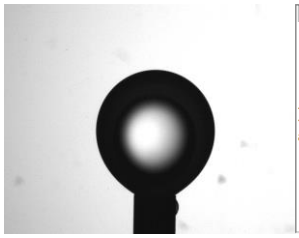
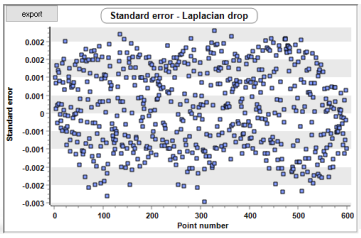
Standard error, five reasons you should check the drop profile

INTRODUCTION

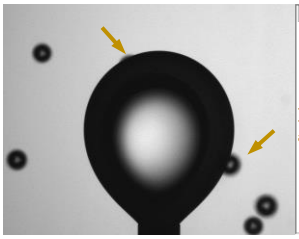
The measurement of surface tension using the pendant (or rising) drop method is based on the analysis of the profile of a Laplacian drop. It means that the contour of the drop follows a shape described by the Laplace equation. When the drop is not Laplacian, the calculation of the surface/Interfacial tension by drop shape analysis is made with an error. Therefore, it is the most importance to ensure this standard error is not significant before making the measurement. To assess the value of the standard error, the TRACKER™ Software function "one measurement" analyzes the residuals between the theoretical model and the real profile of the drop. Five frequent cases can be met.

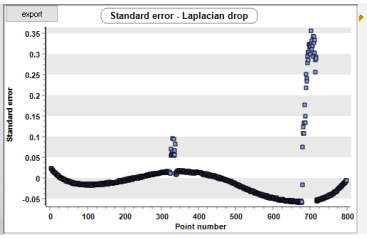




Laplacian profile

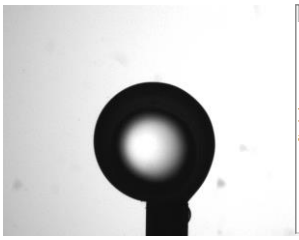
The residuals represent the difference between the real profile and the theoretical profile. Thus, a Laplacian drop will have low residual values and will be anisotropically distributed in a cloud of points along the profile. This signature is characteristic of a Laplacian drop. The measurement of the surface/ Interfacial tension will be correct.

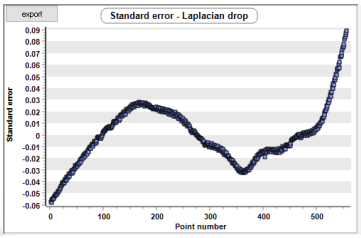




Interrupted profile

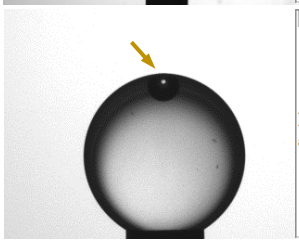
The profile of the drop is interrupted by bubbles suspended in the background or stuck to the wall of the glass cuvette. In this case, the residuals are significant in 2 points where the profile is interrupted. Note that dust or aggregates can also adsorb at the interface and interrupt the drop profile.

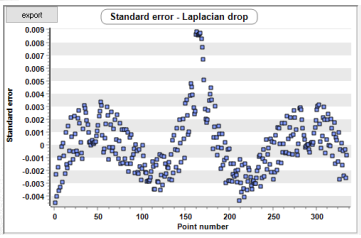




Moving profile

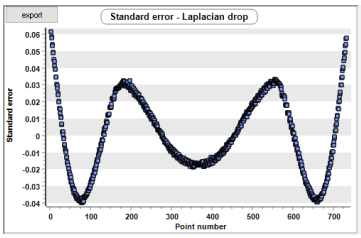
Mechanical stirring or external vibrations can lead the drop to become asymmetric. In that case, the motion is highlighted by a characteristic S-shape profile. The pendant drop method is very sensitive to vibrations that can cause this type of profile or make the measurement noisier. It can be necessary to isolate the instrument or use anti-vibration table.





Air bubble trapped in oil drop

A trapped bubble of air rises inside the oil drop and increases the buoyancy force and stretches the oil drop. Therefore, the surface tension calculated will be lower than it really is. In such cases, the profile of the drop looks like an ace of spade. This characteristic profile can reveal very small air bubbles that can't be seen but that are clearly highlighted by the TRACKER™ Software.



Solid membrane

When a solid membrane is formed at the interface, the interface has no longer a "liquid" behavior, meaning that the drop shape is not only the result of a competition between surface tension and gravity anymore. In that case, the drop is no longer Laplacian and the standard error increases. Then, Tracker™ Pressure sensor can be used to measure Laplace pressure inside the bubble.

Saving drop profile standard error data also gives valuable information about the nature of the interface. The recording of standard error data can be set with the other experiment parameters in the software. In addition, as the images can be saved automatically, the drop profile can be analyzed post measurement.

CONCLUSION

The residuals analysis (standard error) is an easy and quickly way to check that the drop profile is Laplacian:

- First, as an indicator before making a measurement to ensure that the calculation is reliable.
- Second, as an indicator of the state of the interface and additional information about the evolution of its chemistry.