



SURFTENS

Smartphone-based Optical Tensiometry – Smart & Affordable

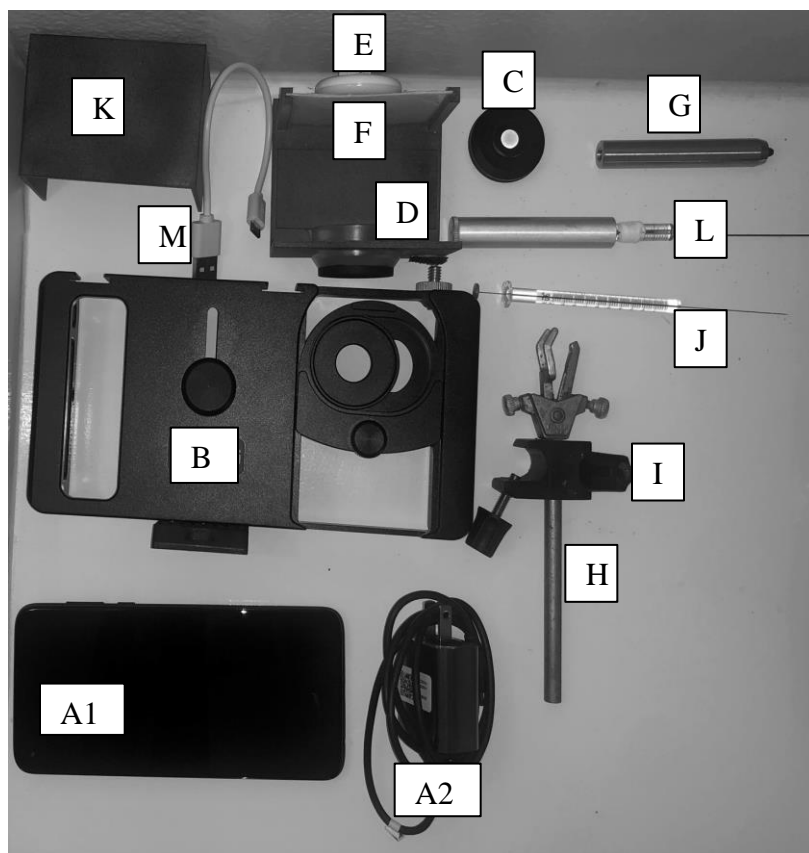
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Parts List

Motorola G-Power phone, (A1) & Phone Charger, (A2)
Universal Phone Holder, (B)
Macro Lens, (C)
Stage integrated with lens hood, (D)
LED light, (E)
Light Diffuser, (F)
Optical post, (G)
Syringe Holder, (H)
Black rod connector, (I)
10 microliter syringe, (J)
Stage Cover, (K)
Threaded plunger pump syringe - 100 microliter (L)
LED light charger, (M)
Bubble measure (not shown)
Benchtop tripod (not shown)





Apps needed on the phone:

Levelling app (such as Bubble Meter)

Video to frame converting software (such as)

Apps needed on computer:

ImageJ (free)



Assembly

1. Gather all the parts: Motorola G-Power phone, Phone Charger, Macro Lens, Stage Cover, Stage, Universal Phone Holder, 10 microliter syringe, Threaded plunger pump syringe - 100 microliter, Syringe Holder, LED light, LED light charger, Light Diffuser, Physical Bubble Measure, & Benchtop Tripod.
2. First attach the phone to the Universal phone holder by lifting the retractable bracket of the holder on the back side and sliding the phone in. Tighten adjusting knob.
3. Then on the other side where there is a hole for the lens, unscrew the knob until the adjuster for the lens placement is freely movable.
4. Then adjust the hole both vertically and horizontally until it lines up with the lens and screw the knob tightly to keep in place.
5. Next screw the macro lens onto the hole that was just adjusted to the lens of the phone.
6. Next get the tripod and screw the universal holder on top of it.
7. Push lens hood of the integrated stage onto the macro lens to firmly attach lens to stage.
8. Attach the LED light by clipping it onto the small slit at the back of the stage.
9. Attach the light diffuser by sliding it between the two standing prongs on the stage.
10. Open levelling app and adjust the attached smartphone to 0 degrees on the x and y planes, and tightly secure knob on the tripod.
11. Level stage by placing the physical bubble level onto the stage rotating the lens hood.
12. On the left side on the top of the universal holder, screw in optical post, connect optical post to the syringe holder using the black rod connector.

Note: Instructional video available at www.surface-science.com

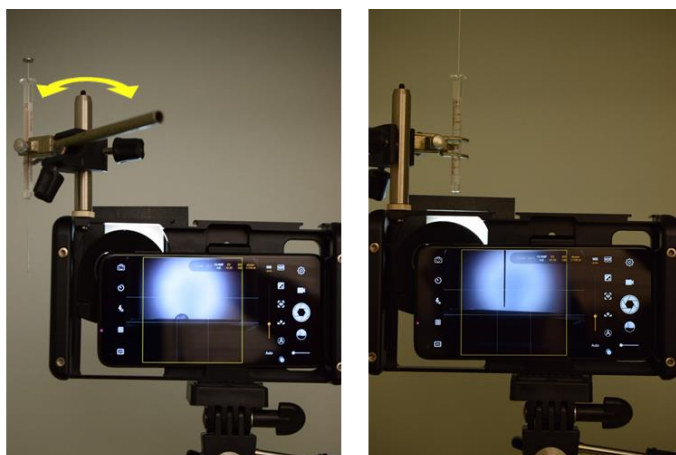


Contact Angle Measurement

Image Acquisition:

Sessile drop tensiometry:

1. Open the levelling app (for e.g. Bubble Meter) and adjust the phone to 0 degrees on the x and y planes using the adjusting knobs on the tripod.
2. Place the bubble level onto the stage and rotate the lens hood to achieve a 2 degree slope towards the lens.
3. Place the substrate under investigation on the elevated stage close to the lens.
4. Fix the relative position of the syringe tip on the substrate. The height of the syringe tip is adjusted by adjusting the black connector. With the height fixed, the distance of the syringe to the black connector is fixed using the black connector (the other knob). Finally the precise point of the syringe tip is fixed using the collar at the bottom of the optical post. At this point the syringe can be swiveled by rotating the optical post from the screw attached to the Universal Phone Holder,
5. Fill the syringe with the target liquid up to 10 microliters. Swivel dispenser to position.



Syringe swivels enabling easy sample collection and dispensing



6. Carefully dispense the liquid onto the substrate (preferably close to the macro lens).
Swivelling action enable easy syringe placement at a desired location
7. After the liquid rests on the substrate for 30 seconds, the syringe should be swiveled away and the stage cover should then be slid on top of the stage around the two prongs. Turn on the LED should also be turned on through the button on the back of the LED light device. If LED does not turn on, charge the LED using the cable provided.
8. With the camera app, adjust the focus to ensure that droplet is in focus.
9. Take a picture of the droplet.

Tilting angle measurement:

1. After the stage is completely level take a picture of the liquid on the substrate.
2. Next tilt the entire stage (usually around 5-10 degrees) using the Bubble Measure App.
3. Take another picture.
4. Repeat steps 2 and 3 until the liquid falls off.

Advancing and Receding angle measurement:

1. After setting up the device swap the regular 10 microliter syringe for the Threaded plunger pump syringe - 100 microliter.
2. To withdraw liquid, turn the syringe counterclockwise. Swivel the syringe to position.
3. Turn video capture ON.
4. Dispense the liquid by turning the syringe clockwise. Stop, when the contact angle does not change any more. This is the advancing contact angle.
5. While the syringe is still in contact with the liquid, the liquid is now withdrawn until the angle between the liquid and substrate is constant. This is the receding contact angle.
6. Turn video capture OFF. Capture frames from the captured video with the constant advancing and receding angles.

Note: Instructional video available at www.surface-science.com



Angle Measurement

1. There are three methods to measure the contact angle. Two methods are calculated at the smartphone. The third method is based on the Image J software, and the droplet pictures need to be sent to a computer where the analysis is performed. Of the methods calculated at the smartphone, the first method is based on the $\theta/2$ method, and the second is based on the automatic determination of the droplet boundary and fitting of the boundary to the Laplace equation.
2. The $\theta/2$ method uses the length of the base of the drop and its height to determine the contact angle. In the SurfTens app, tap on the $\theta/2$ method in the angle measurement step. Determine the two three phase contact points, and the top of the drop as instructed using the cross hairs. The horizontal and vertical lines of the cross hairs are moved by moving fingers along the edge of the screen. When satisfied with the placement of the cross hair, tap the contact angle button to reveal the measured angle. Save the angle under the filename.
3. The second approach calculated at the smartphone follows the well-known axisymmetric droplet shape analysis (ADSA) technique. From the angle measurement section, click on the ADSA method. Confirm that the boundary chosen is suitable. If not, choose the baseline by shifting the baseline using the cross hairs. When satisfied of the fit of the calculated equation, tap the finalize icon.
4. For analysis with Image J, send the picture over to a computer that has the application ImageJ downloaded. Using the Contact angle feature in Image J, find the contact angle.

Note: Instructional video showing each of the three methods of determining contact angle are available at www.surface-science.com



Error Resolution

If the steps in the above sections ended up in the failure follow the following steps:

- Determine which part of the assembly process or procedure process does not look correct.
- Proceed to then disassemble to one part back or go back one step in the procedure.
- Slowly reassemble using the directions once more
- If the problem reoccurs or there are missing parts contact: rushil.ganguli@gmail.com