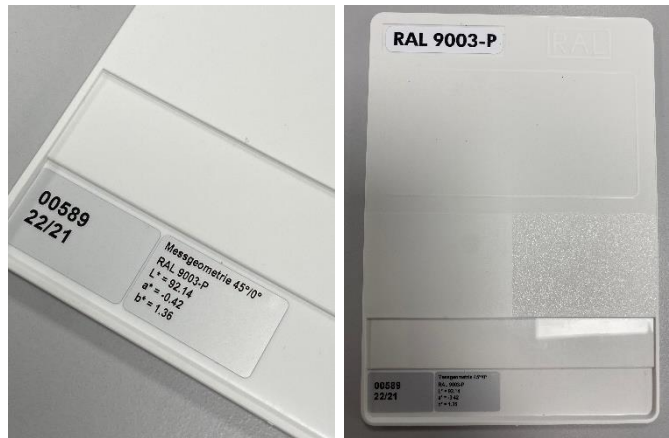

Place the white reference RAL plastic color card at a distance of approximately 75 mm to the optical sensor front end. It must be ensured here that the rear side of the RAL plastic color card is facing up (in the direction of the light spot) (a sliding carriage that holds the RAL plastic color card and is placed at the sensor front end during the white calibration, is provided for the inline calibration). Next, the SPECTRO3 MSM DOCAL Scope software is started and the menu option CALIB is selected. The software-supported calibration process is started with a double-click on **START CALIBRATION ASSISTANT** on the user interface.
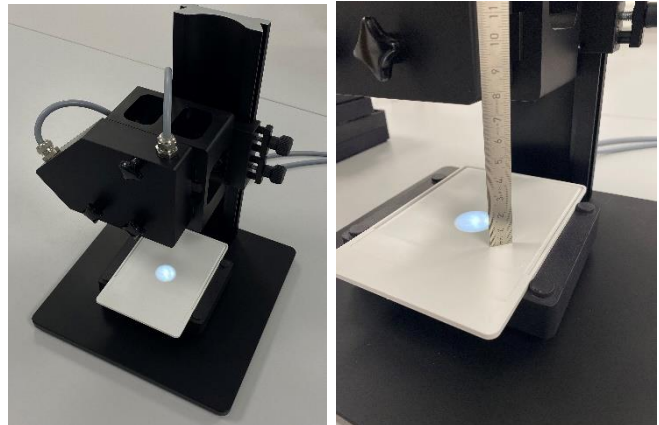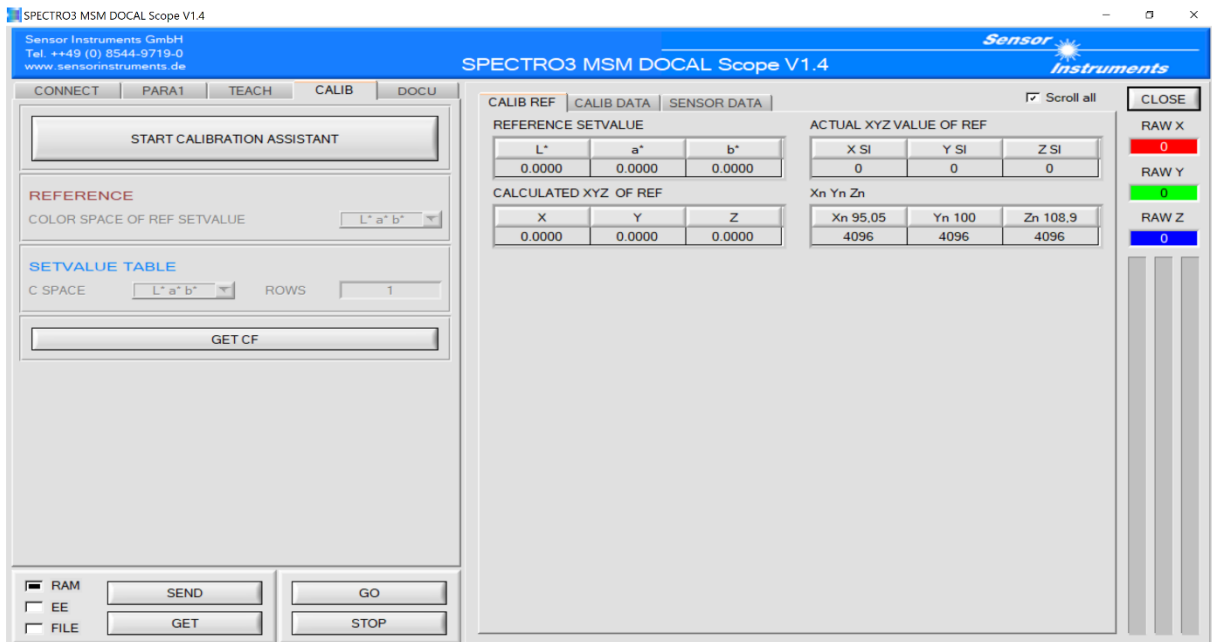
Upon double-clicking **START CALIBRATION ASSISTANT,** the following message appears:
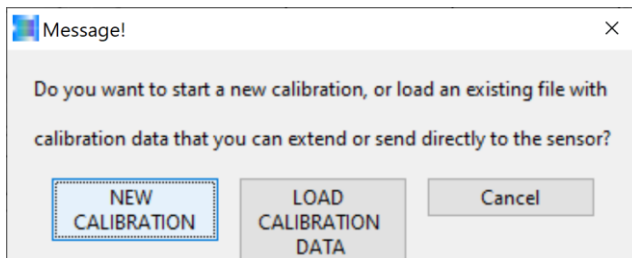
It is possible here to choose between a new or an existing calibration process. In our example, we open a new calibration process and hence, we click **NEW CALIBRATION**.
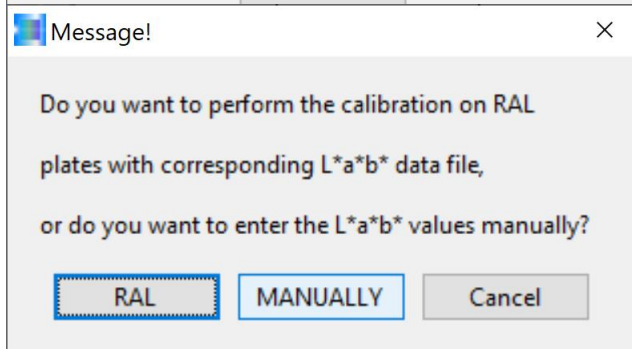
Now, a selection has to be made whether calibration has to be done with reference to the RAL plastic color card or directly to the recyclate. In our example, we select **MANUALLY**, so that we're calibrating with reference to the recyclate, we get our own injection molded platelets made, which are then measured with the colorimeters that are already available in the laboratory.
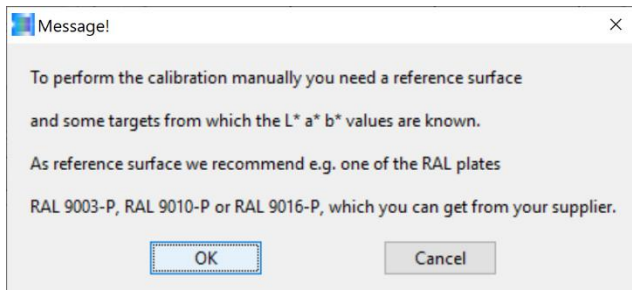
The software wizard now suggests one of the possible RAL plastic color cards for whiteness comparison. In our example, we use the RAL 9003-P

and place it with its rear side up on the upended recyclate holding bowl, or inline in the sliding carriage provided for the purpose, and once this has been done, acknowledge with **OK**. Please note: The distance between the sensor front end and RAL 9003-P should be 75 mm.
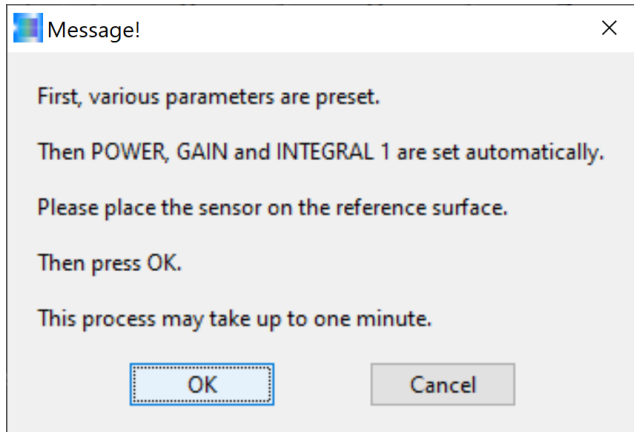
The software wizard now points out that the setting of the suitable light power POWER and the suitable amplification factor GAIN, along with the software amplification factor INTEGRAL is being started. At the end of a successful whiteness comparison, the raw values X, Y, Z are in the upper third of the available dynamic range, i.e. approximately between 3800 und 2500. Upon completion of the whiteness comparison, the RAL plastic card RAL 9003-P along with the upended recyclate holding bowl or the sliding carriage (in the case of inline calibration) can be removed from the front end of the sensor. Acknowledge with **OK**.
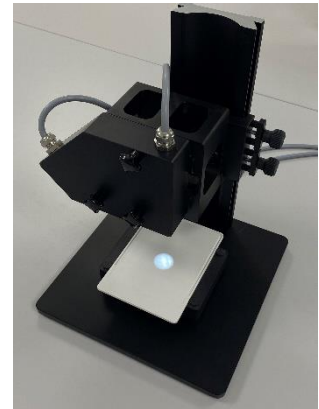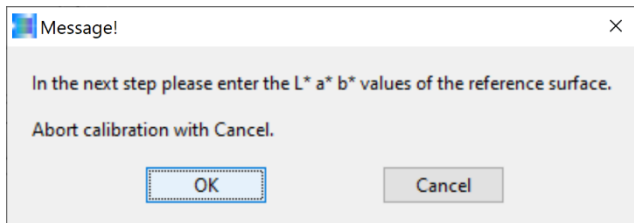
The L*a*b* value of the RAL 9003-P (and here, the 45°/0° value) are now required for determining the conversion factor. This can be seen from the RAL plastic color card or the sleeve of the RAL card. Acknowledge with **OK**.
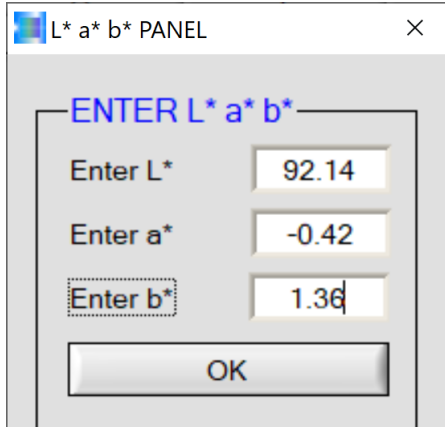
Input of the L*a*b* color value, determined by the 45°/0° method and the corresponding label on the card. Acknowledge with **OK**.
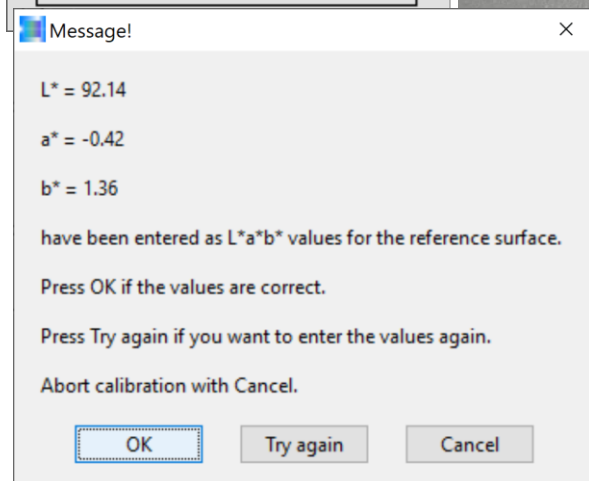

In order that any erroneous input of the L*a*b*-value can be corrected, the L*a*b*-value that has been input is displayed again as a precaution. If erroneous, click **Try again**, else acknowledge by clicking the **OK** box.
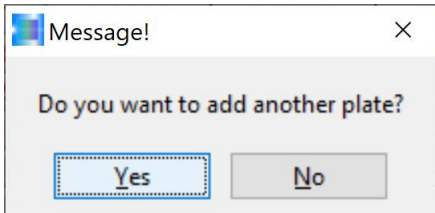
The software wizard now checks whether calibration is to be done for more plastic cards (in our case, recyclate). We acknowledge that with a click of the mouse on **Yes**.
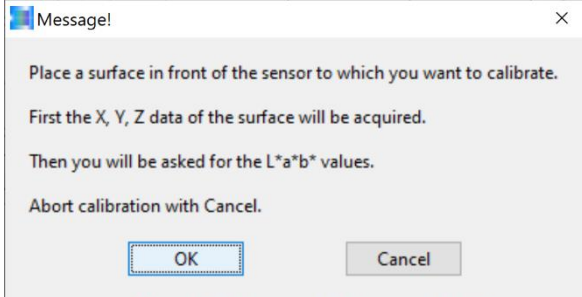

Next, the bowl filled with the recyclate for calibration has to be positioned on the measurement table of the SPECTRO-3-0°/45°-MST laboratory measuring instrument at a distance of 85 mm to the front end of the sensor (in the case of inline devices, it has to be ensured that the surface of the recyclate stream is at a distance of 85 mm to the front end of the sensor), and then acknowledge with **OK**.
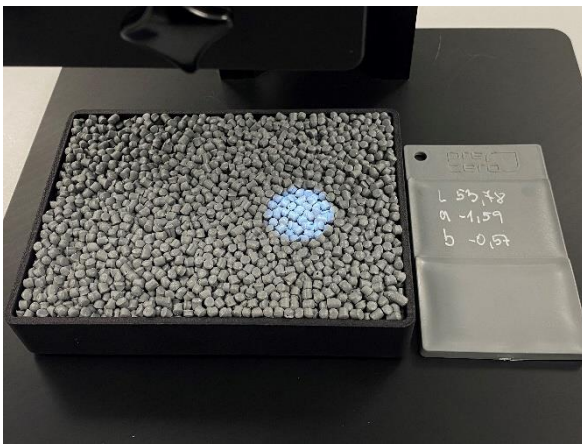
There appears a message that first of all, the X, Y, Z values necessary for calibration are recorded and upon completion of the measurement process, there is a prompt for the L*a*b* color value of the injection molded platelet matching the recyclate.
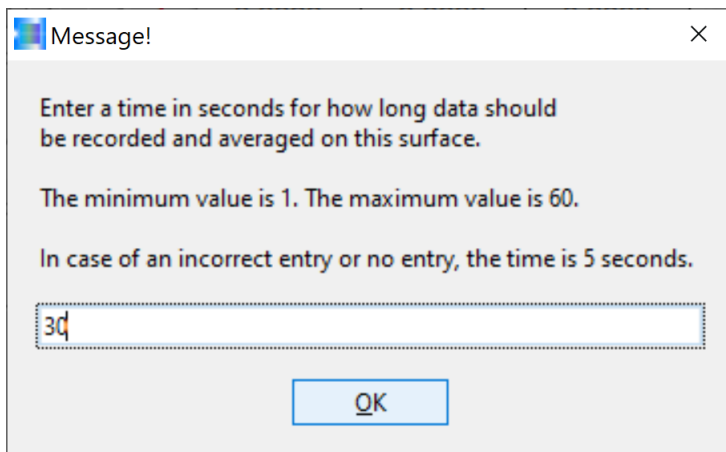

In order that the measurement process can start, there appears a prompt for the desired measurement period (in our example, 30 s). Upon clicking **OK,** the measurement process starts. Now, for a duration of 30 s, the recyclate bowl must be moved, while keeping a constant distance of 85 mm from the front end of the sensor, (with the inline device, that is taken care of the vibrating chute, which moves the recyclate stream).
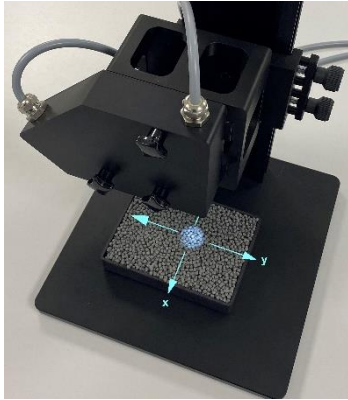
During the measurement period (here, over a period of 30 s), the bowl with the pellets must be moved in the x- and y-directions on the measurement table to reduce the influence of the random position of the granulate grains under the light spot to the maximum possible extent.
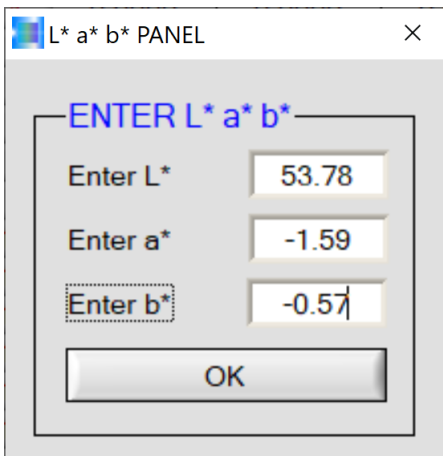
After the measurement period has elapsed (here, the 30 s), for the L*a*b* color value determined by the laboratory colorimeter for the injection molded platelets corresponding to the recyclate must be entered in the L*a*b*-PANEL.
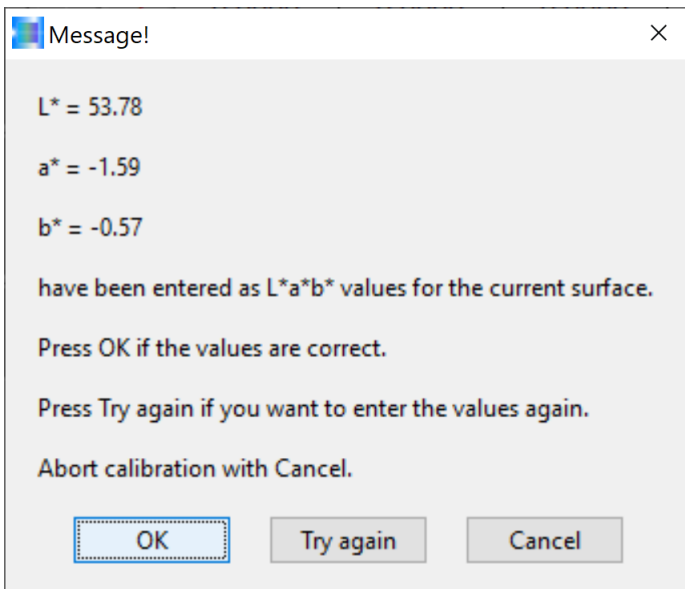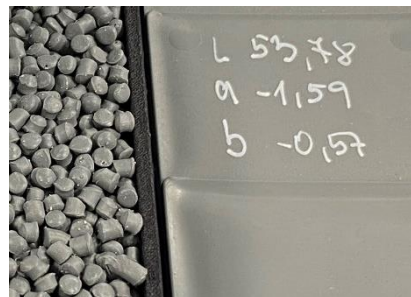
Then, there is once again a message about the values that have been input on the SPECTRO3 MSM DOCAL Scope Windows® user interface. After confirming that the L*a*b*-values that have been input are correct, the calibration process can be continued by clicking **OK**.
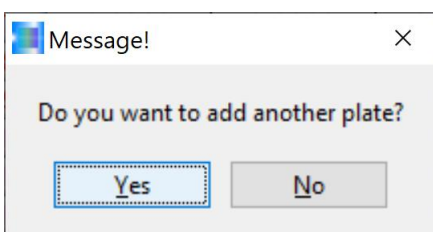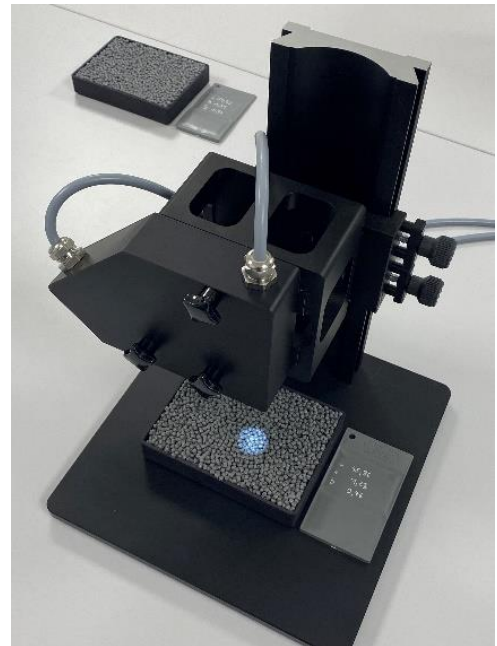

The calibration software wizard then checks with the user whether calibration with reference to another recyclate sample is to be carried out. In our example, we acknowledge this question with **Yes**.

Message!   ×

Place a surface in front of the sensor to which you want to calibrate.

First the X, Y, Z data of the surface will be acquired.

Then you will be asked for the L*a*b* values.

Abort calibration with Cancel.

[OK]   [Cancel]
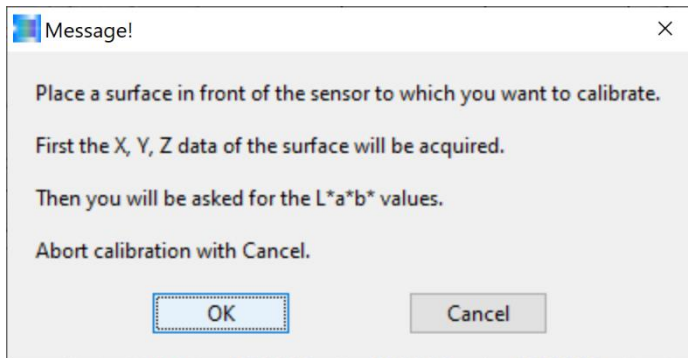
Now, the second recyclate sample in our example should first be placed below the front end of the sensor (the distance between the recyclate sample and the front end of the sensor is 85 mm, as earlier) and confirmed by acknowledging with **OK** (for inline calibration, the production should be switched to the recyclate to be calibrated for this purpose).

Message!   ×

Enter a time in seconds for how long data should be recorded and averaged on this surface.

The minimum value is 1. The maximum value is 60.

In case of an incorrect entry or no entry, the time is 5 seconds.

| 30 |

[OK]
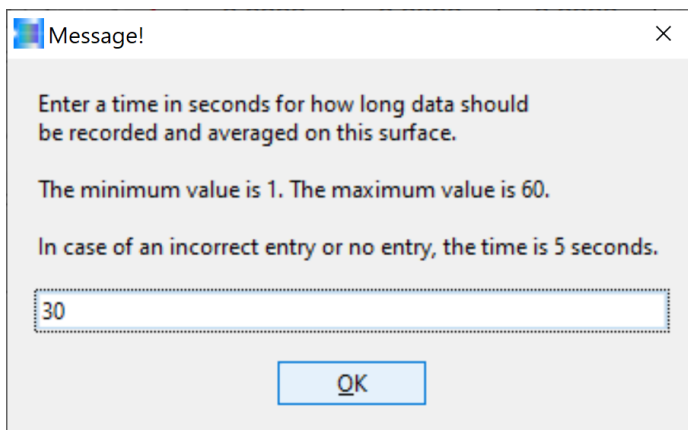
Now once again, the message with the prompt for the measurement period appears, i.e. over what period of time measurement values of the recyclate surface are to be averaged. In our example, this would once again be 30 s. Confirm with **OK**. Here too, the following applies: during the 30 s, the recyclate must be moved in the x- and y-direction (in inline operation, the vibrating chute takes care of the movement of the

pellets).

Movement of the recyclate bowl in the x- and y-direction. Ideally, the movement in this case should take place with a speed of 50 mm/s to 100 mm/s, which roughly corresponds to the recyclate stream speed during the manufacture of the pellets in the vibrating chute.

Upon completion of the measurement period (here, 30 s), the average X, Y and Z raw data are recorded and the software wizard now prompts for the L*a*b* color value of the injection molded platelet corresponding to the recyclate just measured, measured on the surface of the injection molded platelet using a laboratory colorimeter.
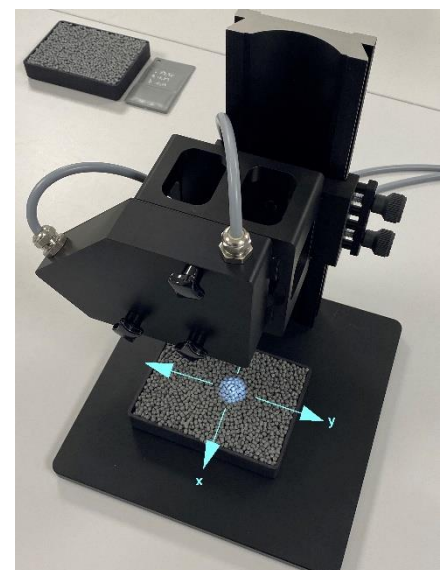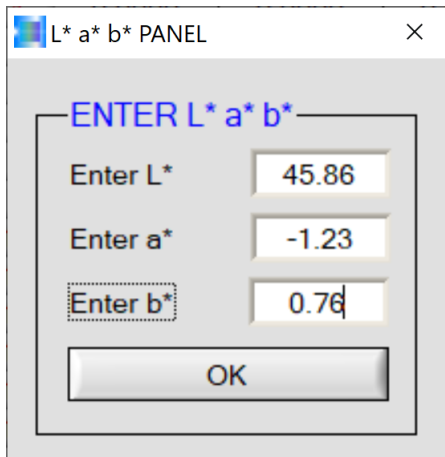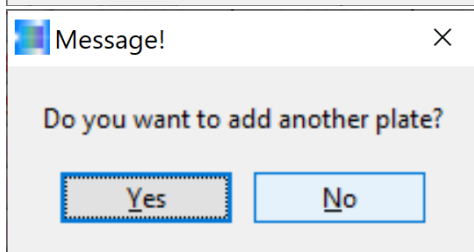
Input of the L*a*b* color values noted on the injection molded platelet in the L*a*b* PANEL interface and acknowledgement with **OK**.
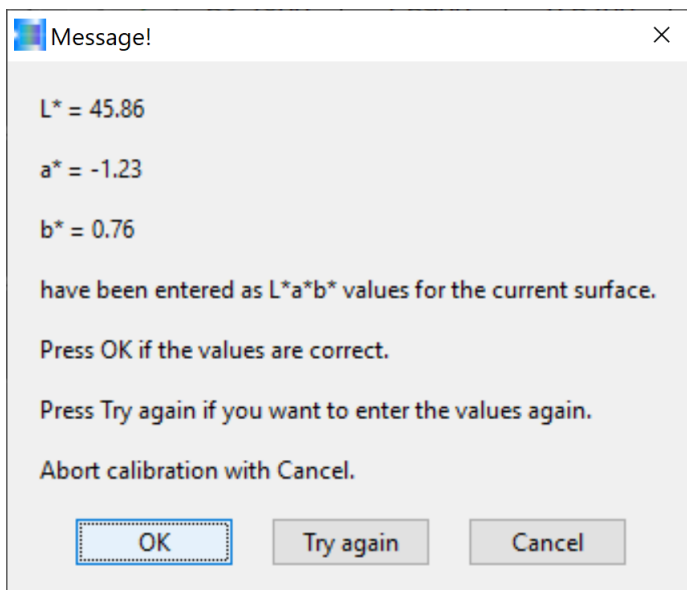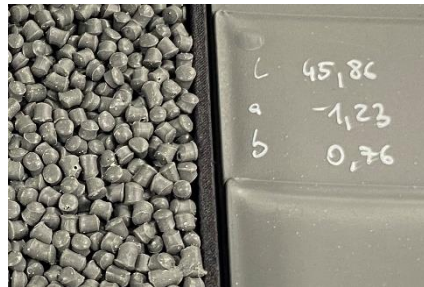
The software wizard now shows the L*a*b* color values that have been input once again, for checking by the user. If they match the L*a*b* color values on the relevant injection molded platelet, acknowledge with **OK**, else click the **Try again** button.

Now, by acknowledgement or activation with the **Yes** software button, the procedure for calibrating to additional recyclates can be continued. In our example, however, we have decided to end the calibration at this point, so as to then continue to add new recyclate calibrations. We thus confirm with the **No** software button.
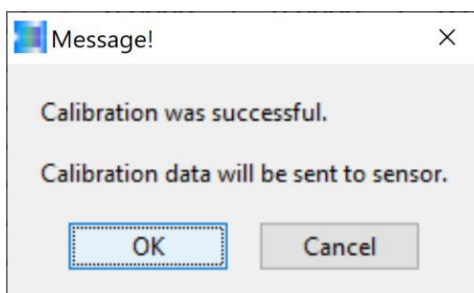
The calibration software now calculates, upon ending the calibration process, the conversion factors, so that the L*a*b*-values of the recyclates measured with the SPECTRO-3 color measurement system are the same as the L*a*b*-values that are noted on the injection molded platelets. Acknowledge with **OK**.
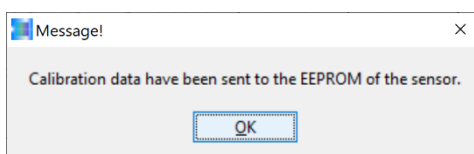
One more notification from the calibration wizard that the conversion factors have been saved to the non-volatile memory of the control electronics of the sensor system. This message can be acknowledged with **OK**.
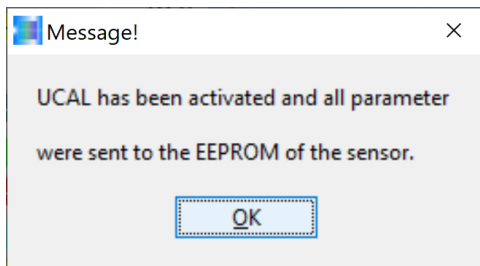
This is followed by a message that the sensor system is now working with the new calibration data. This message can also be confirmed with **OK**.
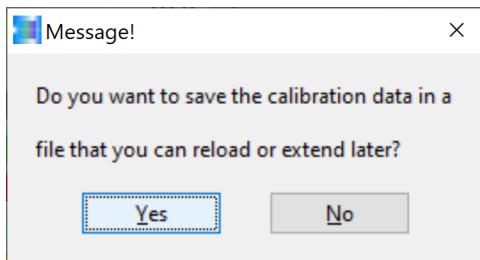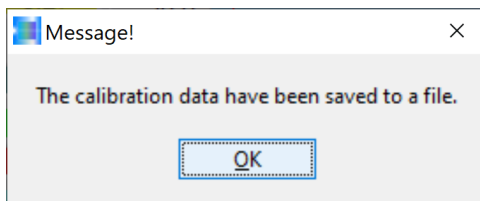

The calibration wizard now asks whether the calibration data should be saved to a file. We confirm this with **Yes**.
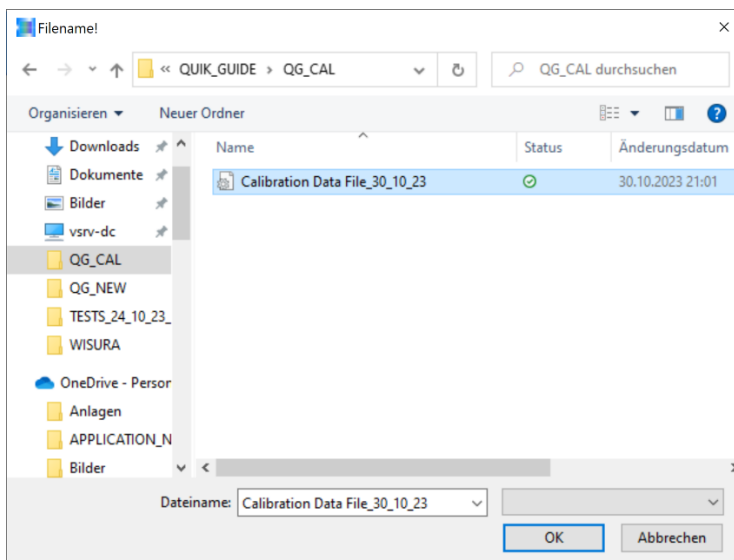
Now, a file has to be created, which can be accessed again later.
In our example:

Calibration Data File_30_10_23 here saved to the folder QUIK_GUIDE / QG_CAL.

By clicking the **OK** button, the calibration data is saved to the selected file.

There follows a message from the calibration wizard that the calibration data could be successfully saved to the selected file.
This message can be acknowledged with **OK**.
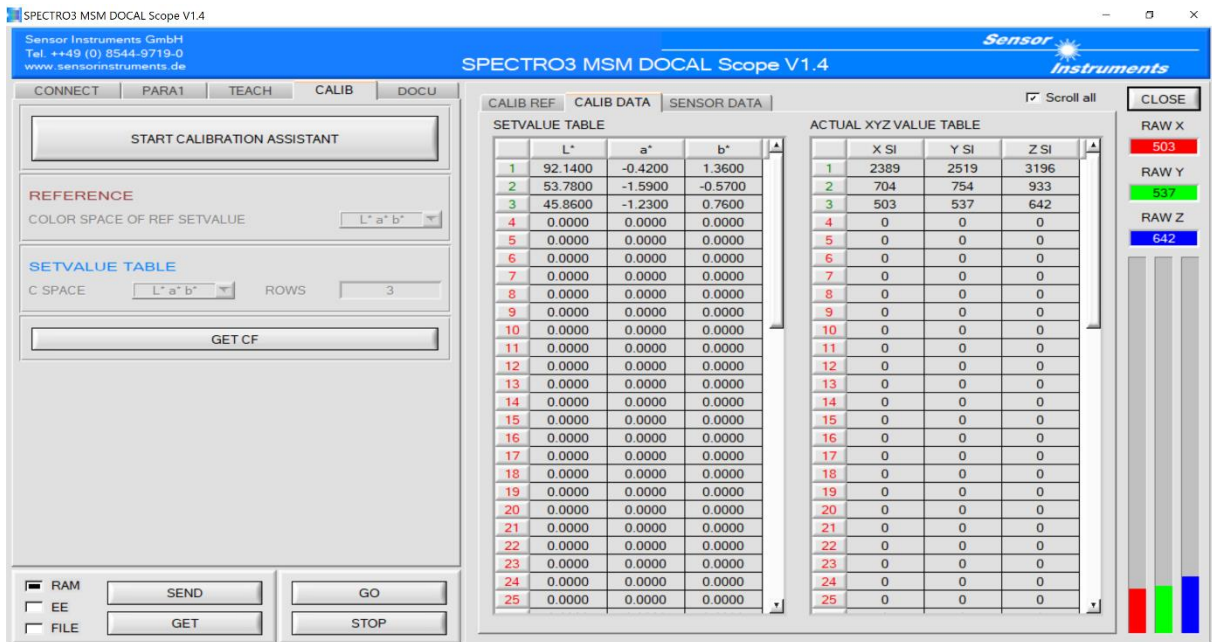
The color measurement system would now be ready to deploy - but in our example, we now want to calibrate to more recyclates, which means that we must once again call the calibration wizard: click the **START CALIBRATION ASSISTANT** button**.**
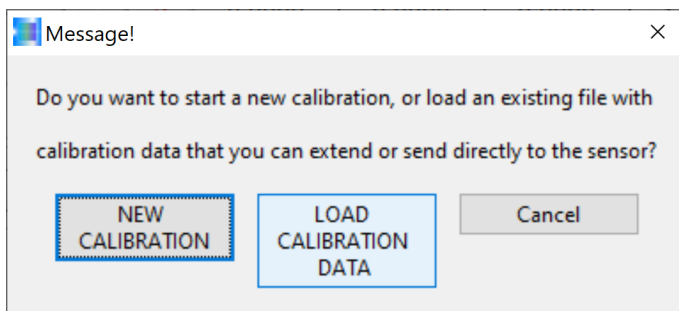
Since we have already created a file, but want to calibrate to more recyclates, we must click the **LOAD CALIBRATION DATA** button.
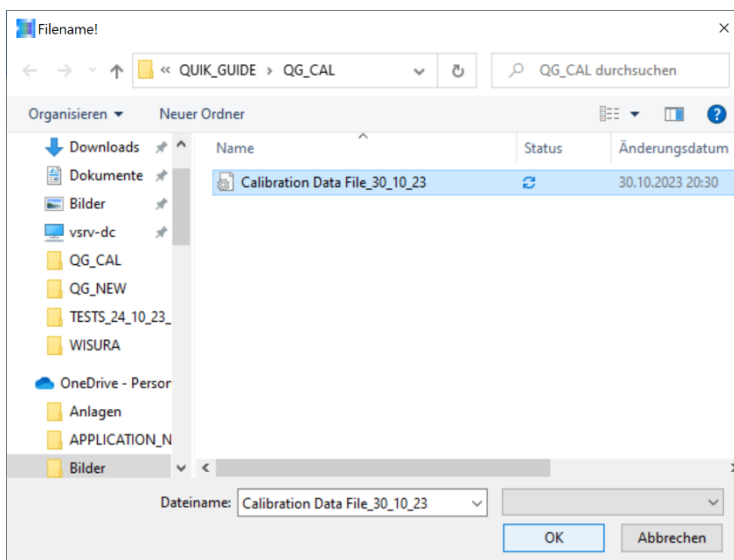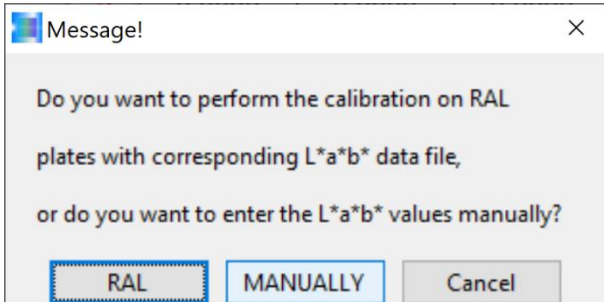

We thus select our file **Calibration Data File_30_10_23** that already exists.

Selection is then completed with the **OK** button.
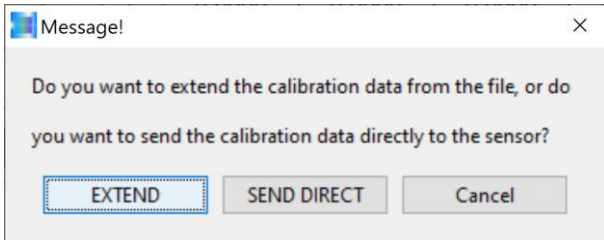
We want to extend the existing calibration file, of course, and therefore we select the **EXTEND** button.


The recyclate samples that are to be added are not RAL plastic color cards, and therefore we acknowledge with **MANUALLY**.
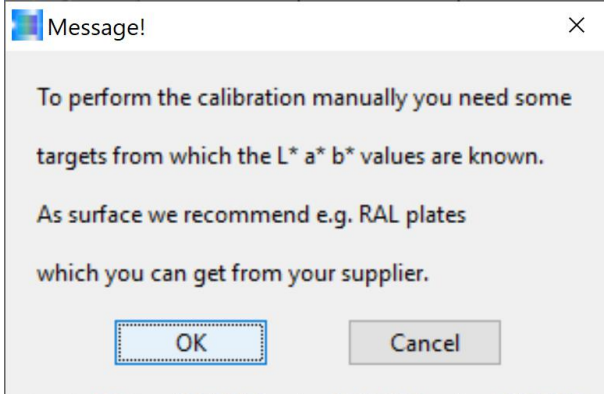

The recyclate to be calibrated must now be placed, filled in one of the plastic bowls provided for the purpose, under the front end of the sensor, once again at a distance of 85 mm. This message can be acknowledged by clicking the **OK** button. In the message that follows, there is a prompt about the additional sample (in our case, not a plastic plate, but the recyclate sample). This message can be closed by acknowledging with the **Yes** button.
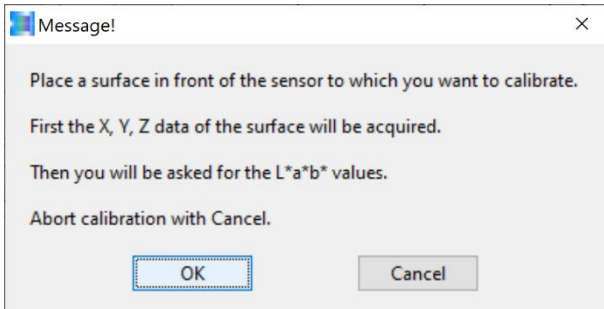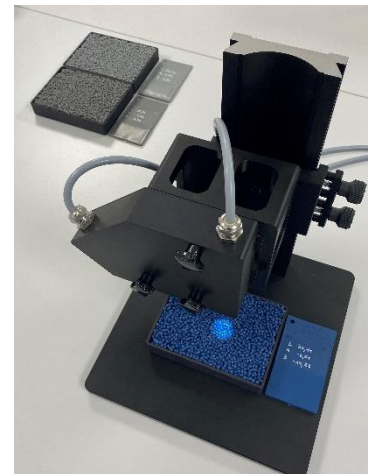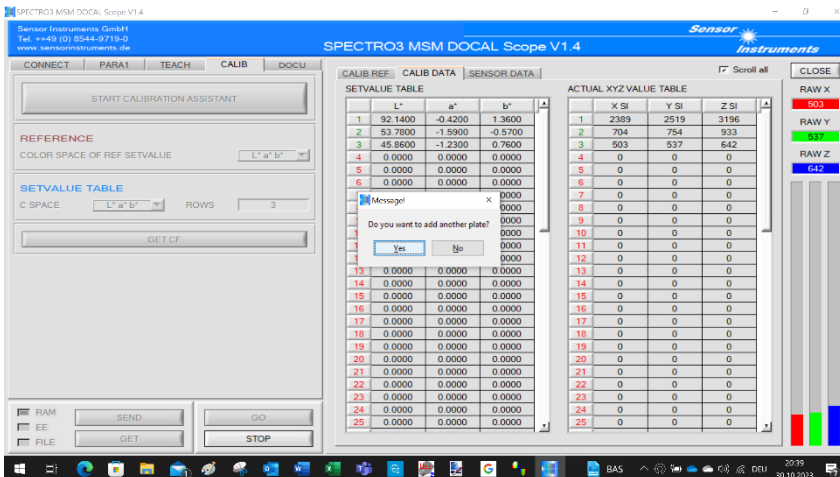

Once again, we make sure that the new recyclate sample is at the correct distance (85 mm) below the front end of the sensor.
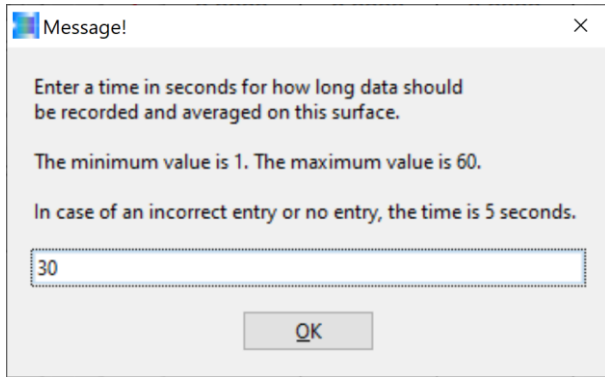
Here again, we select a measurement period of 30 s and acknowledge the message by clicking the **OK** button. Now, the bowl with the recyclate sample has to be moved in the x- and y-directions on the measurement table during the next 30 s, without changing the distance to the front end of the sensor (85 mm) when doing so (in inline operation, the vibration chute takes care of the movement of the pellets).
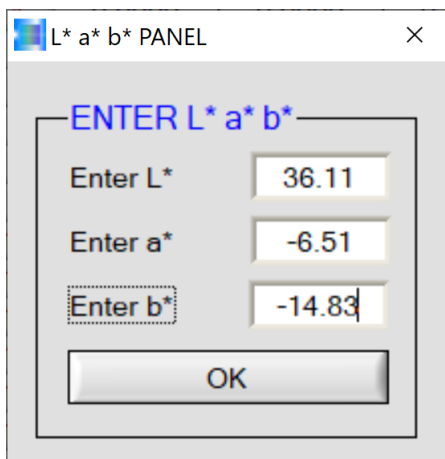

Now the L*a*b* color value of the injection molded platelet corresponding to the recyclate can be transferred to the L*a*b* PANEL interface, in the field ENTER L*a*b*.
The L*a*b* color value is adopted by the calibration wizard by acknowledging with the **OK** button …
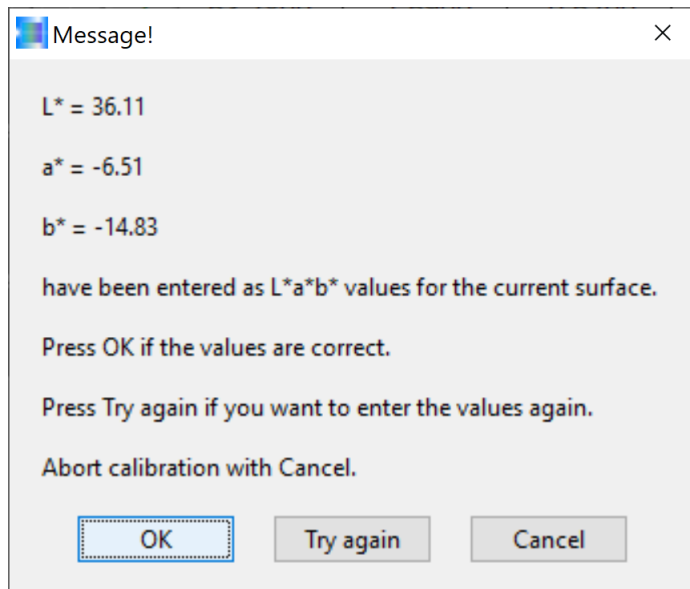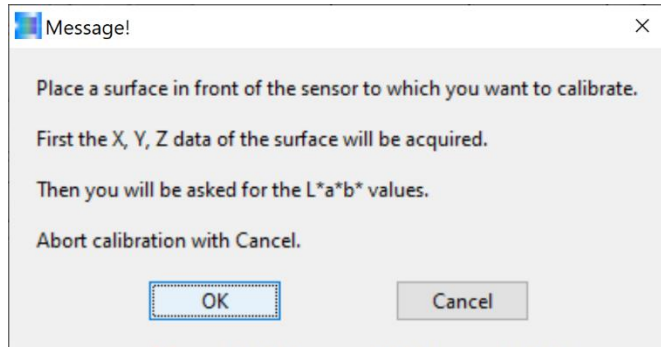

… but that only after the L*a*b* color value has been once again inspected and found to be OK. Acknowledge with the **OK** button.
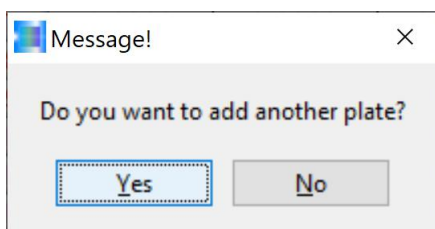
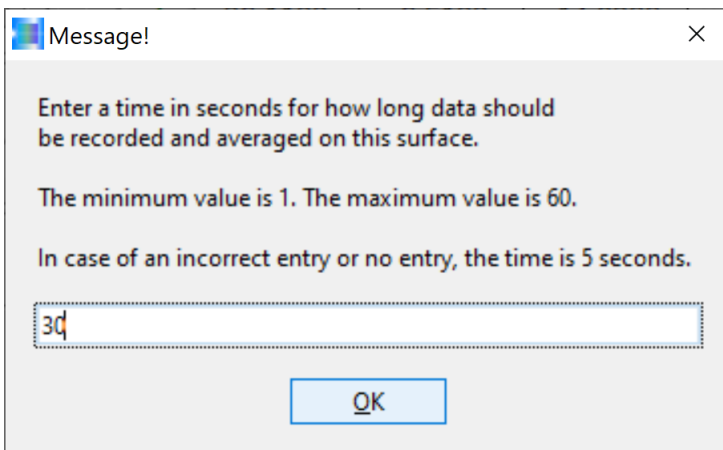Since we still want to calibrate to more recyclates, we acknowledge this message with **Yes**.
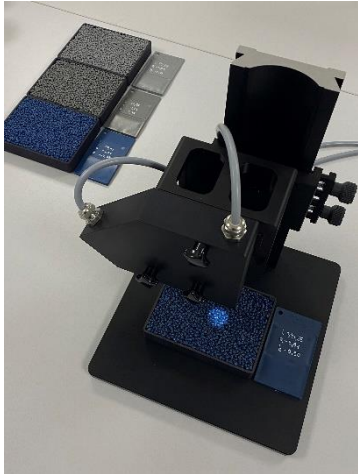
The process continues with the next recyclate. One of the recyclate bowls provided for the purpose is to be used here as well, and it must be positioned at a distance of 85 mm below the front end of the sensor. This message can be

acknowledged with **OK**.

The question regarding the measurement period comes up again. Here, too, we specify 30 s and acknowledge with **OK**. In this case as well, to achieve the best possible result, it is recommended that the recyclate bowl be moved, during the measurement period of 30 s, in the x- and y-direction at a speed of 50 mm/s to 100 mm/s while ensuring that the 85 mm distance to the front end of the sensor is maintained.
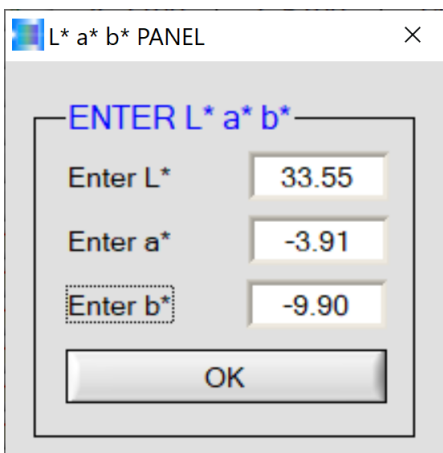

Upon completion of the measurement process (after 30 s), the L*a*b* color value of the injection molded platelet that is identical to the recyclate can be transferred to the L*a*b* PANEL. Confirm with **OK**.
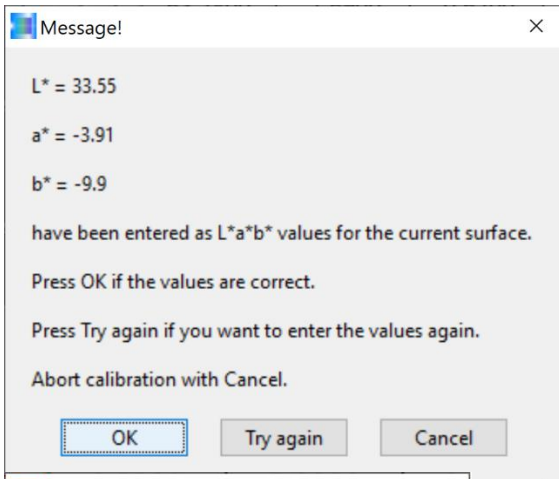
Here too, the calibration wizard displays the L*a*b* color values that have been input once again, so that in case of an erroneous input, the color value can be corrected by using the **Try again** button. On the other hand, if the color value matches, the **OK** button can be clicked to continue the calibration process.
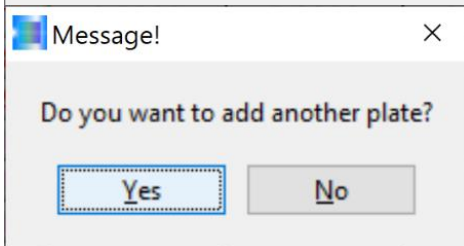
In our example, we have to calibrate with reference to a recyclate sample: We thus confirm with **Yes**.
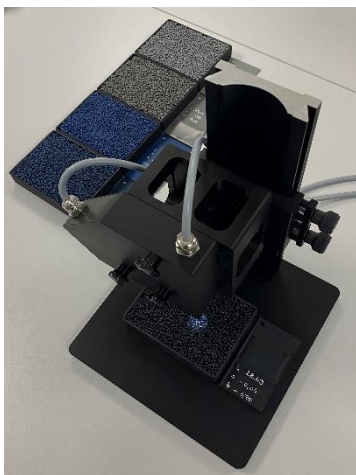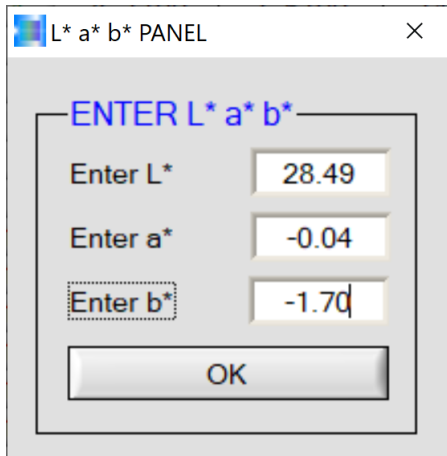

The recyclate to which calibration is still to be done should be filled in the plastic bowl and placed at a distance of 85 mm below the front end of the sensor. Confirm with **OK**.
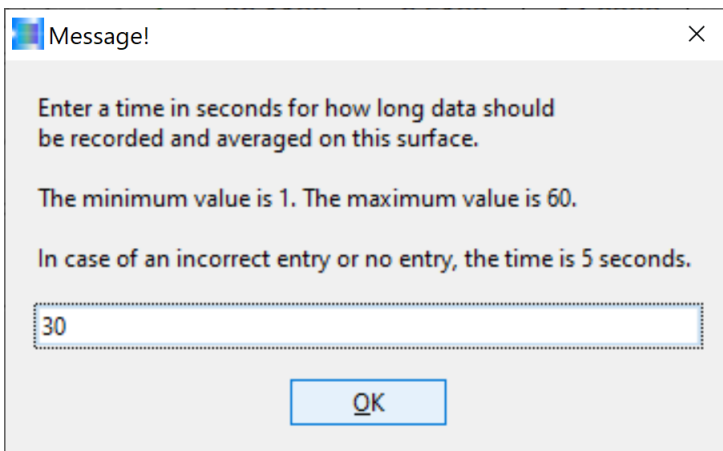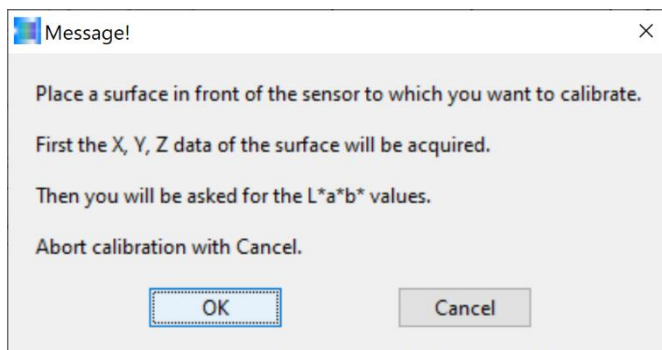

We select a measurement period of 30 s for the last-but-one recyclate sample. After the **OK** button is activated, the bowl with the recyclate should be moved in the x- and y-direction for the duration of the measurement, without the distance to the front end of the sensor being changed.

The L*a*b* color value of the injection molded platelet that originates from the same batch as the recyclate to which calibration is to be done is now entered in the L*a*b* PANEL interface. The input is then acknowledged by clicking the **OK** button.
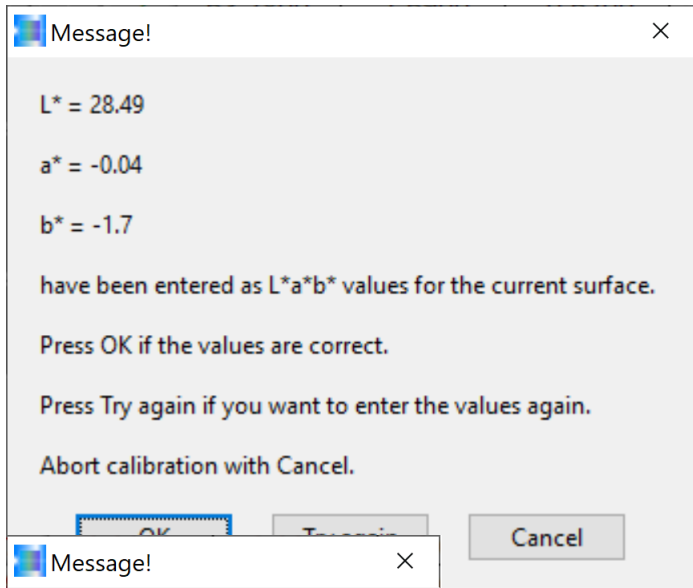

The calibration wizard now wishes to ensure once again that the L*a*b* color value has been correctly input. If an error has occurred here, continue by clicking the **Try again** button, else click the **OK** button.
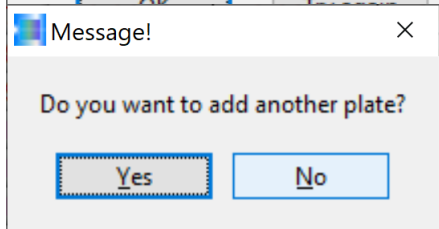
The program continues with the question about more samples to be calibrated. For the moment, our example is complete, and therefore we respond to the question with **No**.
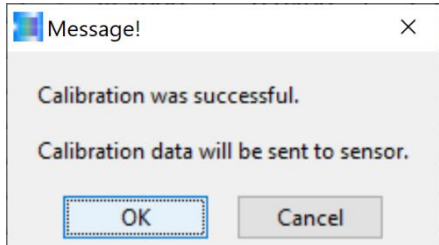

Now, the display from the calibration wizard that the calibration was once again successful, and the calibration data were sent to the control electronics of the sensor system. This message can be confirmed with **OK**.
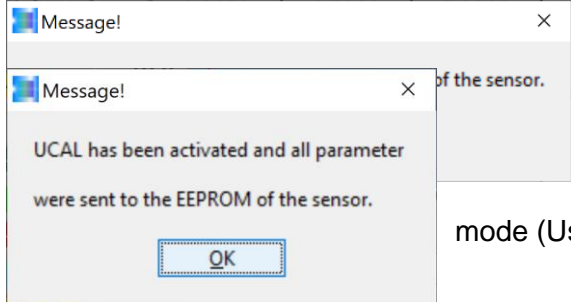

This message notifies that the calibration data set has been sent to the EEPROM of the control electronics of the sensor system. This message can also be confirmed with **OK**.

The calibration wizard now activates the UCAL mode (User Calibration Mode) within the control electronics

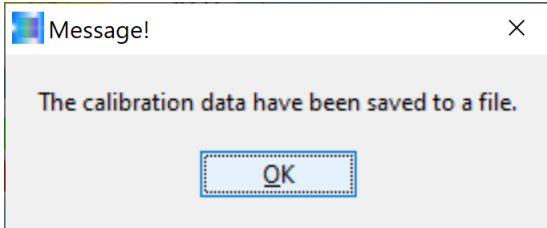of the color sensor system. Continue by clicking the **OK** button.
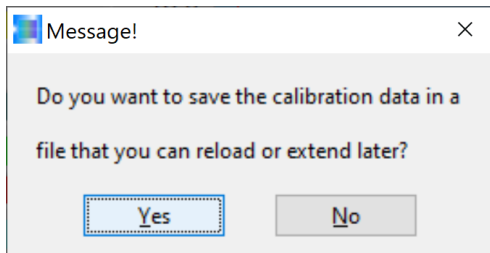
The calibration wizard now asks whether the expanded calibration data set is to be written to the existing file, in a new extended file or should not be saved at all. In case the calibration data is not to be saved, the **NO** button should be clicked; on the other hand, if the calibration data set is to be saved to a file: Activate the **Yes** button.
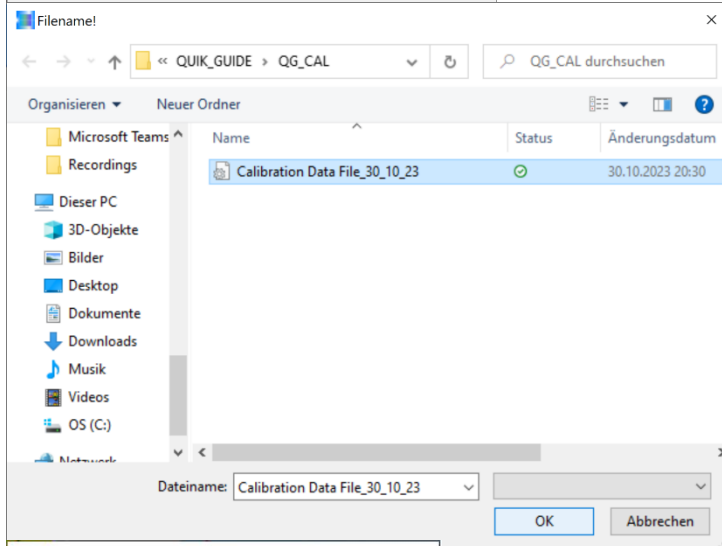

In our example, we decide on the file that already exists, whose content (calibration data set) is to be extended, and confirm the process by clicking the **OK** button.
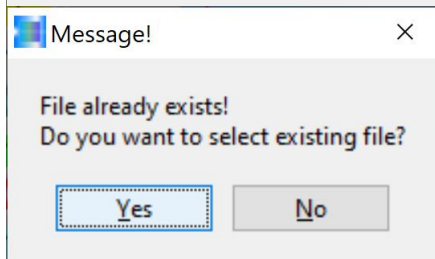
There now follows a message that the file to which we want to write already exists. If the file name matches, this message can be acknowledged with **Yes** else with **No**.

In our example, we have achieved the following: The color sensor system with the extended calibration set can now be commissioned for recyclate measurement in the laboratory, as also inline in the plant. This message can be closed by clicking the **OK** button.
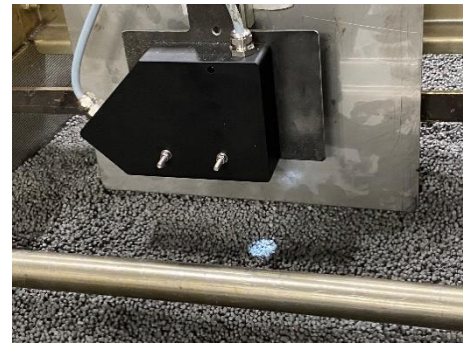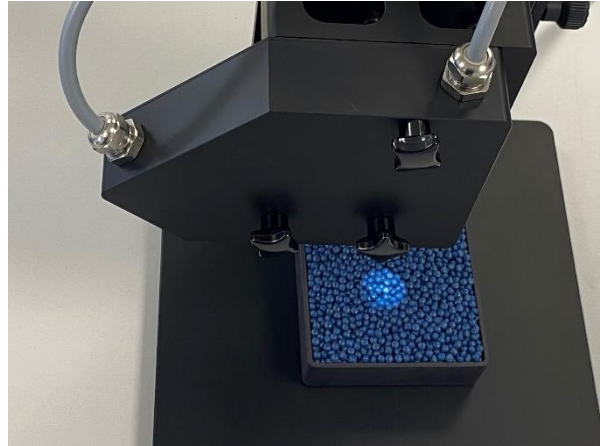
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